

2. RESEARCH ACHIEVEMENT

RICE

Studies on the Growth Pattern of New Rice Strain

The growth pattern of the new strain of rice "Taichung yu 365" (Fig. 1) was compared with that of Tainung 67 (*japonica* type) and Taichung Sen 10 (*indica* type). The materials were grown at one-month interval from April to August 1987. Sampling and record keeping were made 30 days after transplanting. The data of growth analysis were evaluated by establishing the growth curve as well as growth equation of various traits. The new strain Taichung yu 365 showed an intermediate growth pattern between *indica* and *japonica* type rices. The growth vigor from vegetative growth stage to ripening stage in *indica* type rice was found to be stronger than that of *japonica* type rice. The degree of growth vigour varied under different temperature conditions due to different planting months. Under the high temperature conditions, the *indica* type rice showed a better growth pattern. It was observed that under the high temperature condition, the growth pattern of the new strain Taichung yu 365 appeared to be similar to that of *indica* type variety while under the low temperature condition, it tended to be similar to that of *japonica* type variety. These results indicated that the newly selected line Taichung yu 365 had a wider adaptability under the environment of Taiwan. Further experiment

on yielding capacity, resistance to diseases etc. will be carried out for this particular new line.



Fig. 1. The maturing stage of new strain of rice—Taichung yu 365.

Variation in Agronomic Characters and Harvest Index of Rice by Monthly Planting in Taiwan

Various agronomic characters such as plant weight, tiller number, panicle weight and harvest index of 100 rice varieties were evaluated at monthly planting. The results indicated that all agronomic traits investigated differed according to different months of planting. The values of plant height, tiller number, panicle weight, harvest index were smaller in September because of lower temperature (Fig. 2), but no significant differences in the performance of agronomic characters were observed during the summer season of June, July and August. The growth

duration varied from 75 to 160 days. This was due to the change of monthly temperatures and daylengths at the time of flower bud formation. The values of coefficient of variation (CV), tiller number, panicle weight, harvest index and growth duration were as high as 20% or higher but those of plant weight was 10.0% only. The CV value for harvest index varied from 10.5 to 23.2% due to different months of planting. The smallest CV value of harvest index was found in those planted in July, and those planted in August come to next. The best time for selecting the harvest index should be decided based on the time of the best performance of harvest index.



Fig. 2. The uneven growth of rice plants due to low temperature when transplanted after September.

Linkage Analysis of *lhs^a* Gene of Naked-grain Rice

According to the report of Shao *et al.* (1980), the naked-grain rice was isolated from the progeny of the cross between rice (*Oryza sativa*) and wheat (*Triticum aestivum*). In the contrary, the report of Hsieh (1985) indicated that the naked-grain character of rice seems to be due to mutation, because the chromosome behavior of naked-grain rice was normal. The

zymograms of peroxidase and acid phosphatase of this strain indicated the pattern of *indica* type rice. The purpose of this study is to locate the gene of naked-grain *lhs^a*, on the linkage map. Crosses were made between the mutant line carrying the naked-grain character with Taichung 65 isogenic line carrying various gene markers (Fig. 3). No clear linkage relation between *lhs^a* gene and other genes were observed. This was due to the high sterility in both F_1 and F_2 generations in the crosses studied. Because Taichung 65 is a *japonica* type variety while naked-grain rice belongs to *indica* type rice. The naked-grain rice was further crossed with "long hull sterile rice" (Kinoshita *et al.*). The results indicated that the naked-grain gene and the long hull sterile gene was located at the same locus on the linkage group 11. This result was similar to that reported by Khush *et al.* (1986).

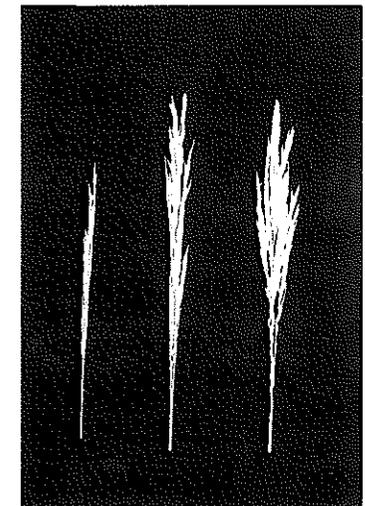


Fig. 3. The panicles of naked-grain rice (NGR) and long hull sterile (*lhs*) and their F_1 's, left: NGR, right: *lhs*, center: F_1 's of NGR and *lhs*.

Breeding of a New *Indica* Rice Variety—Tai Sen 1

Tai Sen 1 (Fig. 4) is a newly developed *indica* rice variety from the crossing of Taichung Sen Yu 358 (♀)/Tainung Sen Yu 107 (♂), and has officially registered and released in 1988. The results of grain quality analysis for Tai Sen 1 indicated that the rate of head rice was 53% and 63% higher than that of Taichung Sen 10 in the first and second crops respectively. The amylose content of the new variety was 14.9% and 19.4% lower than check variety in the first and second crops respectively. Because the rice grain of the variety has lower gelatinization temperature therefore the cooked rice is softer and more sticky in texture. Those characters contributed much to the acceptability of the variety by the consumer in Taiwan. The results of yield trial of this variety during the first crop of 1985 through the second crop of 1987 showed an average yield of 7,298 kg/ha in the first crop, and 4,923 kg/ha in the second crop which are 2.6% and 7.5% higher than the control variety

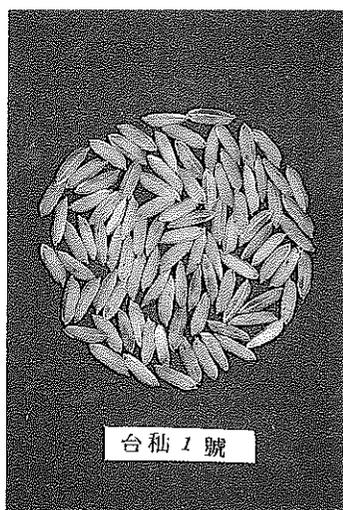


Fig. 4. New *indica* rice variety—Tai Sen 1.

Taichung Sen 10 respectively. The district yield trials conducted at 3 locations from 1986 to 1987 showed that Tai Sen 1 yielded 7,629 and 5,712 kg/ha in the first and second crops respectively, which were 0.3% and 3.3% higher than Taichung Sen 10. The semi-dwarf and high nitrogen response characters of this new variety contributed mostly to the high yield. Further, after the repeated experiments, it was noticed that stability of yield performance was much better than that of the earlier released cultivar Taichung Sen 10.

UPLAND CROPS

Improvement of Cultural Technique for Ratooned Sorghum in the Paddy-converted Dryland

The experiment was conducted to detect the stem-cutting stage, tillering number, ratooning height and method of fertilizer application for ratooned sorghum so that to increase the grain yield. The results of the experiment indicated that the best time of stem-cutting is about 2-12 days after harvesting. Yield will be decreased drastically when stem-cutting delayed over 20 days after the harvesting. A 10 cm height soil banking should be made by cultivator 10 days after stem-cutting, so that to control the growth of the ineffective tillers. One half of the total amount of nitrogen fertilizer should be applied to the ratooned sorghum as a basic fertilizer immediately after the stem-cutting and the remaining amount should be split into two parts and applied to the field 20 and 40 days after the stem-cutting as the top dressing.

Effect of Sowing Time on Agronomic Characters of Buckwheat

In winter crop, the variety of Sioluk had the same flowering date as Miyazaki however, with the delayed sowing time the maturity of Sioluk will very much prolonged in comparison with that of Miyazaki. The variety of Miyazaki showed that the same growth period even sown at the different sowing times with the exception of that sown on Oct. 15th. In spring crop, both Sioluk and Miyazaki showed the same growth period when sown at different sowing times. In winter crop, both varieties showed higher plant height when they were sown earlier. The plant height become shorter when they were sowed from Nov. 5th to Dec. 25th. In spring crop, from Jan. to April, the later the sowing time, the higher the plant height. In winter crop, the number of branches of more or less similar in these two varieties. In the late sowing at the spring crop, more branch number was obtained. In winter crop, either Sioluk or Miyazaki showed no significant difference in grain yield among the different treatments of sowing time with the exception of those sowing on early November showed lower grain yield than that of old variety Toyodo No. 1, which is widely cultured in Taiwan. It was noticed that the newly introduced varieties Sioluk and Miyazaki, when they were sown in April, no seed harvest was possible. The performance of 1000 grain weight of the variety Sioluk appeared to be better when it was sown from Nov. 5th to Jan. 15th. In case of Miyazaki, it perform better when it was sown from Oct. 5th to Jan. 25th.

Specification in Starch Component in Job's-tears (*Coix acryma*)

Three varieties of Job's-tears, namely Thailand, A-Li-Shan and Taichung S. No. 1 were evaluated with regard to the grain-starch components. Two rice varieties *i.e.* Taichung 189 (non-sticky) and Taichung Glu-70 (sticky) were also used as checks. The results showed that the crude starch content and starch powder extract of the variety Thailand were found to be 64.2% and 84.7%, which is higher than the others, but 10-20% lesser than those in rice. The amylose content in A-Li-Shan was 15.4% which is 5-7 folds higher than that of varieties Thailand and Taichung S. No. 1. The amylose content in non-glutinous rice (check) "Taichung 189" was 17.9%. Based on the SEM studies (Fig. 5), the starch grain of Job's-tears was found to be ball type and that of rice was found to in polygon shape. The size of starch grain in the variety "Thailand" was $14.53 \pm 4.70 \mu$ which is the biggest among the varieties studies. It is twice as big as that rice

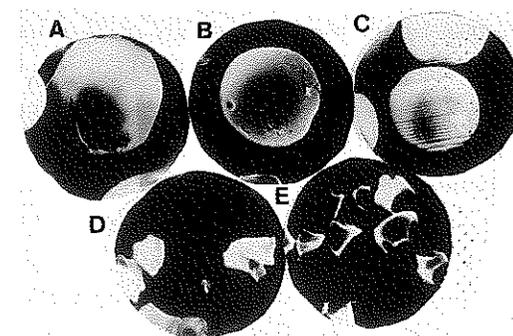


Fig. 5. Scanning electron micrographs of starch grains of Job's-tear and two rice varieties.

A: Thailand; B: A-Li-Shan;
C: Taichung S. No. 1;
D: Taichung 189;
E: Taichung Glu-70.

starch (checks). The physical properties, pasting temperature and maximum viscosity of Job's-tears varieties "Taichung S. No. 1 and Thailand" were found to be more or less similar to the glutinous rice, Taichung Glu-70 (check). The absorption spectra of starch-iodine reaction in A-Li-Shan and Taichung 189 showed the similar pattern in A600 and A660. Therefore, Taichung S. No. 1 and Thailand performed to be the sticky Job's-tears varieties.

Genetic and Breeding Studies on Tannin Characters in Hybrid Sorghum

Tannin is one of the most important phenolic compounds in sorghum, and the content of tannin is not only related to the nutritional values of feed but also affects the seed germinability and its bird-resistant ability. The four isogenic lines *i. e.* TUI-1, TUI-2, TUI-3 and TUI-4 series in tannin acid content were used as male parent to cross with 80B or 2R parents. The agronomic characters of F_1 plants and F_1' seed characters were studied. The plant height, panicle height and grain weight of F_1 plant were found to be superior to their parents, and days to 50% flowering was observed to be 3-10 days earlier than their parents. The shape and colorness in F_1' seed were similar to those of their male parent. The peroxidase isozyme patterns (Fig. 6) found in 80B group were similar to their female parent. However, that in $2R \times TUI-1$ and $2R \times TUI-3$ showed differences in the bands of R_f -0.5 and -0.6. The tannin content of F_1' hybrid seeds was less than the average amount of their parents. However, the germinability of F_1 seeds tended to be increased in accordance with the increase

of tannin content.

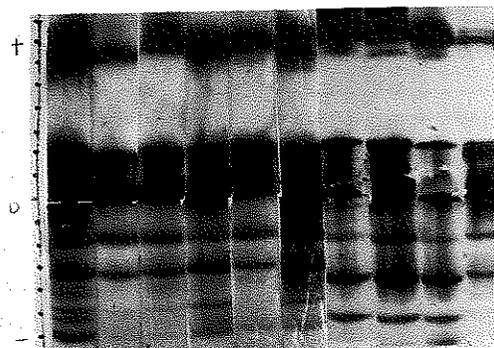


Fig. 6. Zymograms of peroxidase in sorghum seeds of 80B, TUI-1, TUI-2, TUI-3, TUI-4 and their progenies, From left to right: 80B, TUI, $80B \times TUI-1$, TUI-2, $80B \times TUI-2$, TUI-3, $80B \times TUI-3$, TUI-4, $80B \times TUI-4$.

HORTICULTURAL CROPS

Breeding of Snap Pea

Taichung Ten Shih 3A (TTS 3A) (Fig. 7) snap pea is developed by crossing "Sugar Snap" with "Knight". It will be registered and named as "Taichung No. 13" this year. TTS 3A is a white flower, pole-type snap pea, leaves are small size, and have tender branches. Single flower begin blooming at node 13-15. This lower pod-setting position is favored for trellis cultural practices. The green pod is crispy and sweet, the sugar content is 13-14 Brix well suited to fresh market and processing. Pod shape of TTS 3A is more uniform than "Hsin-Jen". The green pod maturity is about 15-20 days earlier than "Hsin-Jen". Because of the characteristics of lesser branches, the pod yield is lower than "Hsin-Jen". TTS 3A have loose abscission layer which is very easy in picking. This line is tolerant to Fusarium wilting disease, but is

not resistant to damping off, powdery mildew and root rot.

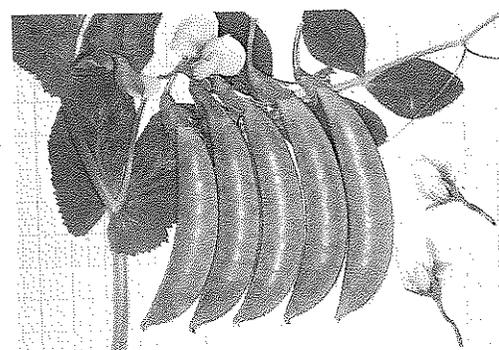


Fig. 7. Taichung Ten Shih 3A snap pea.

Development of a Rust Resistant Variety of Snap Bean, Taichung 1

Taichung 1 (Fig. 8) is a green-podded pole bean with resistant to rust disease released by Taichung District Agricultural Improvement Station. This variety is developed by using the local cultivar "Black Creaseback", which is susceptible to rust, backcrossed four times to a rust resistant bush bean line "15R-55-BK" introduced from Puerto Rico. It was registered and released in November, 1988. This variety belongs to indeterminate, type IV growth habit. Average days to first harvesting are 53.5 and 55.5 for spring and fall crops respectively. Average days to last harvesting are 92.5 and 90.5 for spring and fall crops respectively. Average pod yield at two years of regional trial are 22.4 and 19.5 tons/ha for spring and fall crops, respectively; of which is 7.1 and 4.8% higher than "Black Creaseback". The degree of rust resistance ranged from "Resistant" to "Highly resistant" and "Highly resistant" for mountain and lowland areas, respectively. Pod have good appearance and quality. The high yielding and wide stability characteri-

tics made it very suitable for spring and fall crops production in central and southern Taiwan.



Fig. 8. Rust resistant variety of snap bean, Taichung 1.

Studies on Increasing the Healthy Cuttings of Chrysanthemum

The purpose of this study was to compare the effect of rooting hormone, fungicide, liquid fertilizer and hydroponic nutrition to increase the cuttings of chrysanthemum flower under sand, soil and hydroponic cultural conditions. The feasibility of producing healthy seedlings of chrysanthemum was also evaluated. The result indicated that soaking cuttings in 1000 ppm NAA before planting can promote root growth, and increase rooting percentage, but root length was unaffected under soil and sand culture conditions. In hydroponic condition, the concentration of NAA should be lowered than 5 ppm. When its concentration is over 20 ppm it will inhibit the growth of roots, and over 100 ppm it will cause serious damage on the roots. There are no significant differences in prevention

of basal stem rot and root growth by soaking cutting in Benlate (1000 times) and liquid fertilizer (1000 times) for 10 minutes. The hydroponic nutrition can promote the root growth of cutting with the E. C. value lower than 0.95 mmho, while over 1.5 mmho will cause damage on roots. Compared the cultural methods, soil culture has the best result of enhancing root growth, followed by sand culture. The result of hydroponic culture in this study was far from satisfaction. Further experiments with the additional treatments will be conducted next year.

The Yield Performance of Water Oat (*Zizania latifolia*) Grown under Different Soil Conditions

This experiment was aimed to select the high yielding tiller of water oat for planting. The mother plants of water oat was transplanted on December 30, 1986. The harvesting of spring crop started from the middle of May or 136 days after transplanting, and ended in the late June. The harvesting of fall crop started from late August to early September or 244 days after transplanting, and ended in the middle of October. The average numbers of tiller of spring crop obtained from a mother plant of water oat were: 9.2 tillers per plant from a coarse-textured soil with shallow water (a). 8.6 tillers per plant from a loamy soil with shallow water (b). 2.8 tillers per plant from a coarse-textured soil with deep water (c). 2.4 tillers per plant from a loamy soil with deep water (d). The rate of rhizomes formed from the transplanted tillers were 45.4% from the treatment (c), 45% from the treatment (b), 43% from the treatment (d), 33.9% from the treatment (a). Yield of shoot obtained

were 240 kg/10 a (118.7%) from the treatment (d), 202.2 kg/10 a (100%) from the treatment (b), 199.9 kg/10 a (98.9%) from the treatment (c), 186.3 kg/10 a (92.1%) from the treatment (a). The yield of shoot in the treatment (d) significantly higher than all other treatments. Fall crop are ratooned crop from the spring crop. The rate of rhizomes formed from the ratooned plants are, 72.5% from the treatment (a), 71.6% from the treatment (b), 67.7% from the treatment of (d) and 60.5% from the treatment (c). Yield of shoot, 610 kg/10 a from the treatment (c) (101.3%), 606 kg/10 a from the treatment (a) (100.7%), 602 kg/10 a from the treatment (b) (100%) and 590 kg/10 a from the treatment (d) (98%). The yields of shoot were not significantly different from the four treatments in the fall crop. In the four treatments a significant difference in shoot yield was found only in the spring crop. Under the loamy soil with deep water condition the highest in shoot yield was observed.



Fig. 9. Husking the shoots of water oat (*Zizania latifolia*).

The Control of Bacterial Wilt Disease by Grafting in Tomato

The tomato cultivar "Senli" is susceptible

to bacteria wilt disease. An attempt was made to graft the scion of "Senli" to the disease resistant stock so that to reduce the incidence of the disease. The results of the experiment indicated that when tomato cultivar "Senli" was grafted with wild tomato stocks "AVRDC-4711" and "BL-166", it can reduce the infection rate of bacterial wilt to below 1.6%. As the result, the grafted tomato increase the yield by 5170-6620 kg/ha and 4610-5330 kg/ha at summer and fall crops, respectively. The average income increase per hectare is estimated to be NT\$ 91,750-128,000 and NT\$ 17,820-26,460 for summer and fall crops, respectively.

Effects of the Storage Temperature and Cooking Methods on the Quality of Hydroponic Pai-Tsai (*Brassica chinensis* L.)

The experiment is to study the influences of the storage temperature and cooking methods on the quality of hydroponic Pai-Tsai (*Brassica chinensis* L.). The results showed that when Pai-Tsai was stored under 10°C for 4 days, the vegetable appeared to be in fresh condition, though a loss of 2.95% moisture content occurred. When it was stored under 30°C condition for 1 day, a drastic loss (24-32%) of water content occurred. However, it will be recovered after immersed it into running water (Fig. 10). The roots of Pai-Tsai restored their activities which help regain the freshness of the vegetable. The chemical components of boiled Pai-Tsai was subjected to change after 1-3 minutes of heating treatments. The contents of chlorophyll, free amino acid, NO₃-N and NO₂-N of boiled leaves were found to be increased with the prolonged period of heating. Free sugar



Fig. 10. Effect of storage temperature and conditions on the quality of Pai-Tsai. A: at 10°C for 4 days. B: at 30°C for 1 days. C: at 30°C for 1 day plus soaking into water.

Effect of Temperature, Light Intensity and Chemical N on the Quality of Pai-Tsai (*Brassica chinensis* L.)

In order to understand the effect of temperature, light intensity and chemical N on the quality of Pai-Tsai (*Brassica chinensis* L.), the vegetable which grew in the artificial controlled environment by means

of hydroponics, were designed for the growth analysis. The results were summarized as follows (Fig. 11): 62.1% of $\text{NO}_3\text{-N}$ in the Pai-Tsai was accumulated in the leaf stalk, 25.9% in leaf blade and 12.0% in root. But $\text{NO}_2\text{-N}$ was mostly accumulated in the roots (96.9%). When the amount of applied chemical N were increased, the more $\text{NO}_3\text{-N}$ will accumulated in the leaf blade and leaf stalk, and a part of $\text{NO}_2\text{-N}$ in root were moved into the leaf blade. With the increase of light intensity from

16.4 Klux to 45.1 Klux, the amounts of $\text{NO}_3\text{-N}$ and $\text{NO}_2\text{-N}$ in the leaf blade increased remarkably. When the temperature increased from 25°C to 35°C, the amount of $\text{NO}_3\text{-N}$ and $\text{NO}_2\text{-N}$ were also increased greatly. The amount of protein, chlorophyll, crude fiber and ash were increased, when the amount of applied chemical N in the nutrient were increased. On the other hand, the amount of crude fiber, starch, free-sugar and amino acid were decreased. It is indicated that the combination of the high

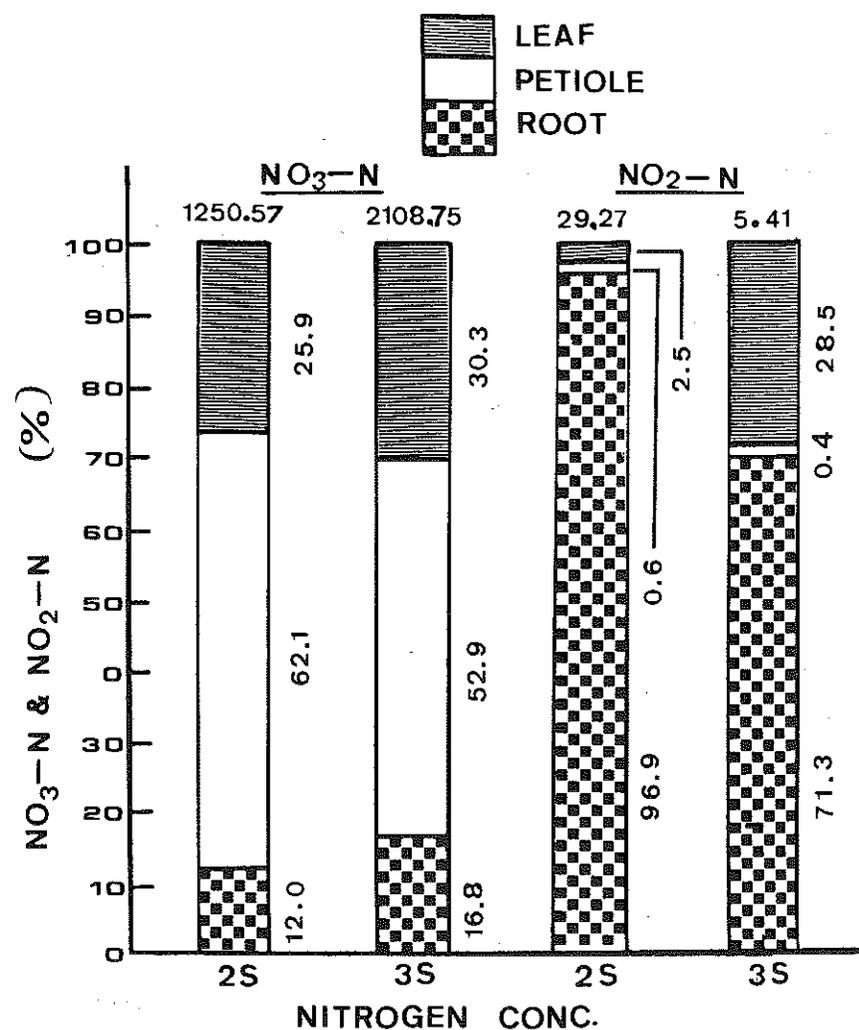


Fig. 11. Increase of $\text{NO}_3\text{-N}$ and $\text{NO}_2\text{-N}$ in the leaf as nitrogen concentration increased from 2S to 3S.

temperature, high light intensity and high chemical N will result in the poor quality in terms of chemical composition in Pai-Tsai.

Effects of DRF Hydroponic Technique on the Yield Potential of Summer Tomato (*Lycopersicon esculentum* mill)

A two-year continuous hydroponic culture of tomato was conducted at Taichung DAIS in 1987. Two tomato varieties San-Li (big fruit size) and Lan-Tuo (mini-tomato) were transplanted at 4-leaf stage in the DRF hydroponic system. The top pinching were done at 7-8 clusters stage. The results indicated that the fruit yield and the growth period were significantly decreased with the increase of air temperature. However, the harvest period was remarkably prolonged. In other words, the numbers of fruit set on the upper clusters were not only reduced but the maturity was also prolonged in the hot summer season. It indicated that the early topping treatment



Fig. 12. Fruit-setting of summer tomato showing 2-3 clusters of fruit per plant at DRF hydroponic system.

at the culture of tomato in 2-3 clusters stage to shorter the growth period might be useful for the hot summer. An advanced experiment with 2-3 clusters (Fig. 12) of hydroponic mini-tomato was conducted at the summer season in 1988. The results revealed that the mini-tomato could be cultivated twice hydroponically at the hot summer with a growth period of 45 days with fruit yield of 52.19 kg/100 m².

A Method of Promoting Flowering and Berry Growth for Grapevine

Due to previous season grape overproduction, low lignization rate, early defoliation and regrowth of mature branches resulted in deficiency of nutritional accumulation in branches. Many problems occurred on the following fall and winter grape production after pruning: short flower cluster and abnormal shoot development, which will cause short fruit cluster and crowded berries. At maturity, the berry was cracked resulted in yield reduced. In order to solve the above problem, beside to upgrade the management of branches development at previous season, using plant growth regulator to promote the growth of flower cluster is feasible. We have conducted the experiment of GA application (GA_3 30-50 ppm) on branch of "Himrod Seedless" grape variety at 6 days before and after blooming to promote the length of flower cluster. When 2 ppm of GA was applied on "Kyoho" the similar effect occurred. It increased the percentage of parthenocarp as the GA concentration increased. The recent study indicated that when 0.2% of Cytex (contained 0.1% cytokinin from the extract of seaweed) was mixed with 0.5 ppm of GA_3 and applied on the branches of

grapevine it could promote the growth of flower cluster and increase the fruit weight and fruit size, without affecting the seed number of berry (Fig 13).

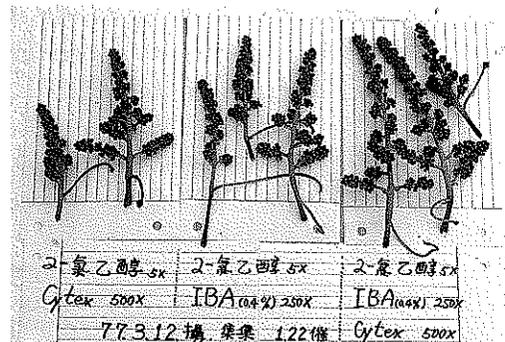


Fig. 13. Application of plant growth regulators on promotion of flower cluster in grape.
Left: 2-chloroethanol + Cytex,
Center: 2-chloroethanol + IBA,
Right: 2-chloroethanol + Cytex + IBA.

The Development of the Technique for Production of High Chilling Requirement Pears under the High Temperature Condition of Lowland Areas

The top-grafting method is popular in "Henshan" pear production in Taiwan. But this cultural practices needs large amount of expensive imported scions and intensive labors. We have conducted the experiment on using manual technique to promote the formation of flower buds of scions under the local condition. The top-grafting practices has to be done each year also. The present experiment is to explore the possibility of reutilized the high chilling requirement scions that have been top-grafted on the "Henshan" pears at previous year. The technique is now developed through the application of Hydrogen Cyanamide (0.75-1 μ) on the shoots (Fig. 14). Hydrogen

Cyanamide application has been proven to be an effective method for breaking dormancy and to promote flower buds formation at the following spring season. This labor saving method is expected to be able to produce high-quality temperate pears at lowland area.



Fig. 14. Promotion of fruit-setting of top-grafted scion on "Henshan" pear.

Studies on Shoot Growth and Promoting Fruit-setting of Grapevine

Under the current cultural practices of high population density and over supply of fertilizer, the grape trees need strong pruning to limit the expansion of tree canopy during winter season. And at the high temperature and humid conditions the shoots tend to be outgrewed and the flower cluster cannot have enough nutrition resulted in poor pollination, fruit dropping and parthenocarpy. The proper pruning during grape dormancy stage can adjust the amount of branches, followed by bud thinning after sprouting and trimming of weak basal branches will balance the growth

of fruit bearing shoots. The tree will have better response to the application of plant growth regulator and adequate leaf-fruit ratio during fruit development stage. Application of Alar and C.C.C. before blooming will control the growth of new shoots, prevent the competition between new shoots and fruits and thus increase the rate of fruit setting. The new shoot with length within 30-60 cm at blooming stage have the better fruit setting rate. The growth length of shoot between 40-50 cm after flowering could increase the fruit size and quality of berry (Fig. 15).

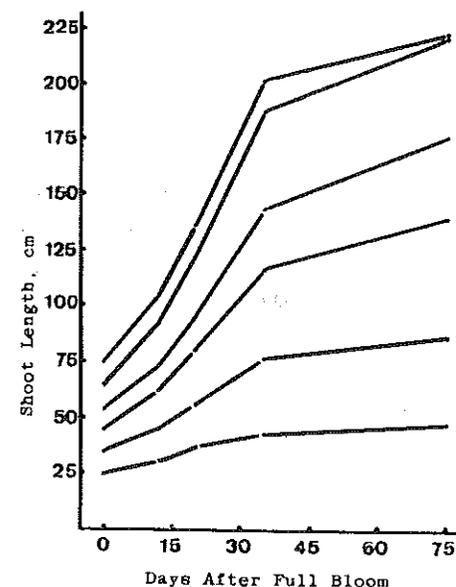


Fig. 15. Effect of different shoot lengths at blooming stage on the growth of fruiting shoot of Kyoho grape. Shoot length at blooming stage:
A, 20-29 cm; B, 30-39 cm;
C, 40-49 cm; D, 50-59 cm;
E, 60-69 cm; F, 70-80 cm.

PLANT PROTECTION

Effects of the Stripe Virus on Rice Yield and Yield Components

Tainung 67 (a *japonica*-type rice) was single-plant transplanted and inoculated with rice stripe virus (RSV) at different growth stages to study the effect of virus infection on rice yield. The experiments were conducted in pot under greenhouse conditions in the 2nd crop season of 1984 and the 1st crop season of 1985 at the old site of Taichung District Agricultural Improvement Station (TDAIS) in Taichung city as well as in the 2nd crop season of 1985 and the 1st crop season of 1986 at the Taichung DAIS, at its present site in Changhua. Similar experiments conducted in field were taken at Taichung city in the same crop seasons of previous experiments. In the 1st crop season inoculation with RSV at 10 to 30 days after sowing (DAS) resulted in 100% losses of the rice yield for both pot and field tests. When test plants were inoculated at tillering stage (60 DAS), the yield losses were 90 and 84% for the pot and field tests, respectively, and at sound panicle formation stage (100 DAS), the yield losses were 30 and 23% for these test conditions, respectively. However, there was no yield reduction when inoculation was done after booting stage (110 DAS). In the 2nd crop season, inoculation at seedling stage (from 10 to 20 DAS) resulted in 100% yield losses for both pot and field tests. The yield losses were 55 and 28%, respectively, for the two test conditions, when inoculation was at tillering stage (50 DAS). However, there was no yield reduction observed when inoculation was made at early booting stage (70 DAS). Apparently, the rice growth period for RSV infection which would cause substantial yield reduction was shorter in the 2nd crop than in the 1st crop. Under field conditions, the effect of rice stripe

disease on the yield of naturally infected plants was studied. Tainung 67 was planted at 5 plants per hill and infected plants were tagged individually when symptoms appeared. In the 1st crop, the yield losses of infected plants with first symptoms appearing from tilling (50 days after transplanting, DAT) to booting stages (80 DAT) were from 54 to 63%. When symptoms appeared at heading (90 DAT) and milk stages (100 DAT), the losses were 32 and 22%, respectively. There were no significant yield losses for those plants with symptoms appearing after dough stage (110 DAT). In the 2nd crop, the yield reduction was 41-66% when symptoms appeared booting stage (60 DAT). However, symptoms were not observed after milk stage (80 DAT). Analysis of the effect of RSV infection on the yield and yield components showed as the following. The yield reduction in the 1st crop was mainly due to a reduced number of panicles and to a lesser extent a reduced number of spikelets per panicle. In the 2nd crop, the yield loss was caused by a reduction of panicle number, the 1000-grains weight, the percentage of filled spikelets and spikelet number per panicle in order of importance.

Some Epidemiological Studies on Rice Stripe Virus Disease

The rice stripe virus disease (RSVD) has become a most destructive insect transmitted virus disease of the first rice crop in Taiwan in recent years. In central Taiwan, the insect vector, small brown planthopper (SBPH) (*Laodelphax striatellus*) could propagate two generations in ratooned rice or wheats during the winter season. Both the stripe infected plants and the

insect vectors survive during winter seasons will become the virus source of infection in the next year. In the paddy field SBPH could be detected throughout the year and its population reached a peak during early June and October for first and second crops, respectively. During the period of 1984-1987, about 13,546 SBPH were collected in 138 collection attempts (2 collections per month) in Tatsuen, Changhua Hsien and Paituen, Taichung city and test individually. The results revealed the active transmitter of RSV were detected almost all attempts and about 6.7% in average of the insects were RSV-transmitter. The active transmitters reached a peak during early May to later June in the 1st crop and during later September and early October in the 2nd crop. The analysis data of diseased plants appearance revealed that there were two infection periods of RSV observed in the 1st rice crop. The 1st infection period occurred during seedling stage until 20 days after transplanting and the major sources of transmitter were the overwintering insects and it caused about 1-10% of the total infection rate of the 1st crop which varied from year to year and location to location. The second infection occurred during 40-60 days after transplanting and the major source of transmitters were the 1st generation of SBPH which multiplied in the paddy field. The infection rate were estimated over 80% of the total infection of 1st crop. The infection rate of RSV in the first crop can be forecasted as $Y = 12.46X - 0.143$ ($R^2 = 0.9988^{**}$) (where Y means estimation of percentage of products value of natural population and active transmitter during March to April).

Purification and Serology of Echinochloa Ragged Stunt Virus

Echinochloa ragged stunt virus (ERSV) was purified from infected *Echinochloa crus-galli* var. *oryticola* by homogenizing fresh leaves or roots in 0.25 M phosphate buffer, pH 7.2, containing 0.01 M $MgCl_2$ and 1% 2-mercaptoethanol. Sap was clarified by adding carbon tetrachloride to a final concentration of 20% and stirred for 10 mins. After centrifugation at 10,000 g for 15 mins the supernatant was saved and treated with 1% Triton X-100. It was centrifuged again at 10,000 g for 15 mins. The supernatant was centrifuged through a 5 ml pad of 20% sucrose at 55,000 g for 1 hr. The sediment thus obtained was suspended, layered on 20-50% linear sucrose gradients and centrifuged for 90 mins at 85,000 g. The virus band was drawn and concentrated by centrifugation for 1 hr at 55,000 g. The purified preparation was dominated by spherical virus particles about 55-58 nm in diameter and had a UV absorbance ratio of 260/280 in the range of 1.8-2.16. Contaminating host material was not evident when the preparation was examined in an electron microscope. The serological relationship of ERSV with rice ragged stunt virus (RRSV), maize rough dwarf virus, oat sterile dwarf virus and rice black-streaked dwarf virus was tested by immune electron-microscopy and by protein. A gold labelling, using purified ERSV as antigen. The results indicate a close relationship serologically between ERSV and RRSV, but a lack of it between ERSV and other plant reoviruses tested.

Four New Recorded Agricultural Insect Pests from Taiwan

Heterococcus rehmii Lindinger was discovered at Taichung area in 1988, while as it was the new record for Taiwan and Mainland China. *H. rehmii* damaged the inner part of leaf sheath of rice plant in booting stage. *Cataphrodium rubripenne* Hope was the new insect pest for pear, and damage the stem of pear. *Maruca testulatus* Geyer (Fig. 16) and *Crytophlebia ombrodelta* (Lower) (Fig. 17) damaged the pods of snap bean. However, it was the new insect pests of bean. Above four new insect pests were subjected for their classification and characterization



Fig. 16. New record of insect pest in snap bean, *Maruca testulatus* Geyer.

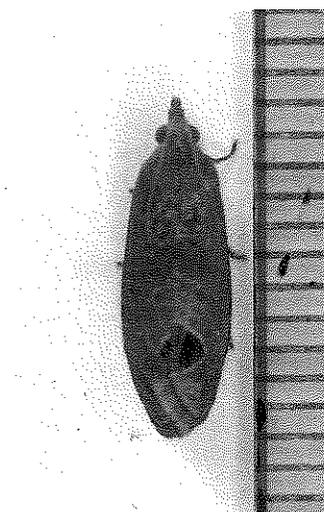


Fig. 17. New insect pest of snap bean, *Crytophlebia ombrodelta*.

The Occurrence and Improvement of Control Method for Scarab Beetle of Vineyard

Six species of scarab beetle (Fig. 18) have been recorded as the pests of grape, i. e. *Anomala cupripes* Hope, *Anomala expansa* Bates, *Protaetia orientalis* Govy and Percheron, *Anomala castaneiventris* Bates, *Protaetia Cultra* Waterhouse, *Calopotisia formosana* Moser etc. The results showed that the population density in *Anomala Cupripes* was the highest, *Anomala expansa* and *Protaetia orientalis* was the second ones. *Anomala expansa* and *Anomala cupripes* damaged the leaves, fruits and buds, while *Protaetia orientalis* damaged the mature fruits. The population peak of these beetles was during June to July. For the bioassay, we decide the sex by the end of abdomen of these beetle. *Protaetia orientalis*, *Calopotisia formosana*, *Protaetia culta* were tested by banana, and had a good effectiveness, the laboratory test by Y-type tube was the same. Insecticide tests in the field indicated that 2.8% Deltamethrin E. C. at a rate of



Fig. 18. Damage of grape leaves by scarab beetle.

2000-fold, or 24% Methomyl S. at a rate of 1000-fold, and 46.84% Carbofuran F. P. at a rate of 1200-fold were more effective for controlling these beetles than any other chemicals tested. Injecting the Methomyl or applied the granulated Temik around the stem also have good control of beetle larva.

The Occurrence and Improvement of Control Method for *Bradybaena similaris* of Vineyard

Bradybaena similaris belongs to Gastropoda, which feeds and damages the flowers, fruits, buds and leaves and excretes the excreta mucous membrane, which affects the quality and quantity of grape. The population peak is during May to September. The pattern of spatial distribution of this snail in the vineyard appear to be the uniform type of distribution. The optimum sampling size for this snail observation on grape vine indicated that at the snail density of 1/plant, sample sizes of 259 and 1,597 plants were need to fulfill precision levels of 0.25 and 0.1, and the density of 5/plant, sample sizes of 41 and 256 were estimated. PET bottle, black PE cloth, PE plate, PE cloth, slime, tooth paste, vanslin, metaldehyde, metaldehyde (weeding before application), metaldehyde paste were tested. The results showed PET bottle, black PE cloth, PE plate had the best efficiency of control, the percent control was over 90%. The percent control of metaldehyde granule, metaldehyde paste and PE plate was ca. 80%. Metaldehyde under weeding before application, the percent control was from 40 to 60%. Slime, tooth paste, metaldehyde, metaldehyde paste was 2-3 weeks for the residue, whileas 6 weeks for black PE cloth. For all tests indicated that PET bottle

method (Fig. 19) was best effective, and it was available to recommend to the grape grower.

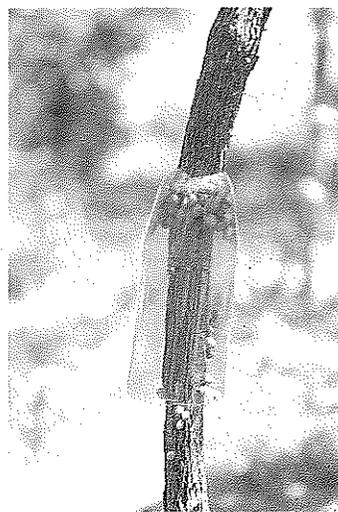


Fig. 19. Control of *Bradybaena similaris* by PET bottle.

Occurrence and Control of Blackleg of Cabbage

Among 21 cabbage varieties screening for blackleg resistance, Ho-feng, Tsuen-chu #1, Chu-tung, Nung-shi 2335 and Tsuen-yang showed slight resistance, which only forming brown spots on the surface of stem. The germination rate of spores decreased as the decrease of relative humidity. Under 100 and 98% of relative humidity, the germination rate of spores was 92.3% and 80.1%, respectively, and no germination below 92% of R. H. Result of chemicals screening test indicated that Fungaflor and other 12 chemicals could inhibited the growth of mycelium in the lab condition. Pot experiment indicated that Fungaflor, Fenarimol and Mertect have the best control of blackleg. The survival test of pathogen showed that the soil contained pathogen at 3 months after harvest didn't produce any symptom.

Soil treatments of urea, CaCN₂, lime dust and S. H. mixture have no effect on the control of blackleg.

Economical Evaluation of Using Different Bagging Materials for Control Melon Fly on Bitter Gourd and Sponge Gourd

The results of using different bagging materials for control melon fly on bitter gourd and sponge gourd indicated that all materials have control effect on melon fly. On the fruit development of bitter gourd 10 days after bagging the brown PP bag have the best effect, next is the double-layer paper bag. On the appearance of bitter gourd, the double-layer paper bag and black PE bag have the whitest color. The cost of bagging materials for black PE bag and brown PP bag are NT\$ 0.07, double-layer bag is NT\$ 0.1. From the above result, it is recommended that at early vining stage use double-layer bag, and at fruit-stage use black PE bag, brown PP bag or newspaper. Among five bagging materials, white paper bag have the best control effect, which is water-proof. On the effect of sponge gourd fruit development 7 days after bagging, the reinforced water-proof bag have the best result, next is newspaper bags. The cost of the PP bag is NT\$ 0.07, the reinforced water-proof bag is NT\$ 0.01 per bag.

The Utilization of Sex Pheromones for the Monitoring of Pest Population

Some noctuid moths pheromones were tested. Dry type and wet type traps were applied to monitor the population fluctuation of their moths. The results showed that the

synthetic sex pheromone had a good attractance (Fig. 20). Large number of moths could be attracted in the field using synthetic sex pheromone while only few were trapped by light. Preliminary studies indicated that the peak of number of *Chilo suppressalis* was at late-August, early-October in 1987, early-February, early-March, late-July and early-September in 1988. The population peak of *Spodoptera exigua* was at early-November in 1987, mid-January and late-March in 1988, the second peak of this insect was at late-July and mid-August. The population peak of *S. exigua* in Tanwei was at late-January, late-February, late-March, mid-April, early-June, late-July, early-September, mid-October, and mid-November. The population peak of *Spodoptera litura* in Fongyen was at late-January, mid-February, mid-April, late-May, late-July and late-October.



Fig. 20. Monitoring the population of *Spodoptera exigua* by insect sex pheromone trap.

The Population Density and Efficacy Assessment for Control of Rodent in Taichung Area

Field rat is one of the wide range and important pests in the farming land. Thirteen species of rats have been recorded

as the rodent pests of agricultural crops from the present observation. The annual peak of population density and occurrence rates for five major pests are as follows: *Bandicota nemorivaga*, from March to October, 2.9%; *Rattus losea* and *Apodemus agrarius*, from July to October, 32.7% and 10.6%, respectively; *Mus formosanus*, from December to January, 51.4%; *Rattus norvegicus*, September, 2.4%. Extermination percentage of rats for Taichung, Changhua, Nantou county and Taichung city was 65.5%, 91.5%, 84.3% and 58.6%, respectively. The sex ratio for male and female is 56.7% and 43% before extermination, while 63.9 and 36.1% after extermination. Baiting acreage in Taichung areas for farming land and public land are 133,795 and 16,390 ha, respectively. The control cost is NT\$14,524,767.

The Sampling and Analysis of Pesticide Residue before Harvesting in Vegetable

The survey of residual level of pesticide on vegetables before harvesting collected from Taichung area was carried out from July 1987 to Oct. 1988. All samples (Fig. 21) were examined by bioassay and biochemical methods. If pesticide residue on the examined samples were beyond tolerance level, then traced procedure and educated program will execute for the farmers and advised them to delay the harvest time on those high residue vegetables. This survey indicated that 86.7% of 2474 of the tested samples collected from July 1987 to June 1988 were evaluated to be safe. The 92.5% of 871 tested samples collected from July to Oct. 1988 also were considered safe. Further studies showed that the high residual

samples were found about 19.1% in beans and peas; 12.6% in small leafy vegetable; 12.2% in fruit vegetable; and 10.9% in large leafy vegetable. The sample contained high residue of pesticide were found in root vegetables and cucurbita vegetable. Comparing the tested vegetable samples, strawberry, celery, cabbage, leek, mustard and eggplant had higher pesticide residue than other samples. However, bitter melon, luffa, carrot, water oat and kohlrabi didn't find and pesticide residue.

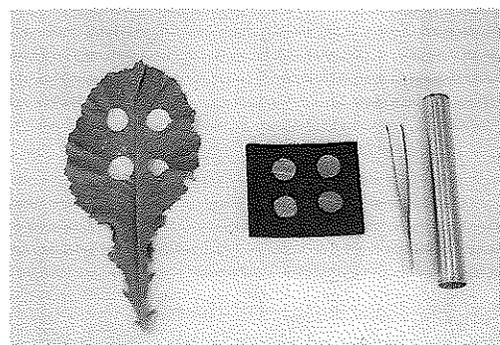


Fig. 21. Leaf-disks sampling method of vegetable crop for residue analysis.

SOIL AND FERTILIZER

An Experiment of Monitoring Air Pollution by Indicator Plants

This experiment is designed to test the feasibility to use indicator plants to monitor air pollution. Its final objective is to establish an economical, simple and effective air pollution monitoring system for protecting the air quality of our country or communities. Two monitoring spots has been established at each of the 5 townships, Huatan (brick factory area), Homei, Senkang, Lungching, and Tatu (Taichung Power Station area) in 1987. In 1988, two additional

monitoring spots has been established at the two townships, Tali, and Tanzi. Eight species of indicator plants, gladiolus, peanut, banana, guava, yon-tsai (water convolvulus), cowpea, sesame, and rice were selected to join the experiment. Among the 12 monitoring spots, two of them at Huatan had 4 kinds of plants, gladiolus, peanut, banana, and rice showing the injury symptoms of fluorides, and the fluoride contents of the plants were higher in the two spots than those in the other 10 spots. However, only four of them, gladiolus, peanut, banana, and rice showed typical and easily identified symptoms that were suitable to be used as indicator plants for detecting fluoride pollution. Generally, these symptoms were more severe in the second crop season than in the first crop season. Although sulfur oxides is the most prevalent air pollutant in this experiment, only the plants at Tanzi displayed the injury symptoms of sulfur oxides, and sesame and gladiolus (Fig. 22) were the two plants showed severe, typical, and easily identified symptoms that may be used as indicator plants for detecting



Fig. 22. Gladiolus, indicator plant for pollution of fluoride.

sulfur oxides pollution. It was apparent that the two plants, guava and rice required higher concentration of sulfur oxides to make them show more severe symptoms, that seemed to be used as the indicator plants for higher concentration of sulfur oxides. Though cowpea showed serious injury symptoms of sulfur oxides, however its symptoms were easily confused with the symptoms of some diseases in the later part of growing stage (Fig. 23).

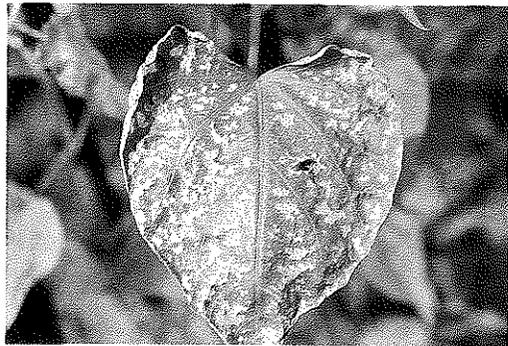


Fig. 23. White-flower Ipomea, indicator plant for pollution of sulfur oxides.

Study on the Effect of Liming on Acidic Ponkan Orchard

In order to understand the effect of liming on soil fertility maintaining, nutritional status, fruit yield and qualities of Ponkan citrus. A 3-year field experiment was carried out at Tungshi, Taichung county. The soil pH was 4.9. Lime and dolomite with 1.5 and 3.0 ton/ha were used. Results showed that the application of liming materials *i.e.* lime or dolomite increased soil pH, exchangeable Ca and Mg, and leaf Ca and Mg. The yield as well as the qualities *i.e.* juice rate of acids (sweetness) and solid/acidity of Ponkan were increased significantly by the application of liming (Fig. 24). Statistical analysis showed a slight antagonistic relation-

ship between leaf Ca or Mg and leaf K. Solids and acid content of fruit were closely related to leaf K and P. Thus, the improvement of fruit qualities by the application of liming materials was to increase Ca, Mg, P and K content in leaves. In order to maintain soil exchangeable Ca and Mg and to neutralize soil acidity, an amount of 1.5 t/ha of liming material is recommended to use annually in Tungshi area.

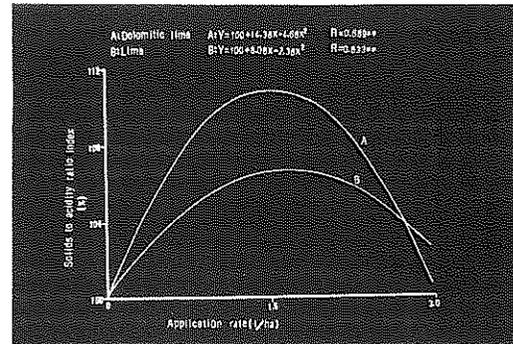


Fig. 24. Relationships of the rate of dolomitic lime and lime with the index of ratio of solid to acidity in Ponkan fruit.

Evaluation for the Suitability of Growing Corn on the Upland Converted Paddy Field in Taichung Area

In order to determine whether the upland converted paddy fields are suitable for cultivation of corn. A series of field experiments was held in different soils of Taichung district in 1987. In the spring crop, paddy soils of Taichung and Nantou, except hilly areas, had a higher yielding capacity than that in Changhua and its coastal areas. On the contrary, paddy soils of Changhua showed a higher yielding capacity than Taichung and Nantou in the fall crop, except coastal areas. The hilly and coastal areas are influenced by the

cold temperature and strong monsoon wind, thus caused low yield of corn. Corn yield was also influenced by planting dates. From early February to late April in the spring and from early July to middle September in the fall are planting periods of corn in Taichung area. The highest yield was obtained when planted in the middle February (spring crop) and late August (fall crop). Among soil groups, the well-drained latosol showed the highest yield potential for corn. Medium textural sandstone-shale alluvials and slate alluvials also give a high yield of corn. Calcareous soils with higher pH showed a better performance in the fall than those of noncalcareous soils. Soils with higher level of available phosphate (higher than 50 ppm) and potassium (higher than 67 ppm) gave a higher corn yield than the soils with low available phosphate and potassium (Fig. 25).

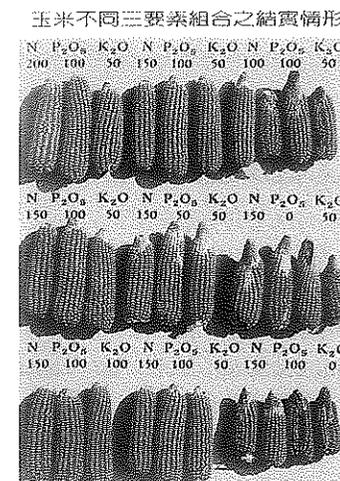


Fig. 25. Comparison of corn ears at different rates of N-P-K fertilizer treatment.

AGRICULTURAL MACHINERY

Performance Test of Front and Rear Mounted Plow

The plowing system includes a front mounted reversible plow and a rear mounted reversible plow. The plows (Fig. 26) are mounted on the FORD 7610.86 hp front wheel assist (FWA) tractor. The instrumentation system was designed for collecting dynamic force distribution on tractor's front and rear three point linkages. Components of the instrumentation system include an onboard Apple II Computer, an analog to digital (A/D) converter and 15 channels of sensors. In each run, when the forward speed and plowing conditions were steady, the data collection routine was executed for 50 seconds. Total number of data collected by each run is 7500. All collecting data was saved in disk file, then converted to actual force data by another computer. The performance of the system was evaluated statistically. In general, the specific drawbar power increased as the ground speed increased. When at the same speed, plowing at clay soil needs about 100% to 120% more specific power than plowing at sand soil. Although the field conditions appeared to be the same and the plowing system was equally adjusted for left plowing and right plowing, the specific force requirements for right and left are different in most results. Apparently the adjustment



Fig. 26. Performance test of front and rear mounted plow.

differences were relatively sufficient and these plows were very sensitive to adjustment.

Experiment on Subsoil Cultivation and Fertilization Machine of Grape

A multipurpose pneumatic cultivator (Fig. 27) which can blow high pressure air and liquid into deep soil has many functions such as cultivating, fertilizing and pest controlling. Experiments were conducted in grape orchard to investigate the different cultivation and fertilization effects among the subsoil fertilizing and traditional fertilizing areas. The results showed that the distribution radius of injected liquid was 55 cm and the depth was 70 cm. The growth of the grape veins in subsoil fertilizing area was better than that of the traditional fertilizing area. The soil fertility in subsoil fertilizing area was higher than that of the traditional fertilizing area, and so was the nutrient concentrations in grape leaves. The average grape weight and sugar contents was not significantly different between each treatments, but the fertilizer usage of the subsoil fertilizing area is 1/4-1/2 lower than the traditional fertilizing area.

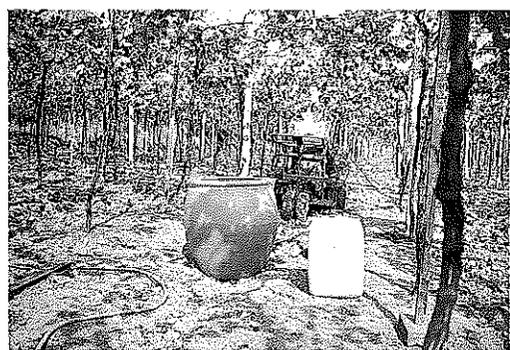


Fig. 27. Subsoil cultivation and fertilization machine of grape.

AGRICULTURAL EXTENSION EDUCATION

Survey on Land Utilization and of Agricultural Production Planning in Changhua County

Changhua is one of the most important agricultural areas located on the central part of Taiwan. The major agricultural production include rice, upland crops, vegetables, fruits, flowers and animal husbandary which are especially suitable to the natural condition of this area (Table 1). According to the future development plan made by the Taichung DAIS and Changhua county, the cultivation of rice and grain crops must be carried out through the rice-seedling centers and the upland-crop cultivation centers by the system of contracted farming so that to increase the management scale. For horticultural crops, a high technology and investment and intensive farming system combined with the establishment of special crop zones should be employed. The production of animals already attained the economic scale. The future work must concentrate on the treatment and control of the animal wastes. For the fishery production, the near-by seashore will be the center for future development. The soil conservation and sightseeing farming could be carried out on the slope land in Changhua. Agriculture in Taiwan faces with the problems of rapid industrialization and imported foreign agriculture products. The government's agricultural protection policy is still needed to help increase the income of farmers. The agriculture structure, farming technology and rural integrated development, especially the welfare of farmers in Changhua area should be further improved.

Table 1. Total acreage, total production and average yield of selected crops in Changhua county.

Crop	Total Acreage (ha)	Yield (kg/ha)	Total production (ton)
Rice	71,815	5,559	393,083
Peanut	7,737	1,751	13,551
Barley	395	4,192	16,558
Sorghum	798	3,156	2,518
Fruit trees	7,905	13,429	106,157
Vegetables	17,171	12,713	218,290

A Survey on the Fruit Tree Production Trainees in Taichung DAIS

A total of 317 trainees who completed the fruit production courses organized by this Station in 1986-1987 were surveyed with regard to the post-training farming situations. Only 103 of the questionnaires were useful for analysis. The SPSS (Statistical Package for the Social Science) was employed for this study. The results indicated that the majority of the trainees are younger than 35 in age and received a higher education. They are now still engaged in the agricultural business. Most of them still keep the traditional thinking on the farmland *i.e.* rather to buy instead of to sell the land. They feel the agriculture is very hopeful even if they are facing many difficulties. A follow up training programs are welcomed. When they face some problems in farm management, they seek help from other farmers, then the extension workers of Farmers' Association, and the specialists of DAIS. Very few trainees had the experience of applying agriculture loans offered by government because of the complex procedures of application. About half of the trainees do not know the detail

of contract farming system which is strongly encouraged by the government (Fig. 28).

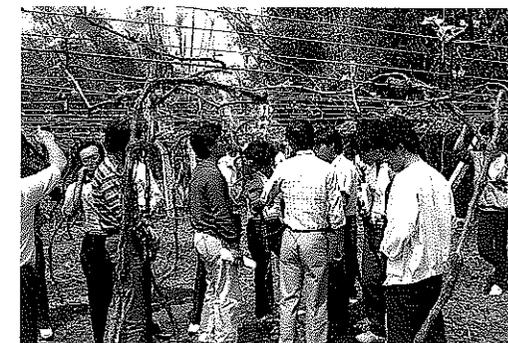


Fig. 28. Field day of grape production training course for youth farmer.

AGRICULTURAL ECONOMICS

An Analysis of Production Cost and Return for Tunnel-cultivated Water Convolvulus in Taichung City

In this study, 10 farmers for tunnel-cultivated water convolvulus in Taichung city were randomly taken as the sample farmers for investigation. The original data was taken by visiting the farmers with survey questionnaire. The results of analysis were as the follows. The average first production cost of tunnel-cultivated water convolvulus was NT\$ 87,607 per 1,000 m² and the second production cost was NT\$ 90,969 per 1,000 m². Based on the cost for NT\$/kg, it was NT\$ 8.8 and NT\$ 9.1 for the first and second production cost, respectively. Labor cost was the major input for the production of tunnel-cultivated water convolvulus which was around 70.5% of the total cost. The rest were facilities cost of 6.0%; fertilizer cost of 5.7%; and pesticides cost of 4.8%, respectively. The gross return for production of tunnel-cultivated

water convolvulus was NT\$ 140,286 per 1,000m². The production cost, the profit, the return of family labor and the farm earning were NT\$ 90,969, 49,317, 109,634 and 111,632 per 1,000m², respectively. Based on the annual cropping system (1st tunnel-cultivated water convolvulus—2nd rice), the gross return per 1,000 m² was NT\$ 147,271. The production cost, the profit, the return of family labor and the farm earning were NT\$ 98,545, 48,726, 109,873 and 113,224 per 1,000 m², respectively.

An Analysis of the Production Cost and Return for Vegetables Produced by Water Culture in Taiwan

There are only two private hydroponic farms with comparable size and economic cultivation in Taiwan. These two farms were chosen for analysis of the production cost and revenue for leafy vegetables. The results are as the following: The average production cost per 1000 m² for hydroponic leafy vegetables in these two farms were almost the same, NT\$ 1,143,704 and 1,167,785 for farm on Miaoli and Tainan, respectively. However, the structure of production cost were not exactly the same especially for the detailed cost of current inputs. The average first production cost of these two farms were NT\$ 35.4 and 39.3 per kg and the second production cost were NT\$ 38.1 and 42.7 per kg for No. 1 and No. 2 farms, respectively. The fixed cost in No. 1 farm was counted for 44% of the total production cost and the variable cost was counted for the rest 56%. The total sale at the break-even point in No. 1 farm was NT\$ 3,601,187, which was higher than its actual total sale of NT\$ 2,940,000. The quantity of sale at the break-even

point was 102,857 kg which was more than its actual sale quantity of 84,000 kg. The fixed cost in No. 2 farm was counted for 37% of the total and the variable cost was counted for the rest 63%. The total sale at the break-even point in No. 2 farm was NT\$ 2,147,735 which was lower than its actual total sale of NT\$ 2,463,750. The sale quantity at the break-even point was 47,724 kg which was less than the actual sale quantity of 54,750 kg. The total annual loss for No. 1 farm was NT\$ 260,084 and the loss per 1000 m² was NT\$ 92,953. Therefore, the payback period of facilities would be 4.5 years with the interest of capital not considered. If the interest was counted, the time for capital return would become 5.5-6.2 years. For No. 2 farm, the total annual profit was NT\$ 128,182 and profit per 1,000 m² was NT\$ 64,090. If the interest of capital was not counted, the payback period of facilities would be about 4 years. However, if the interest was counted, the payback period would become 4.8-5.4 years.

HOME ECONOMICS

Survey on the Lunch Eating Habit and Working Performance for the Farmer's Household in Taiwan

A total of 2012 households from the western district of Taiwan were surveyed with regard to the lunch eating habit as well as working performance in 1987. The average size of the farm household sampled was 6.63 persons, 75% of the farmers and their wives surveyed. were around the age of 41 years old. The results of the survey indicated that the breakfast was considered by most farmers to be the most important

among the three meals a day. 43% of family surveyed indicated their strong will to do their housework together as a team, and 73% of them satisfied with this kind of housework. 47% of family take lunch together with family members and 62% of them satisfied with this manner (Table 2). Economy factor, deliciousness, nutrition, sanitation and the simplicity of serving lunches are the major concern for the members of household. However, nutrition of food is regarded to be the most important by the housewives. Most housewives spent 31-60 minutes to prepare foods. The equal time is usually used to have their lunches. The families which use about 30 minutes time for dish-washing consisted of 79% of the total household surveyed. The persons older than 50 years of age were found to prefer eating rice

as the main food. The younger person with higher education and those with higher income tended to be keep away from this eating habit. More farm families in the northern Taiwan take their lunches out of home, in comparison with those in central and southern Taiwan.

Studies on the Relationship Between Taste and Quality of Kyoho Grape

This is a preliminary study trying to find the relationship between the chemical quality and acceptability of Kyoho grape. A total of 281 grape samples were collected from Tatsuen, Tungshih, Cholan, Hsinshe, Tienleng and Hsinyi. The grape collected from six places were used for quality analysis as well as for eating test by different consumers. About 58% of the consumers participated in the eating quality test preferred the grape with high sugar content, but 41% of them preferred the taste of sweet mixed with a little bit sour. Most consumers like to choose the fruits with large size, darker color and good appearance as the best quality of grape. Based on the fruit appearance and eating quality, the taste of grapes produced in Shinyih and Shinshe or Tsuolan were the most excellent ones. The grapes from Shinyih had larger fruit size, darker color, harder in texture, higher in the ratio of sweetness and sourness. The grape from Tatsuen showed a very high sugar content. The consumer showed a significant difference on the standard of like or dislike on the bases of sugar content, color, hardness aroma and sweet/sour ratio, etc. Therefore, it is very difficult to draw a conclusion as to what quality of the grape is the best one.

Table 2. The frequency and satisfaction with that did housework and had meals with their families.

Character	Did housework with their families		Had meals with their families	
	No. ¹⁾	%	No.	%
Frequency				
Always	431	21.4	940	46.7
Usually	862	42.8	872	43.3
Rarely	536	26.6	147	7.3
Never	150	7.5	22	1.1
Missing value	35	1.7	33	1.6
Satisfaction				
Very satisfied	329	16.3	599	29.7
Satisfied	1477	73.3	1250	62.1
Dissatisfied	99	4.9	43	2.1
Very dissatisfied	7	0.4	2	0.1
Missing value	102	5.1	120	6.0

1. Total number=2012.

ACTIVITIES OF AGRICULTURAL EXTENSION EDUCATION IN 1988

Strengthened Assistance to Farmers' Associations

The main purpose is to strengthen the assistance for Farmers' Association in Taichung areas to accelerate its business development. Besides, promoting production conditions, developing available resources as well as guiding the strategies including the improvement of marketing system providing production materials, developing rural communities and promoting farmer's welfare are the major functions of Farmers' Association. From July 1, 1987 to June 30, 1988, expenses for agricultural extension

Table 3. The amount of expenses and number of members in Taichung areas.

County & City	Farmers' Associations	Full members	Associated members	Business profit	Expense for agri. extension
Taichung County	21	59,418	44,835	246,081,000	129,537,000
Taichung City	1	11,227	14,653	27,261,000	16,407,000
Changhua County	26	107,395	25,272	257,490,000	140,251,000
Nantou County	13	61,052	19,261	173,278,000	99,480,000
Total	61	239,092	104,021	704,110,000	385,675,000

Organization and Guidance for Core Farmers

Integration of primary extension organizations and activities were carried out in township Farmers' Associations. During this year through the assistance of the Station to those Associations have organized 1,841 agricultural study groups with 20,206 participating farmers, 265 4-H club groups with 2,037 rural youths, and 1,515 home economic groups with 15,385 participating

(Table 3) to a total amount of NT\$ 385 million had been extended to 61 township Farmers' Associations in Taichung areas. The expenses were used to help these Associations to provide better services and to improve the incomes of their members.



Fig. 29. Director Dr. Hsieh briefing to the foreign visitors of this Station.

farm women. The cumulated record for such groups organized is 3,621 with a total of 37,898 participants (Table 4). Meanwhile, the Station also helped those Associations to design extension programs and communication for agricultural information, and a mail box for agricultural services was provided to answer questions from farmers and instructors were provided for training courses held by Farmers' Association (Table 5). Besides these guidances, the Station also offered instructors on some special

Table 4. The grouping for the 80,000 core farmers program in Taichung area.

County & City	Agric. study groups		Home economic study groups		4-H Club		Total	
	No. of groups	No. of persons	No. of groups	No. of persons	No. of groups	No. of persons	No. of groups	No. of persons
Taichung City	48	360	44	339	13	124	105	823
Taichung County	491	5,123	323	3,158	96	730	910	9,011
Nantou County	507	5,921	419	4,220	77	738	1,003	10,879
Changhua County	795	8,802	720	7,668	79	715	1,603	17,185
Total	1,841	20,206	1,515	15,385	265	2,307	3,621	37,898

Table 5. The accomplishments of agricultural extension education of Farmers' Associations in Taichung areas for 1988.

Item	Farm extension	4-H extension	Home economics extension	Total
No. of extension programs	7,494	4,560	6,572	18,626
No. of interviewed households	87,089	33,824	41,419	162,062
No. of participating trainees	100,270	41,726	99,730	241,726
No. of participants of meetings	46,141	16,388	30,401	92,930
No. of persons participated extension activities	143,165	64,289	123,192	330,946
Number of extension agents	327	80	82	489
Number of groups	4,502	1,679	669	6,850
No. of group members	25,310	16,417	20,572	62,299

subjects for the on-job training courses for staff of Farmers' Associations or foreign trainees.

were held: training classes for 310 agricultural instructors and 4 symposiums for core

Agricultural Training Center

The agricultural training center of Taichung DAIS was set up in 1985, is aimed to provide training courses for farmers and agricultural extension personnel. Its purpose is to improve farming methods and techniques, increase production efficiency and income, bettering levels of living, and lifting the social and educational standards of rural life. The following training activities



Fig. 30. The demonstration meeting of those involved in agricultural communication.

farmer leaders, with a total of 173 participants; and 10 seminars for agricultural extension personnel of the level of township and county, with a total of 268 participants. 21 training courses have been conducted in 1988, with a total of 751 participants.

Agricultural Consultation Services

In the past, the consultation services is a diffusive strategy of agricultural extension but it had a poor effectiveness in past experiences with the traditional model. So we took a innovative strategy for consultation service to further persuade farmers to adopt a new information and technology through the unilateral consultation model. First example of this consultation model which was held in 1985, recognized that the new model was more efficient than ever. Therefore, in the following years, the new model was adopted by this Station. In 1988 this Station, under this model, the consultation services included five subjects such as hogs, rice, vegetable, hydroponic culture and parental education have been carried out. A total of 720 participating farmers, 92 present specialists, 72 townships



Fig. 31. Farmers from Farmers' Association visiting the hydroponic farm of the Station.

participated and the range of percentage increased over the traditional model in a year basis is 12-44% (Table 6).

Table 6. A comparison between the traditional and unilateral models of agricultural consultation meeting.

Consultation model	Average No. of farmers attended each meeting	Average No. of specialists attended each meeting	Average No. of townships participated at each meeting
Traditional	57.83	7.88	1.17
Unilateral	104.00	12.50	7.10

Agricultural Communication

Agricultural news and technological know-how are transferred to the farmers through the media such as TV, radio newspapers and magazines (Table 7). Recently, emphasis has been put on the small-scale communications.

1. Agricultural TV Programs

A total of 17 five-minute agricultural TV programs were planned and produced by the Station during this year. It is contributed to the "Farm Report" and "Agriculture Column" shows broadcast each noontime from Monday through Saturday on Taiwan Television and China Television Stations, respectively. The Station also produced a total of 14 titles of educational taped materials for the training of the 80,000 core farmers.

2. Agricultural Broadcasting Programs

A 60-minute agricultural program entitled "Agricultural World" is broadcast at 1:00 P. M. every Sunday on the second channel (1,242 AM) of the Broadcasting Corporation of China (BCC). The agricultural programs of local radio station were

produced by this Station in cooperation with BCC.

3. Agricultural News

According to the ideas of Loomis and Buezele (1975), expressed in their strategy for rural improvement (or development) whether they are governmental organizations or non-governmental institutions should not wait for things to happen by themselves, but bring about change through planning. Our Station, following this "make things happen" strategy, has tried its best to cooperate with all the concerned media institutions. As a result, the Station and the news media coordinated on the distribution of agricultural news, prepared by Taichung DAIS as Table 7.

Table 7. Media coverage of agricultural news prepared by Taichung DAIS in 1988.

Media	News releases
TV	48
Radio	78
Newspapers	114
Magazines	44

4. Agricultural Extension Publications

Agricultural information and technological know-how transmitted to farmers through publications can be one of the most efficient agricultural communication activities. During 1988, the followings were the main publications carrying out this activity:

(1) Research Bulletin:

Its contents consist the results of research findings at this Station in 1988. This bulletin may provide the best evidence of our contributions, and serve as the basis for future development of the research activities at this Station. 21 issues have

been published up to date.

(2) Special Publications:

It is a proceedings of a symposium on various topics that is organized and published by this Station. The Special Publications has reached No. 14. The last three issues were published during this year.

(3) Agricultural Newsletters (Quarterly):

This publication has a circulation of approximately 25,000, and is aimed mainly at core farmers, young farmers and agricultural extension personnel. Its contents include the agricultural technology, agricultural laws and administrative orders, new agricultural know-how, farm life, extension activities, etc. The Quarterly has reached Vol. 10, No. 4.

(4) Extension Bulletins (Monthly):

It is published monthly and sent to concerned agricultural organizations and core farmers. 85 issues have been published.

5. Agricultural Taped Materials Library

A total of 589 pieces of video-tape covering agricultural extension, business administration, home economics, and other educational video-tapes have been collected in the library from areas all over Taiwan. During 1988, they have been lent out to



Fig. 32. Camping activity of the youth farmers from 4-H group.

the township Farmers' Associations to a total of 1,015 times. Moreover, Farmers' Associations have obtained 407 copies of these video-tapes.

Promoting the Model of Joint Farming

The Second-Stage Farmland Reform program is one of the most important agricultural policies that will sustain growth in agricultural sector and ensure coordination with overall economic development needed in the 1990's. This program includes: (1) financial support for the purchase of farmland to expand the farming scale; (2) joint, entrusted and cooperative farming; (3) land consolidation; (4) farm mechanization; and (5) other supporting activities. Joint, entrusted and cooperative farming is considered to be the major step for enlarging the farming scale without affecting the existing land ownership. Due to some limitation factors caused by existing conditions, the progress is not very successful. A new adjusted model which can solve some of limited factors was

released by the Station and welcomed by farmers. This model is encouraged by the Government. In central part of Taiwan, a total of 1347 ha. or 53% of total extended acreage were carried out under this new model.

Promoting Rural Development and Construction

In coordination with local Farmers' Associations and in consideration of the farmers' desire and rural developmental trends, a total of 83 supervisory personnel and 1520 farming family housewives received training in various courses. In addition, 5 nutrition cookbooks were published in accordance with the production of seasonal vegetables. In respect to enriching cultural facilities, preserving good social tradition, cultivating mutual assistance and promoting social harmony, the "I Love My Village" movement was carried out in 132 villages during this fiscal year. A total of 29,118 farm families benefited from this effort.