

RICE

The main purpose is breeding rice varieties for high grain quality and yield as well as resistances to disease and insect pests. The first japonica rice Taichung 65 and the first indica rice Taichung (N) 1 developed through hybridization in Taiwan were released, respectively, in the early years of 1929 and 1956. The new variety Taichung 189 (japonica type), characterized by its good eating quality, high grain yield and resistance to blast disease, was released in 1984. The short-grain japonica type glutinous variety Taichung (gl) 70 and the long (indica) type glutinous variety Taichung Sen (gl) 1. were also released in 1984. Because of their good grain quality and high yielding potential, the acreage cultivated to these varieties is increasing rapidly. As for the non-glutinous indica varieties, Taichung Sen 3, Taichung Sen 10 and Taichung Sen 17 are the popular varieties released by this station.

In the past, experiments on cultural practices were mainly directed to spacing, fertilization methods, irrigation practices, ratoon techniques, etc. Recently, more emphasis has been laid on weed control, mechanized system of rice culture and the improved cultural techniques to raise the grain quality of rice.

1. Development of Rice Variety

Taichung No. 189 is developed by crossing Tainung No. 67 with Taichung No. 187. With the characteristics of strong culm, blast resistance, good rice quality, and stability in grain yield, it was named and released to the farmers on June 17, 1983.

Taichung Sen 3 is an indica rice developed in Taichung DAIS. A selection derived from the cross of Mean-don-chieh with IR-24. It was named and released in 1976. It was resistant to rice leaf blast and neck blast but susceptible to bacterial leaf blight.

Taichung Sen 17 is a newly developed indica rice from the crossing of Taichung Sen Yu 223 (♀) × IR 17488-2-2-1 (♂) and officially registered and released in 1984. This new variety possesses the characters of semi-dwarf type, erect leaves, resistance to lodging and high responses to N-fertilizer. It is a medium grain size and wider grain variety, with 33 gm of 1000-grain weight and 25.6 gm of 1000-total-milled-rice-weight that are heavier than those extension varieties such as Taichung Sen 3, Taichung Sen 10 and other varieties.

The provincial district yield trials conducted at 10 locations in 1983, showed that Taichung Sen 17 yielded 7058 kg/ha in the first crop and 6864 kg/ha in the second crop. The advanced yield trial of 1982 and 1983 showed an average yield of 7711 kg/ha in the first crop and 7587 kg/ha in the second crop. This variety is moderately resistant to leaf and panicle blast and bacterial leaf blight. It is highly resistant to brown planthopper. The degree of expansion, low gelatinization, high

amylose and hard gel consistency are the same as Taichung (N) 1.

Taichung Sen 10 is an indica variety with medium long grain. This variety was named in the 1st crop in 1979. It was resistant to rice blast and brown planthopper. Besides it showed very high yield performance, especially in the 2nd crop.

Taichung Sen 5 was an indica rice developed in Taichung District Agricultural Improvement Station by crossing Kaohsiung Sen-yu 12 (female parent) with IR 22 (male parent). It was named and released in 1977. It was resistant to rice blast and bacterial leaf blight.

Toyonishiki was a high and stable yielding japonica rice with several favorable characteristics such as early maturity, cold tolerance and good grain quality. It was suitable for rotational cultivation with some summer and winter catch crops, such as cantaloupes, pickling cucumber, vegetables, peas as well as various upland crops. It was also suitable for cultivation in the coastal areas for reducing the injury of monsoon.

2. Comparison of Rice Breeding Methods Between Pedigree and Single Seed Descent

The differences of grain yield among F_6 and F_7 lines were not significant when three methods were applied in both crosses. Grain yields of F_5 selected lines were similar between pd1 and pd2 methods, even with pd1 method, the F_5 lines were selected from the high yield lines of F_3 . Therefore no significant effect of selection was found in F_3 generation. This result concluded that there were no significant difference among the three selection methods. However, the SSD method saved labors and was found more efficient in the utilization of land.

3. Growth and Yield Components of High-Yielding Rices

Rice plant in the first crop was profited by its longer duration of growth and optimum temperature. So it has abundant number of tillers. However, the rice in the second crop was transplanted by the end of summer, thus its vegetative growth period from transplanting to panicle formation stage was just under the high temperature. The growth period of the second crop was hence shortened 29 days in Tainan 5 and 25 days in Taichung (N) 1. In the second crop, the elongation of stalk and leaf caused the reduction in the tiller per unit area for about 40%, and the reduction in panicles per unit area by 36% as compared with the first crop. The number of spikelets per panicle, percentage of ripened grains and weight of 1,000 grains in the first crop did not show better than in the second crop. These

phenomena suggested that 30% yield reduction in the second crop was mainly due to the less number of panicle per unit area. On the other hand, the plant morphological characters between the two crops also varied. The percentage of stalk weight to total dry weight of the second crop at ripening stage was higher than that of the first crop. Especially Taichung (N) 1 was highly significant. Moreover, the ratio of grain-straw of the second crop was lower than that of the first crop.

The net assimilative rate in the second crop was higher than the first crop before rice booting. Beyond the booting stage the first crop exceeded the second crop. On the other hand, the nutritional translocation of starch and nitrogen in the straw of the first crop and second crop was similar. The analysis of starch and nitrogen contents in straw at ripening stage revealed that the first crop was 8% and 21% higher than the second crop respectively. The grain starch of the first crop was 2% higher than that of the second. But the nitrogen content of the grain in the first crop was 2% lower than that of the second. The nutritional translocation in the second crop was very similar to the first crop.

4. Several Agronomic Traits and Adaptability of New Indica Rice.

To evaluate the agronomic traits and the adaptability of the new indica varieties of rice, 5 varieties were tested at 10 locations in 1983.

The result showed that Taichung Sen 17, Tainung Sen 19, Tainung Sen Waxy 2 and Taichung Sen Waxy 1 yielded higher than the check variety Taichung Sen 3 in the 2nd crop, and also in the 1st crop except Taichung Sen Waxy 1. A stability test indicated that the highest yielder Taichung Sen 17 showed a wide adaptability in the 10 sites tested.

Recently, the agronomic characters and pests resistance of the indica varieties have been improved in Taiwan. However the cold tolerance still need to be enhanced.

5. Use of Genetic Diversity in Rice Production with Special Emphasis on Pest Management

The present study was aimed to evaluate whether the disease epidemics of rice could be controlled or reduced by the method of "multi-variety" culture. The seeds from the three varieties, Tainung 67, Tainung 69 and Taichung 189 were mixed in different proportions to form several multi-variety blends and then planted in an experimental field. The degree of blast disease epidemics and grain yield etc. from

the mix-varieties were compared with the single-variety plantings. The competition of plant growth in terms of agronomic characters and grain yield, as well as blast disease infection was also studied.

The results of the multi-variety experiment indicated that the mixture of 1 part of Tainung 67 with 3 parts of Taichung 189 showed the best performance with respect to blast disease resistance and grain yield. The grain yield of mix-variety was 26-27% higher than that of single-variety culture. The results of the competition experiment also indicated that the plant height and the degree of blast disease infection were reduced when the varieties Tainung 67 and Taichung 189 were alternatively planted. The "cooperative effect" enhanced the number of tillers and grain yield in the blend of Tainung 67 with Taichung 189.

6. Breeding for Resistance to Several Biotypes of Brown Planthopper

The preliminary results indicated that Taichung Sen Shih 346, 348, 353, 356 and 358 were resistant to multi-biotypes of planthoppers and blast disease. The yields of the above selections were 6.3-16.2% higher than that of check variety, Taichung Sen 10, and 55.3-69.7% higher than that of Tainung 67. In addition, Taichung Sen Shih 353, 356 and 358 have good head rice (over 60%), low amylose, low gelatinization temperature, soft gel consistency, and good quality. Taichung Sen Shih 346 and 348 have high amylose (26-27%), intermediate to low gelatinization temperatures, hard gel consistency. It is good for rice products.

Taichung Sen Shih 329 has carried a recessive resistance gene *bph4*. Taichung Sen Shih 339 and 338 carried a dominant resistance gene *Bph3*. The yields of these selections were higher than the control Taichung Sen 10. In addition, they have several good agronomic characters, such as good rice quality, high head rice and cold tolerance. The elites of these strains showed the characters of high yielding, good grain quality, and resistant to several biotypes of brown planthopper.

7. Resistance to Brown Planthopper in Rice

Five indica varieties including two breeding lines, IR13539-11-1 and IR17488-2-2-1, introduced from the International Rice Research Institute and three local varieties, Taichung Sen 3, Taichung Sen 10 and Taichung Sen-yu 223, were tested for the degree of resistance to 5 biotypes of the brown planthopper. IR 13539-11-1 was found resistant to biotypes 1, 2, 3 and 5, but susceptible to biotype 4. IR17488-2-2-1 was susceptible to biotype 5, but resistant to the other 4 biotypes. Taichung Sen-yu 223 was resistant to biotypes 1 and 3 and Taichung Sen 10 moderately resistant to biotype 1 and resistant to biotype 2. Taichung Sen 3 was found highly

susceptible to all biotypes. These results coincided with the reactions of brown planthopper occurrence density under field conditions in Changhua county where biotype 1 prevailed.

The results from the F_1 and F_2 generations of the crosses between susceptible variety Taichung Sen 3 and resistant varieties/lines Taichung Sen-yu 223, Taichung Sen 10, IR13539-11-1 and IR17488-2-2-1 showed that the resistance to brown planthopper of Taichung Sen-yu 223 was attributable to a single dominant gene *Bph1^a*, which exerted its effect of resistance to biotypes 1 and 3. Taichung Sen 10 was resistant to biotypes 1 and 2 because of the recessive gene *bph1^b*. The IR13539-11-1 carries a dominant gene *Bph2^a*, resistant to biotypes 1, 2, 3 and 5. IR17488-2-2-1 carries a single recessive gene *bph2^b*, resistant to biotypes 1, 2, 3 and 4.

Bph1^a and *bph1^b*, also *Bph2^a* and *bph2^b* were respectively alleles.

8. Attributes of Hopper-Predator Community in Rice Field

A hopper-predator community in an experimental rice field was observed weekly with regard to information content (H'), formation of a geometric series or the grade of orderly distribution of component taxa (R^2), and clumping index (I). These community attributes changed with time in close association with one another, and attained the highest values around the heading time of the rice. Significant correlations were found between the density of prey and that of predators when a certain time-lag was assumed for the increase of predators.

9. Comparison of Four Brown Planthopper Biotypes and the Reaction of Several Rice Varieties

Studies were designed to compare the morphology, the ecology and the host preference of 4 biotypes of brown planthopper as well as the blast resistance of 10 rice cultivars.

Biotype 1 (reared on T (N) 1) plant hopper has the heaviest body weight and the longest body length. It gave symptoms on various rice cultivars. Biotype 2 (reared on Mudgo) was the most destructive colony although the hopper was the smallest and lightest among the 4 biotypes. Biotypes 3A and 3B (reared on H 105 and Samba, respectively) were the same colony. They showed the same reactions to selected rice cultivars and had similar ecology and morphology. The 3A and 3B showed the extension of nymphal duration, reduction of nymphal survival, as well as the nonpreference while they were reared on resistant varieties.

The reaction of resistance to 4 biotypes of brown planthopper in 10 rice cultivars was studied in green house with bulk seedling test. T(N) 1 and TKM 6 showed high susceptibility to all biotypes, while ASD7 and IR1541 were susceptible to 3 of them, except biotype 1. CNS X1, CNS XIII and Hsinchu-I-Geo-Gen were resistant to biotype 1 and biotype 2; nevertheless they were susceptible to biotypes 3A and 3B. Rice varieties derived from IR9-60, JP 5 and Mudgo were highly resistant to biotype 1, 3A, and 3B but susceptible to biotype 2.

10. Quality Classification of Taiwan Rice

Usually, rice grains were classified into three grades depending on the percentage of milled rice, grain appearance, cooking and eating qualities. However, so far the USDA standard was found not to be applicable in Taiwan. We, therefore, suggested that the category should include the percentage of head rice, translucency, white center, white belly, white back, amylose content and gel consistency. According to the suggested system, a total of five grades, has been developed. For the consideration of market, and price, however, a 5-10% difference for each grade seem to be needed.

11. Effects of Environmental Factors on Rice Quality

Rice quality is determined by the physicochemical properties of rice grain. The quality usually depends on grain appearance, milling rate, amylose, and protein content etc. These characteristics of rice are also influenced by the practices as well as the environmental factors during grain filling and storage. The relationship among environmental factors and the physicochemical properties of rice grain are discussed.

The percentage of rice grains invaded by insects and the discolored grains increased with the advancement of storage period, but the translucency of grain decreased. More rice grains were invaded by insects in pack than without it. The percentage of discolored grains was lower under non-packed than packed. Among the different types of grains, the highest percentage of grains invaded by insects and the discolored were found from japonica rice. But no significant difference of insect invaded grains was found between the two indica types. The least number of discolored grains was obtained from the long grain indica rice. The poor grain appearance and eating quality were found from short indica grain. And no significant difference was found between japonica and long grain indica. The percentage of milled rice was found slightly higher from japonica grain than indica grain. The results indicated that, except the percentage of milled rice, the rice quality of newly improved long grain indica variety can be kept as good as japonica variety.

12. Quality of Long Grain Rice

Since volume weight is negatively correlated with grain length, it is difficult to expect the long-grain rice to perform the originally stipulated volume weight of 532 g/dcm³. Judging from its similar milling rate to short-grain rice, the reasonable volume weight of long-grain rice for marketing should be adjusted to 512 g/dcm³.

The milling rate of long-grain indica rice was lower than that of japonica rice, Tainan 5, by 2.29%. However it was similar to that of short-grain indica rice. Its bran content was respectively lower than Tainan 5 and short-grain indica rice by 2.38 and 1.2%. It has high translucency, less abdominal white and heart white, medium or low gelatinizing temperature, and high protein content (9.27% in average). Besides, some long-grain indicas have high amylose content. The general quality of long-grain rice was superior to those of short grain indica and japonica rice.

Long-grain indica rice has low and high amylose varieties. The high amylose could be marketed at the same price with short grain indicas. The low amylose could be marketed about 2.29% lower than the japonicas.

13. Improved Method of Measuring Chalkiness and Translucency of Milled Rice

The degree of grain whiteness increased with the increase of sample size and the value became stable when sample size went up to 6.5 gram. The degree of whiteness was the value of reflection of grain chalkiness. The value was converted into the five conventional rating of white belly and white core of rice grain.

Six pieces of white plastic discs, 1 mm in thickness and 6 cm in diameter were inserted into the sample dish. The value of measurement (T) was confirmed to be the same value obtained from measuring the translucent part of rice kernel.

The result further confirmed, that the values of translucency and whiteness of rice kernel estimated by the above mentioned methods were reliable because it avoided vicious values of visible inspection.

14. Hot Water Treatments on Inhibition of Germination and Quality of Harvested Wet Rough Rice

Soak seeds in 75°C hot water for 30 seconds inhibited germination at three different moist levels under various piling periods. The 1000-grain weight of milled rice and the percentage of brown rice were slightly increased. However,

the percentage of head rice and broken kernels varied markedly with the rice varieties. The percentage of head rice from hot water treated Tainan 5 and Taichung Native 1 was only 50% of the nontreated, whereas no difference was observed in Kaohsiung Sen 1 and Chianung Sen 8. The cooking and eating qualities including gelatinization temperature, amylose content, and crude protein content of the tested varieties differed insignificantly when soaked in 70°C hot water and then piled for 3 days. Grain appearances, including translucency, white belly and white center, were unchanged after hot water treatments. But the color of the milled rice turned brown following the increase of water temperature or soaking time. The results indicated that the soaking of wet rough rice in 75°C hot water for 30 seconds, and piling for more than 3 days under room conditions were sufficient to inhibit germination and the rice quality maintains as good as the untreated rice.

15. Cropping Systems with Early Maturing Rice and Upland Crops

The conventional cropping frequency needs to be adjusted to two or three rice crops followed by a winter catch crop in a year in central Taiwan. The experimental results indicated that planting three crops of early maturing rice increased 33.4% and 24.3% in total production as compared with the system with two rice crops, Tainan 5 and Taichung Sen 3. The data also showed that the production value by planting two early maturing rices followed by one corn or soybean increased by 14.8% and 12.6% as compared with two crops of Tainan 5. However, if the variety Tainan 5 was replaced by Taichung Sen 3, the total production value only increased 6.9% and 4.9%. General conclusion may be made that the farm income can be increased by growing three crops of ordinary rices or two crops of early maturing rices followed by one crop of corn or soybean.

16. Development of Nursery Plate for Mechanical Transplanter

Experimental results indicated that a mixture of the crushed rice husk with peat and pulp subjected to the dry condition to form as nursery plate can be used to replace soils for growing normal seedlings. The nursery plate was 1.3 cm in thickness, 550g in weight, 5.7 in pH value, and 10.2% in water content. The materials and weight of nursery plate were cheaper and lighter as compared with the original seedling plates. Better seedlings were obtained from the seeds embedded in the nursery plate under wet condition and then heated up to 70°C in 12-48 hours.

The results showed that high percentage of germination can be obtained by embedding the seed in the nursery plate and stored up to 90 days.

17. Yield Improvement for the Second Crop of Rice

The low yields in the second crop of rice in Taiwan differed with locality, variety and cultural practices. It was generally known that the improved varieties are more adaptive to the environmental conditions of the second crop season and the improved cultural technique may also help increase the grain yield in the second crop for these varieties. The varieties with high response to N-fertilization and lodge-resistance were recommended for the second crop season in Taichung district. Increasing planting density in order to obtain a higher number of panicles per unit area was also effective for increasing the grain yield in the second crop. Other practices such as proper irrigation, drainage, and disease and insect-pest control were all important to enhance the yield. Proper drainage was critical in the ill-drained area. Prevention of high reduction and accumulation of toxic substances caused by the decomposition of organic matter in the soils are also very important. Selection of semi-dwarf indica rices for the second crop were also recommended. Monsoon damage to the second crop in the west coastal area was reduced by planting early-maturing varieties. Shortening the growth duration of the second crop by ratoon culture was helpful because the monsoon damage at ripening period can be minimized. Good windbreaks was also very important for preventing monsoon damage to secure higher grain yields in the second crop.

18. Minimum and Zero Tillage in Paddy Rice Production

An average of 2.0 per cent missing hills per hectare was recorded in zero tillage plots. It was more difficult and more time consuming to transplant in the zero tillage plots than in the minimum and conventional tillage plots. Combinations of Glyphosate followed by Paraquat gave better effect in controlling weeds than a single application or mixtures of those herbicides. Among the chemical combinations, Glyphosate applied at 1.5kg/ha 7 days before planting followed by Paraquat at 1.0kg/ha 3 days before planting or Glyphosate at 1.0kg/ha 7 days before planting followed by Paraquat at 1.5kg/ha 3 days before planting were most effective in controlling weeds in both transplanted and broadcast-seeded rice. The amount of nitrogen uptake at all growth stages of transplanted and broadcast-seeded

rice was greater from minimum and conventional tillage than from zero tillage plots. In the experiment involving the substitution of herbicides for land preparation in transplanted rice, Glyphosate sprayed at 2.0kg/ha 7 days before transplanting followed by one plowing 2 days before transplanting, chemical combinations such as Glyphosate at 1.5kg/ha 7 days before transplanting followed by Paraquat 1.0kg/ha 3 days before transplanting, or Glyphosate at 1.0kg/ha 7 days before transplanting followed by Paraquat at 1.5kg/ha 3 days before transplanting, gave grain yields similar to the standard one plowing followed by two harrowing treatments. In broadcast-seeded plots, conventional tillage method gave higher grain yields than all chemical treatments.

19. Improvement and Production of Rice

Rice is the most essential crop in national agricultural development. Paddy rice always ranks first in both production value and production hectareage. The production of rice in the past 30 years has increased more than 3.5 times. The contributive factors to the improvement of rice production were as the following: 1) The success of "Rural Land Reform Program" has raised the interest of farmers, and resulted in higher crop yield and better income. 2) "Farm Land Consolidation Program" has led to highly efficient utilization of farm land. 3) A number of new rice varieties of both japonica and indica type have been developed through breeding programs. 4) The improvement of rice cultural methods to increase yield were practical and fruitful. 5) The proper application of chemical fertilizers and pesticides are the two major factors that has helped increase the rice yield. 6) The rapid development of rice mechanization has led to a new phase which has ended the era of labor slack production. 7) Proper flood prevention and adequate irrigation/drainage systems has provided a good guarantee to the success of rice. 8) The expansion of agricultural extension service has led to the efficient utilization of natural resource and modern technology.

20. Possibility of Non-Tillage Rice Cultivation

Application of Paraquat at the rate of 2.0 kg/ha as a substitute for land preparation resulted in more missing hills than in ordinary tillage plots. Experimental results also indicated that there were many missing hills in the continued non-tillage plots. The highest percentage of missing hills per hectare in the non-tillage treatment were 12.9% in the second crop. The transplanting depth of seedling and

number of seedlings per hill was not affected by the transplanter in the non-tillage treatment. In zero tillage plots, perennial weeds can be controlled thoroughly by land preparation in the previous crop. In the first crop high grain yields were obtained from the zero tillage plot applied with 20% additional nitrogen fertilizer. In the second crop grain yields in the ordinary plots were significantly different from other treatments. However, grain yields were not significantly different among non-tillage treatments. Lower grain yield in the plots of continued non-tillage was rather frequent due to missing hills.

These results suggested that non-tillage technique might become an alternative to conventional land preparation. However, the problem of missing hills in the non-tillage plots should be improved.

21. Tillage and Non-Tillage Cultivation on Crop Yields and Soil Fertility in Paddy Field

The pH values in the 0-5 cm and 15-30 cm soil layers and the available K in the 0-5 cm soil layer were not different among the 9 rice cultivation methods. No significant difference in available P content of the soil layers of 5-15 cm and 15-30 cm among the treatments were observed. However, the amounts of organic matter in the 0-5, 5-15 and 15-30 cm soil layers and the available P content in the 0-5 cm soil layers were significantly higher in the treatments where the 1st crop of rice was directly seeded. The pH values in all three layers were significantly lower in the treatment where corn was planted as winter crop. The amount of available K were significantly higher in the plots planted to corn than planted to wheat or lying fallow, however. The total grain yields of the 1st and 2nd crops were significantly higher in the treatments where the 1st crop of rice was transplanted after tillage with any kind of cultivation methods adopted in the 2nd crop. The total grain yield was the lowest in the treatment where two crops of rice were all directly seeded without tillage. The rice yield was also significantly lower in the treatment where wheat was planted as winter crop. The grain yields of wheat and corn differed significantly among 9 different cultivations. In other words, the grain yields of wheat and corn were not affected by the cultivation methods of the two preceding rice crops.

22. Improving the Efficiency of Nitrogen Fertilizer in the Flooded Paddy Soil

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 applied 60% of standard rate of nitrogen fertilizer in mudball or tissue paper were as high as control. Higher number of panicles per hill resulted in the high grain yields of the mudball or tissue paper treatments notwithstanding the decreases of other yield components. The surface broadcasting of nitrogen fertilizer caused much loss and thus needed more nitrogen fertilizer to achieve good yield as compared to the mudball or tissue paper treatment. One split of nitrogen fertilizer applied at panicle initiation stage was the key factor for this treatment to obtain more grains per panicle. The grain yield of SCU treatment was only similar to that of urea broadcast at the same rate in 4 splits, and that of IBDU treatment was significantly lower.

23. Effects of Nitrogen Application on Rice Milling Quality

Nitrogen treatment had significant effect on milling quality, especially affected the head rice percentage. Harvest moisture which related to head rice percentage was affected by nitrogen application. The 100 kernel weight tended to be negatively correlated with head rice. However the percentage of head rice was more affected by nitrogen dose than by 100 kernel weight. The difference of milling quality between varieties Earlirose and M101 was nonsignificant.

24. Effects of Nitrogen Fertilizer and Delaying Harvest on Recovery Rate of Ratoon Rice

Applying 25% additional nitrogen fertilizer at the yellow maturing stage of Taichung 67, a japonica rice, helped induce enough ratoon tillers at harvest. Without applying the nitrogen fertilizer, the plant extended at least 10 days later to obtain the same number of ratoon tillers. Before the emergence of the ratoon tillers, the new roots did not well generate. If rice was harvested at this stage, the stubbles would easily die. However, those plants harvested after the emergence of ratoon tillers, new roots developed simultaneously. Therefore, the stubbles regrew easily and a high recovery rate was obtained.

Application of 50% additional nitrogen fertilizer for the ratoon rice, was helpful to get higher grain yield as compared to the conventional transplanted method in the first crop. Since ratoon rice is easily susceptible to transitory yellowing and yellow dwarf, virus vector control of leaf hopper should be started from the previous rice crop.

25. Principles and Methods of Seed Test

Purity analysis: The object of the analysis was to determine the composition by weight of the sample being tested. Therefore the sample should be separated into the following components: pure seed, other crop seed, weed seed and inert matter. The definition of each component was strictly defined in the International Rules for Seed Testing.

The germination test: The objective of germination test was to obtain information to field planting. Test undertaken in field conditions was usually unsatisfactory, as the results was not reliable. Laboratory methods have, therefore, been evolved and the out door conditions were imitated to give a normal, rapid and complete germination. The definitions of germination, and normal seedling were prescribed in International Rules for Seed Testing.

Methods for breaking seed dormancy: When fresh ungerminated seeds remain at the end of the test period, requested tests would be carried out by applying one or several of the following treatments: (1) Prechilling (5-10°C) (2) Predrying (40°C) (3) Potassium Nitrate (0.2% KNO₃) (4) Low temperature germination (5) Pre-washing and (6) Plant hormone (GA).

Test duration: Time varied from 6 days to 70 days (tree seed) depending on species. Tests may be terminated prior to the prescribed time when the result was satisfactory.

Biochemical test: Species normally germinated slowly or dormant in the test. Biochemical tests (Tetrazolium test) shall be applied to determine the quick viability of seed samples (especially tree seed).

26. Grain Yield and Growth Behavior Affected by Seedling Age and Plant Spaces

Rice seedlings that had been seeded at the same date but transplanted at different time significantly affected the grain yield. Transplanting with 65 day-old seedlings in the first crop resulted in grain yield decreasing by 17-34% as compared to the traditional 25 day-old seedling treatment. Seedlings of 45-day-old transplanted in the second crop reduced grain yield by 10-20% than 15 day-old seedlings. In the first crop, grain yield reduced 2-12% by planting 65 day-old seedlings as compared with conventional 25 day-old seedling seeded at different date but transplanted at the same age. The highest grain yields were obtained from the plots transplanted with 45 day-old seedlings in the first crop, and with 30 day-old seedlings in the second. Grain yields were significantly affected among rice varieties subjected to the various seedling ages. In the transplanting with old seedlings of

indica variety, the grain yields were slightly decreased. However, the early maturity varieties were significantly decreased in grain yield while the old seedlings were grown. The low grain yield of early maturity variety by using old seedlings was attributed to the abnormal heading of rice resulted in low grain number per panicle. The grain yield of old seedlings can be improved with close plant spacings.

Growth duration was greatly affected by seedling age. In the second crop, irrespective of seeded date and transplanted time, the growth duration of rice crop shortened 8-11 days with old seedlings. In the first crop, old seedling transplanting at the same time shortened the growth duration for 6-9 days. However, if the old seedlings were transplanted at the growth period it shortened 9-30 days as compared to the young seedlings.

These results suggest that transplanting healthy old seedling of indica variety at close spacing may be considered as an alternative of using young seedlings.

27. Agronomic Practices Related to Bud Sprouting, Growth and Grain Yield of Ratoon Rice

Grain yields of ratoon crop were significantly different among tested varieties. The yield performance was mainly dependent on the ratooning ability, and also water management. Drained surface water from milky stage to harvest of the main crop inhibited ratoon bud sprouting. On the other hand, continuous flooding at late stage favored ratooning. Hence, the yield from flooded plots were significantly higher than that of surface drainage plots. The required labor for ratoon crop was 38 percent less than that of transplanting. The labor was mainly saved from raising seedlings, land preparation, and transplanting to paddy field. The ratoon rice saved 22 percent production cost and increased the net profit by 16.5%. The ratooning ability was affected by the harvest time of main crop. However, it varied with varieties. For good bud sprouting, variety Taichung Sen 3 should be harvested at 33 days after heading (DAH), and Tainan 5 at 38 DAH. The height of main crop stubbles significantly influenced the grain yield of ratoon rice. The highest grain yield was obtained from the stubbles of 15 cm and cut back to 3 cm, while newly grown ratoon tillers were 15 cm tall. This treatment gave uniform sprouting and heading. The grain yield increased by 13.6 percent, while the rate of nitrogen increased from 80 to 110 kg/ha. Deeply buried nitrogen at 10 cm under field surface increased ratoon yield by 16.7 percent. The plant leaves in these plots remained dark green until maturity. Ratoon ability were found significantly correlated with carbohydrate content in the basal part of culm during maturity.

28. Improvement of Second Rice Crop in Southern and Central Taiwan — Methods for raising rice yields in the ill-drained area in the west coast of Changhua Hsien

This project was aimed to elucidate the possibility of increasing the rice yield of the second crop through various experiments and demonstration of varietal adaptability and cultural practice. The results are as follows:

1. Varietal adaptability in ill-drained areas: eighteen rice varieties/lines were tested in the first and second crops of 1975. On the average the well-drained yielded 6.5% more than that ill-drained in the first crop and 3.4% more in the second. The high yielding varieties/lines which exceeded Tainan 5 were Taichung Sen 3, Taichung Sen-yu 193 and Chianung Sen Selection 8 in the 1st crop and Taichung Sen 3, Taichung Sen-yu 191, and Chianung Selection 8 in the second crop. Indica rice adapted better than japonica to ill-drained soil.

2. Effects of percolation, drainage, and organic matter: broke hard-pan by subsoiler increased the rate of percolation from 1.5 mm/day to 4.0 mm/day in Homei silt-clay soil. Timely drainage tended to accelerate rooting and tillers but inhibited plant height, thus minimized lodging. Finally, the timely drainage yielded markedly more than continuous flooding. Incorporation of rice straw gave poor growth and yielded less than compost.

3. Effects of deep plowing, fertilizer response and drainage: plowing to 18 cm deep and incorporating optimum rate of N-P-K fertilizers with timely drainage gave the best yield as compared with those plots plowed to 12 cm and 24 cm deep with 25% more N-P-K fertilizers.

4. Varietal adaptability in the west coast: long-grain indica varieties/lines gave higher yield than early and ordinarily maturing rices of japonica type in both crops. Among them Taichung Sen 3 (Taichung Sen-yu 195), Chianung Sen Selection 8, Chianung Sen 11, Taichung Sen-yu 191 and 194 showed better in the first crop whereas Taichung Sen-yu 189, 194, 195, and 191 yielded higher in the second crop.

5. Optimum date of planting in the west coast: in the first crop the optimum date of transplanting was from March 10 to 20 using 45 day-old seedling. The transplanting of young seedling too early caused cold wind damage, whereas transplanted too late yielded low. In the second crop, early transplanting crop yielded high. The optimum date of transplanting was prior to July 15. Seedlings transplanted later than the above date showed lower yield due to strong salty wind prevailing in the west coast during the later part of growing season.

6. Effects of wind-break in the west coast: beef-wood (*Casuarina equisetifolia* F.) was the best wind-break against salty wind in the second crop, followed by Miscanthus grass (*Miscanthus japonicas* A. Honda) or fenced with straw. Salty wind damage was less significant, as paddy field was farther than 500 meters from the coast. The protected distance of wind-break was about 5 times of the height of wind

break.

7. Improvement of drainage system: a total of 3300 meters drainage canal was enlarged from 1.5 meter wide to 2.5 meters, and from 1 meter deep to 2 meters. The duration of flooding was then shortened from 3 to 1 day.

8. Drainage demonstration: a total of 10 ha was adopted for the demonstration of timely irrigation and drainage in the second crop. The result showed a 18% increase in grain yield.

29. Methods for Raising Rice Seedling for Power Transplanter

A. Protection against cold temperature and the materials for raising seedling and their effects on the seedling growth:

- (1) The temperature of the soil and rice-hull in the woodbox or woodframe increased 2.17°C when covered with PVC-paper in the open field. The differences were great at 2 : 30 p.m. and less at 8 : 30 a.m. Covering 2-layer-PVC-paper gave higher temperature than 1-layer did. The green-manured bed similar to the rice-straw one in increase of temperature, particularly in the afternoon, showed the highest temperature among the all treatments. In the wood box the temperature of rice-hull was higher than that of soil. The woodframe stuffed with soil and bottomed with PVC-paper on soilbed showed less fluctuation in temperature than the woodbox did. Covering PVC-paper prevented cold injury and might be used for replacing the high cost growth chamber with steam-or electric-heater.
- (2) The cost of material of woodframe for raising seedling was only one-fourth of the woodbox. Moreover, in field operations and storage, the former was much simpler and easier. As to its effect on seed germination and seedling growth it was the same as woodbox.
- (3) The growth rate of seedling in height was significantly correlated at 1% level with soil temperature either in the morning or afternoon. Increasing soil temperature also showed increase in leaf-width and leaf-age. The seedling growth in rice-hull did not show so markedly as in the soil in correlation with temperature. The soil treatment gave better and more uniform growth of seedling than that of rice-hull. Drilled in PVC-groove with soil showed better growth of seedling in early stage but poorer in later stage. Covering 2-layer-PVC-paper gave the best growth in height, leaf-width, and leaf-age followed by 1-layer and no covering was the worst. However, the trend was not identical in number of roots. Top-dressing on rice-hull gave better seedling growth than without top-dressing. The seedling of Taichung (N) 1 showed more vigorous germination and growth than that of Tainan 5.

B. Varietal response to rates of fertilizers for raising seedling:

- (1) The same as in the previous experiments, the seed germination rate and seedling growth in the soil were obviously better than in the rice-hull.
- (2) The seedling growth increased with the increase of N-P-K fertilizers from 0-0-0 to 12-12-6 gms/box in dealing with Taichung Sen 2 and Tainan 5. However, in Taichung (N) 1 and Taichung 186 the maximum growth peak only went up to 8-8-4 gms/box. As far as the growth appearance was concerned, the proper rate of fertilization for soil for raising healthy seedling was 8-8-4 gms/box. Over the rate tended to have looping, soft, and juicy leaves that was apt to cause leaf blast and bacteria sheath blight. However, in case of rice-hull there was a linear effect of N-P-K fertilization on seedling growth from 0-0-0 to 12-12-6 gms/box.
- (3) The indica varieties Taichung (N) 1 and Taichung Sen 2 showed earlier germination and faster growth of seedling in early stage, but surpassed by japonicas Taichung 186 and Tainan 5 under PVC-paper covering. It seemed that the indicas were more thermo-sensitive than the japonicas.

C. Effects of Tachigaren and fertilizers application on seedling growth in rice-hull:

- (1) Tachigaren diluted from 1ml to 375ml/box markedly depressed germination, growth rate of rice plants and elongation of radicle, but hastened leaf-age. However, over 20 days after sowing it tended to accelerate the growth of rice plants, activity of secondary roots, root number and dry matter weight in comparison with control. In appearance, the Tachigaren treated seedling in later stage tended to have root systems of white, crooked, coarse, and branched and able to stand against cold weather, drought, and water submerging. There was no symptom of damping-off either in the treatments with or without Tachigaren since the daily air-temperature was higher than 18°C .
- (2) The soil mixed with 8-8-4 gms/box of ammonium sulfate, calcium superphosphate, and potassium chloride was the best in seedling growth as compared with either rice-hull mixed with 8-8-4, 12-12-6, and 16-16-8 gms/box of the same fertilizers or dipped in the same rate of fertilizers solution or even as high as 20-20-10 gms/box of fertilizers. The seed germination and seedling growth in rice-hull were extremely uneven and slow especially when the rate of fertilizers was increased and mixed with 500 gms/box dry-soil and rice-hull.
- (3) During this experiment the PVC-paper was used for protecting against cold and there was cold spell rather than warm climate. The seedling growth of Taichung (N) 1 was faster than that of Tainan 5.

D. Methods of fertilizer application in rice-hull to seedling growth:

- (1) Mixing 8-8-4 gms/box of ammonium sulfate, calcium superphosphate, and potassium chloride fertilizers with soil before sowing gave the best germination and growth of seedling as compared with two times of top-dressing and without fertilization. Top-dressing of P and K fertilizers was harmful to seedling growth. Treatments differed in height was markedly observed 15 days after sowing and maintained up to 32 days. However, the differences in leaf-width among treatments were only seen at 15 days observation.
- (2) The seed germination and seedling growth in early stage was faster in Taichung (N) 1, but exceeded by Tainan 5 in later stage except root number and leaf-width.

E. Rates of soil and seeding and soil-press to seedling growth:

- (1) Increasing the amount of soil in the seedling box tended to accelerate the growth rates of height, leaf-width, secondary root length, and root number. The proper amount of semidry soil in the seedling box was about 4.5 kg/box.
- (2) Soil without press before sowing showed better germination and growth of seedling in the early stage but no difference in the later stage.
- (3) Higher rate of sowing tended to produce slender and thin seedling but more number of roots and less dry-matter weight.
- (4) Tainan 5 showed better growth in height, leaf-age, root length, and dry matter weight but narrower leaf and less root number.

F. Rates of seeding to seedling growth in broadcast:

- (1) Increasing the rates of seeding tended to depress the increment of dry matter weight but slightly accelerate the growth in height and leaf-age.
- (2) Tainan 5 was more sensitive to the density of sowing when the rates were increased from 150 to 300 gms/box.
- (3) In order to maintain the proper number of seedlings per hill to be transplanted by machines the proper rate of seeding at 180 gms/box for Yanmar and 220-250 gms/box for Iseki, Michubishi, and Kubota are recommended.

30. Introduction to Field Inspection Methods of Seed Multiplications

The present regulations govern the certification of the following crops: rice,

sweetpotato, peanut, soybean, wheat, sorghum, corn, barley, rape, cotton, jute, flax, kenaf and vegetables. All registered crop varieties are subjected to certification for seed multiplication.

The purpose of field inspection is to examine the phenotypic characters of the crop and purity in the field, and to assess and determine the number of weeds, isolations and the disease infection of the seed farm.

Field inspectors will examine the seed plot of all levels. No laboratory seed testing will be made, until the field inspection meets the standards.

Standards for field inspection:

A. Ponlai rice:

(1) General standards:

- (a) One variety only shall be grown on one seed plot.
- (b) Seed farms shall be established on sites where no rice was planted during the previous two crops, except that the same variety was planted in the previous season.
- (c) Isolation between seed farms of different varieties shall not be less than 3 meters.
- (d) Contract seed growers shall have, at least, five years' experiences in rice cultivation with good reputation and have a concrete drying ground and proper seed cleaning and storage facilities.
- (e) A signboard shall be erected on the farm showing:
 - (i) crop season, (ii) kind of seed farms, and crop kind, (iii) names of the varieties and the growers.

(2) Specific standards:

Item	Foundation seed farm	Stock seed farm	Extension seed farm
Other varieties (max.)	None	None	None
Barnyard grass (max.)	None	None	10 plants/ha.
Other objectionable seeds	None	None	100 plants/ha.
Seed-borne diseases and diseases affecting seed	None	None	None

B. Hybrid corn:

(1) General standards:

- (a) At least 3 field inspections shall be made on all classes of seed farms.
- (b) Isolation area for two different classes of seed farms shall not be less than 300 meters.

(2) Specific standards:

(a) Inbred lines: The percentage of off-type plants shall not exceed 2%.

(b) Single cross farms:

(i) The percentage of off-type plants shall not exceed 2%.

(ii) Detasseling of female plants shall be completed before shedding pollen. Field inspection shall be made twice successively when the female plants have 5% or more receptive silks. The total non-detasseled female plants of the two inspections shall not be more than 2.5%.

(c) Double cross farms:

(i) The percentage of off-type plants shall not exceed 0.1%.

(ii) Detasseling of female plants shall be completed before pollen shedding. Field inspection shall be made twice successively when the female plants have 5% or more receptive silks. The total non-detasseled female plants of the two inspections shall not exceed 2.5%.

31. Effects of PVA and PVC Materials on Raising the Rice Seedling of the First Crop

The temperature under NB50N film covering was 1.5°C higher than under PVC when covered in the night. In the daytime, however, the former was 1-2°C lower than the latter under the cloudy day and 0-3°C higher under the sunny day. The tunnel shaped covering increased 2-5.5°C as compared with the flat covering on the seedling. The highest temperature was seen in the treatment of PVC and NB50N in tunnel showing the extreme of 34.9°C in cloudy day, and 47.5°C in sunny day. The ST3800S, having 45-50% of shading, showed nothing for increasing temperature, but was effective for buffering the rapid changes of temperature. The range and c.v. between treatments increased with the increase of temperature.

Both materials of NB50N and PVC markedly increased temperature and hastened the growth of seedling. However, over-temperature (40°C) seemed to overturn the assimilation-respiration rate from positive to negative, resulted in leaf burn and the decrease of dry matter weight. The temperatures were positively correlated with seedling height and negatively with dry matter weight but had nothing to do with the leaf-age. The highly significant affection of the materials on the dry matter weight of rice seedling indicated that the soil was much better than the seedling plate. The seedling raised by soil was less sensitive to temperature fluctuation than by seedling plate.

The rice seedling in the covering treatments in which the temperatures exceeded 40°C showed the symptoms of leaf burn. The degree of leaf burn was apparently influenced by its extreme temperature; the higher the extreme temperature the more serious the seedling showed the symptoms of leaf burn. TN 67 was more sensitive to extreme temperature and heat injury than TCS 3. Seedling raised by plate was more resistance to high temperature than by soil. It was attributed to the better aeration of plate material and root system. Flatting material on the seedling caused mechanical damage to the leaves during the strong monsoon prevailing in the nursery stage of the first crop of rice. TCS 3, having thinner blades, was easier to be damaged as compared with TN 67. However, no mechanical damage was seen in tunnel coverings.

32. Effects of Covering Materials in Preventing the Heat and Rain Damages to the Seedling for the Second Crop of Rice

The directions of tunnel shaped covering materials, either east-to-west or north-to-south, did not show any difference to heat-stress and rain-erosion. The silver tafbell (ST3800S) in E-W direction, however, was better in ventilation to the north-to-south, thus, showed a little effect in lowering temperature. The PVC film had the virtue in preventing rain-erosion but was apt to raise temperature to cause seedling necrosis.

Since ST3800S has proper ties for shading and reflecting solar radiant for 45-50%, it was able to bring down the temperature for 1.5 to 7.8°C in torrid noon-time, and particularly capable of accelerating seedling growth at initial stage but gradually become obscure in later stage. Flatting nylon net on the nursery did not depress the temperature, but minimized rain-erosion. The transparent natural belltef (NB50N), having the similar virtue in increasing temperature as PVC film, was only effective in serving protection to seedling from rain-erosion. The temperature of the nursery under its covering often reached as high as 60°C to cause serious necrosis of seedling. Therefore, ST3800S as well as PVC films were only suitable to be used in the first crop of rice.

The growth of seedling, age and dry weight in the second crop was highly negatively correlated with the temperature over 40°C. TCS 3 was significantly more tolerant to torrid temperature and better in growth than TN 67.

33. Rice Cultivation in Northern Iran: Effects of Rice Planting Date

The results strongly suggested that the earlier the sowing time, the higher the grain yield. Variety Meher sown on March 25 and transplanted on April 18 was ready for harvest on August 25, and yielded 1.1 t/ha or 20.6% more than that sown one month later. Taichung 65 sown on March 25 and also transplanted on April 18 gave 0.84 t/ha or 12.4% more than that sown one month later. In pilot rice farm, Meher transplanted on June 20 yielded 1.6 t/ha or 37.7% less than that transplanted one month earlier. The pooled analysis of correlation between grain yields from two experiment farms and Pilot Project was highly significant. The negative regression coefficient at 59.4 kg/ha/day in reduction of yield was found in delayed planting. In the extension farm, Meher planted in early-mid May outyielded those planted in early-late June by 1.5 t/ha or 29.1% under the same rate of N-fertilizer.

The early sowing tended to inhibit the plant height but accelerated the increase in tillers, the panicles per unit area, and the number of grains per panicle. In pilot rice farm and extension farms, Meher transplanted in June showed yield reduction mainly due to bad weather at ripening stage. Thus, the unfilled grains increased and the grain weight reduced. The result suggested that rice in this area should be seeded as early as possible under cold protected nursery.

34. Rice Cultivation in Northern Iran: Water management of lowland rice

The purpose of this experiment is to compare the effect of water managements scheme on rice growth, yield and water consumption.

The best treatment was the continuous flooding to heading interposed with 5 days' drainage each at 10 and 25 days after transplanting, and 10 days' drainage each before panicle initiation and heading, and further with weekly irrigation after complete heading. Irrigation with timely drainage during the vegetative stage was much better. The treatment increased 6.1% grains and saved 26% water as compared with continuous flooding, being 565 mm vs 759 mm per crop season. The response of rice growth to various water treatments in Taichung 65 was more sensitive than in Meher. Taichung 65 was more beneficial by irrigation with timely drainage, but more easily injured by drought than Meher. Meher, was a leafy variety of lower yield. It consumed more water per kilogram of grain or 1.09 m³/kg than Taichung 65, with 0.69 m³/kg. Irrigation with timely drainage was helpful for soil aeration, thus resulting vigorous rooting activity, tillering ability and grain increase.

35. Rice Research and Prospect of Rice Production in Arid Regions of Saudi Arabia: First trial of double croppings in Gassim

In 1978, the first trial of double crops of rice in Saudi Arabia was made with three long-grain indica varieties. One was local Amberbook and the other two from Taiwan, NTU and Sipi (used in the spring only). These varieties were tested with 4 dates of sowing/transplanting, starting from January 30 to February 26 at 10-day intervals, as the spring crop. And, 5 sowing/transplanting dates, from May 30 to July 30 at 15-day intervals as the summer crop, in a sandy clay soil of Prince Naif's farm in Gassim basin of Saudi Arabia.

From the spring experiment, it was found that rice yield was the highest in February 2 seeding, 5.00 t/ha in Amberbook and 8.43 t/ha in Sipi. The variety NTU gave the highest yield of 10.32 t/ha seeded on February 16, however.

Too early planting plots suffered from serious cold damage in seed-beds and in the early growth stage after transplanting. Late planting reduced tillers and grain yield.

(1) The summer experiment showed that the earliest planting yielded the highest, variety Amberbook was 4.88 t/ha and NTU 7.25 t/ha.

(2) The optimum seeding time was before early June, using 20-day old seedlings.

(3) Late plantings suffered from cold injury after October. Double cropping rice on the same land in Gassim is not practical due to the constraint of weather. Amberbook is suitable for late spring and/or early summer cultivation, while NTU for spring cultivation.

36. Studies on the Yield and Yield Components of Rice under Different Environmental Conditions

I. On the duration of flower-bud formation and young panicle development under different conditions in rice

The process of flower-bud formation and young panicle development of rice was studied under the conditions of different varieties, crop seasons, locations and methods of fertilizer application. Twenty one developmental stages of young rice panicles reported by Matsushima and Manaka were identified and thoroughly described after the detailed microscopic studies.

In the first crop, the panicle differentiation begins 47 days after transplanting in Taipei (45 days in Chiayi) and is completed in 35 days (36 days in Chiayi). In the second crop, the young panicles begin to differentiate 16 days earlier than those of the first crop. Duration of panicle formation in the second crop is 38 days in Taipei (Northern Taiwan), and 33 days in Chiayi (Central Taiwan). It was noticed that the growth period of young panicle differed according to different tillers within a plant.

The high correlation coefficients ($r=0.80-0.90$) between growing date and

developmental stage of the young panicles indicated that the growth of young panicle is in parallel to the growing days. No marked difference in the mean values of developmental stages of young panicle due to spacings was noticed.

37. Studies on the Yield and Yield Components of Rice under Different Environmental Conditions

II. On the relation among leaf-age index, number of tillers and the stages of young panicle development in rice.

- 1). Four varieties of rice, Taichung 65, Chianung 242, Taichung (N) 1 and Tsai-yuan-chung were planted at Taipei and Chiayi to study the relations among young panicle length, young panicle developmental stage, leaf-age index and tiller numbers so that to identify the reliable indicators for determining the time of fertilizer application. Three different methods of fertilizer application and three planting densities were used.
- 2). It was observed that in the first crop at Taipei, leaf-age index at the panicle neck differentiation stage was 77, that of the branch differentiation stage was 78-87, that of the spikelet differentiation stage was 84-91, and that of the end of panicle pregnancy period was 98-100. The leaf-age index was considered to be a good indicator to determine the right time for top dressing of fertilizers.
- 3). When the young panicles reached branch differentiation stage (IV-VIII), the tillering reached its maximum, and approximately 5-7 days after the maximum tillering stage, the young panicle increased its length to 2-5 mm. This was considered to be a good time for the application of "panicle fertilizer".
- 4). Correlation coefficient between number of tillers and young panicle length is $r=0.837-0.880$, that between number of tillers and growing date is $r=0.443-0.521$. Tiller number can also be served as an indicator to determine the developmental stages of young panicles.
- 5). The maximum tillering stage was found to correspond to the leaf-age index of 70 in the first crop at Taipei, and 70-80 in the first crop at Chiayi. Correlation coefficient between leaf-age index and tiller number was $r=0.98$.
- 6). The distance between the auricles of the flag-leaf and that of the immediate lower leaf was also a good measurement to identify the different developmental stages of meiosis and young panicles, though it may vary according to varieties, planting densities and locations.
- 7). The effectiveness of the splitted way of fertilization to bring about the high yield of rice was discussed.

38. Study on the Genotype Variation and the Standardization of Embryonic Rice

The purpose of present studies is to set up the standard of embryonic rice and also to screen the suitable varieties for the embryonic rice processing.

The results indicated that tested varieties differed significantly in the percentage of residual embryo of milling rice. Toyonisiki is the best one for embryonic rice processing, Tainung 67 and Taichung 189 followed after it. Indica varieties are reversely. Generally, a variety with more short, wide and thick grain was more suitable for embryonic rice processing. The results suggested that the standard of embryonic rice should have more than eight degrees of milling whiteness than its brown rice and at least 70% of embryo left in the milling rice.

39. Variations in Ratooning Ability of Rice

One hundred and sixty three varieties of rice from different countries were evaluated for varietal difference in ratooning ability. The results indicated that the ratooning ability ranged from 0 to 122.9%, or differed from variety to variety. The indica-type (or Sen-type) varieties showed a higher (29.0%) ratooning ability than that of japonica-type (Ken-type) varieties (19.5%).

Broad sense heritability, estimated from various variety groups, ranged from 11.18% to 60.17% for ratooning rate and from 0 to 81.81% for ratooned tiller number. It is considered from the present study that the ratooning ability is heritable and can be used as one of the selective traits in a breeding program of rice.

40. Improvement of Rice Variety for Resistance to Blast and Bacterial Blight by Crossing Japonica with Indica

In order to improve the pest resistance of japonica rice, a hybridization by crossing japonica (Tainung 67) with indica (IR 4227-18-3-2) was made in the second crop of 1982. Although partial sterility and black husk grains appeared in the F_1 generation, the phenomena reduced following the backcrossing with japonica. From the progenies of the cross, two lines with the characters of high yield, similar rice quality as Tainung 67, but resistance to rice blast and bacterial blight were selected. This suggested that in the first backcrossing, the genes of blast and bacterial blight resistance in the indica had been transferred to japonica. On the other hand, the physico-chemical properties of rice in the selected lines were similar to Tainung 67, but the eating quality was better.