

RESEARCH AND DEVELOPMENT

RICE RESEARCH

Genetic Analysis of Rice Grain Size with Molecular Markers

RFLP (Restriction fragment length polymorphism) markers are basically co-dominant, phenotype-neutral, free from epistasis and of greater variations. The disadvantages of RFLP include the laborious procedures involved and the relatively high cost. Yet, the RAPD (randomly amplified polymorphic DNA) technique provides a faster and easier approach for exploring genetic polymorphism while requires only very small amounts of DNA.

Many important heritable characters, e.g., spikelet length, spikelet width and yield, are consequences of the joint action of several genes. Yet, little is known about the chromosomal position and interaction effects of genes controlling their expression. Breeders have traditionally improved these traits by selection based on phenotypes at the cost of time and efforts. Now RFLP and RAPD maps can be used directly in selecting desirable genes via their linkage to easily detectable RFLP and RAPD markers.

From this viewpoint, an attempt was made in this paper to examine and analyze the genetics of grain size with molecular markers in the F_2 population

from the cross ID-47 x 83N1168. The results show that QTLs were determined from differences between mean trait expression of marker locus genotypic classes, and described below.

Spikelet length: RG140 (chromosome 1), RG650 (chromosome 7), RG304 (chromosome 11), OPV6-920 (chromosome 9), OPV7-1240.

Spikelet width: RG140, RG147 (chromosome 1), RG13 (chromosome 5).

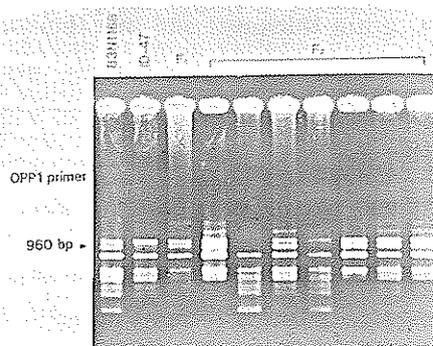


Fig. 1. Opp1-960 RAPD marker in F_2 population of the cross ID-47 x 83N1168.

The Relationship among Grain Size, Yield Components and Grain Chalkiness in Indica Rice

Twelve Indica rice varieties (line) were planted to study the grain size relation to yield components and quality in Indica rice. According to variance analysis of yield, it was not significant between varieties (lines). Those varieties with 29 - 30 gr of thousand grains weight were not necessarily higher in yield than

common grain varieties (lines). The main reason was due to its reducing in one or two yield components such as panicle number per hill, grain number per panicle and the percentage of filled grains. The effect of the percentage of filled grains to yield was significant by path analysis. On the other hand, the grain width was significantly correlated with brown rice rate(%) and total milled rice rate(%). One thousand grains weight of rice were significantly negatively correlated with head rice rate(%). Grain width, grain thickness and one thousand grains weight were significantly negatively correlated with the degree of white belly. This suggested that the grain quality may decline with the grain size.

Tolerance Test of Bacterial Blight Pathogen Strains on Rice Varieties

The 45 released rice varieties were selected for testing. The rice plants at late stage of panicle initiation were sprayed with semi-automatic sprayer with high virulent XM-42 bacterial blight strains, the infection rate was investigated and recorded. The result indicated that Taichung sen waxy 1, Kaohsiung sen 7 were the most susceptible varieties, followed by Taichung 186, Taichung 190, Chianan 2, Chianan 8, Chianung 242, Hsinchu 64, Taichung waxy 70, Taikeng 8 and Taikeng 7. The varieties with medium

bacterial blight infection rate but severely reduced in yield were Taichung 190, Kaohsiung 24, Taichung waxy 70, Tainan 6; while the yields of Taikeng 8 and Taikeng 7 were not severely reduced.

Cultural Test for the F₆ Generation of Indica-japonica Hybrid on Rice (*Oryza sativa*L.)

The test was conducted to study the effects of ideal type selection among 18 F₆ elite lines of indica-japonica rice hybrid and the yields under the different plant density. The trial employed 9 x 9 simple lattice design with four replications, two plant densities (20 x 20 vs 40 x 10 cm), Tcs-10 and Tcsw-1 using as the check varieties. The results showed that the grain yield in the plot with wide row and dense space between plants (40 x 10 cm) were generally higher than the treatment with 20 x 20 cm. The yield of the strain with the highest yield of 1100 g per 1 meter square was higher than the check varieties Tcs-10 and Tcsw-1 up for 20 % and 15 % respectively. These outcomes meet the performance of the coming ideal rice type proposed by IRRI. The average growth days among the trial strains were 7 days earlier than Tcs-10 and 10 days earlier than Tcsw-1, and 26 strains were selected based on the field responses, yields and rice quality etc. Test will be promoted to F₇ generation.

Application of the Bacterial Blight Resistant Near-isogenic Lines for Rice Breeding Program

I. The Agronomic and Physiologic Characteristics of Near-isogenic Lines and their Hybridizations

Bacterial blight caused by *Xanthomonas oryzae* pv. *oryzae* is one of the most serious diseases in rice culture in Taiwan. Several methods of chemical control have been tried against this disease, but none of them showed satisfactory result. It is commonly known that resistant cultivars may help control the disease. The near-isogenic lines which carry different resistance genes were developed by the researchers of the international cooperations. These near-isogenic lines include two current parents IR24 and Milyang 23 that were infected by Taiwanese strain XM42 of this bacterial pathogen. The more resistant lines to Taiwanese strain XM42 among them carried *xa-5*, *Xa-10*, or *Xa-12* resistant genes. The changes of peroxidase activities were also analyzed 4-days after inoculation. The relationship between lesion length of the diseased leaves and the increasing percentage of peroxidase activity was significantly negative. It indicated that the more resistant to this disease the higher increases of peroxidase activity. The hybridization had been held as TCS10/IRBB5 (*xa-5*) for

introducing resistant gene into the popular cultivar TCS10 of Indica rice in Taiwan. The responsiveness of F₁ progenies to the strain XM42 pathogen was susceptible and that of the F₂ population will be investigated in the future.

WEED RESEARCH

A Study of the Population Differentiation of *Imperata cylindrica* in Taiwan

Cogongrass (*Imperata cylindrica*) belongs to the family of Gramineae. The grass can grow in variable habitats, and its ability to endure stress environment is strong. In this study, there were fifteen sites where samples of leaves were collected for assays. Various ecotypes were found, particularly the grass growing at Chuwei is very unique. The grasses grown at Chuwei are wax-like on the surface of plant and rib with a hollow structure without ground tissue. Among the 15 populations of cogongrass in Taiwan, RAPD and PCR-amplified RFLP were employed for studying the ecotypic variation of the grasses. Based on the findings of RAPD, two major groups were found among 15 populations. Of them, the Chuwei population was distinguishedly different from the remaining 14 populations. In studying PCR-amplified RFLP, amplified via the PCR from 45 samples of 15 populations, 2800bp was found in IGS region and 690bp in ITS

region of rDNA in nuclear genome. Thirteen and ten restriction enzymes were used to digest 2 DNA fragments for IGS and ITS studies, respectively. After the clustering analysis, the result of PCR-amplified RFLP in IGS region agreed with the findings of RAPD. However, there is no significant difference among 15 populations based on the analysis of ITS region. Furthermore, variation of rpoC1, C2 and atpI, H, F, A gene fragments were located in chloroplast genome. However, there is no difference between each population detected PCR-amplified RFLP of two regions of chloroplast DNA. It is concluded that there are two different ecotypes based on the data of phenotypic characters and molecular findings. In particular, the population at Chuwei is very unique and is remarkably different from those of other 14 populations.

Effect of Select 25% E.C. on Weed Control in the Peanut Field

This study consisted of six treatments: 1) Select 25% E.C. 0.8 L/ha. 2) Select 25% E.C. 1.0 L/ha. 3) Pendimethalin 34% E.C. 5.0 L/ha. 4) Fluazifop-butyl 17.5% E.C. 1.0 L/ha. 5) Weed control with man. 6) no weed control.

The results showed that Select 25% E.C. 1.0 L/ha had the best effect in controlling Gramineae weeds in both

spring season and autumn season, but no effect on Cyperaceae and wide leaf weeds. Select 25% E.C. 0.8 L/ha and Fluazifop-butyl also showed good results.

In autumn season, it showed that weed control with man was the greatest in peanut production; Select 25% E.C. 1.0 L/ha the next, and Fluazifop-butyl the third.

In spring season, it showed that weed control with man was also the greatest in peanut production; Pendimethalin the next, and select 25% E.C. 1.0 L/ha the third.

The Diffusive Weed Control Effects of Sulfonyl-urea Herbicides in Paddy

The sulfonyl-urea was a kind of low dosage herbicides that was developed recently. For the control of paddy weed, it can be used at low dosage, wide application time and it can control perennial weeds. This experiment was conducted to compare the diffusive weed control effects of sulfonyl-urea herbicides in the paddy. The results showed that the diffusive weed control effects were connected with the solubility of chemicals. There was no chemical damage when applied at the rate of 0.675 - 1.35 g of the chemicals in the same point of paddy. All of these chemicals are less effective for the control of barnyardgrass.

RICE QUALITY

Effect of Germinated Spike on Rice Quality

The experiment was conducted to study the effect of germinated spike caused by continuous rainfall during maturing stage on rice quality. The artificial sprinkling system was set up to simulate the rainfall. The results indicated that the embryo viability was decreased as the grain maturity and sprinkle duration were increased in two crops, but there was a difference between varieties. The germination rate was about 60% and 25% in the 1st and 2nd crops, respectively. The milling quality was also decreased as grain maturity and sprinkling duration were increased. The head rice ratio was only 30 - 40% in the 1st crop. Among the physicochemical properties of rice, only gel consistency was harder by sprinkling. The eating quality was also worse, particularly in the 1st crop. The germinated bud length varied with varieties and sprinkling duration as the milling quality was affected. One thousand brown rice weight was decreased as the sprinkling duration increased. The damaged degree of starch granules varied with varieties in those severely germinated grains, some small holes or loose packing were found on those starch granules.

Effects of Packing Method and Storage Temperature on the Qualities of Small Packing Milled Rice

The variety, Taichung 189, was processed into milled rice, and then packed with vacuum, CO₂ and air in PE bags and then was stored at different temperatures. The stored milled rice were sampled each month for one year to study the effect of storage time, storage temperature and packing method on the grain qualities.

The results showed that the pH value of milled rice decreased in parallel with the length of storage time. The smallest difference in pH value was found when the milled rice both under vacuum and with carbon dioxide flushing were stored at low temperature of 5°C to 10°C or 15°C to 20°C. The pH value decreased significantly when the rice was packed in a sealed polyethylene bag and stored at room temperature.

Texturometer (GTX-2-IN) was used to measure the physical properties of the cooked rice. The results indicated that hardness and cohesiveness increased, but viscousness, adhesiveness and balance decreased during storage when milled rice was sealed in polyethylene bags. Those stored at low temperature showed the better physical properties than stored at room temperature after the similar length of storage. There was almost no change in

the physical properties of cooked rice when milled rice both under vacuum and with carbon dioxide flushing were stored at any one of three different temperatures for one year. The summer's temperature in Taiwan is usually over 30°C, so packing milled rice under vacuum or with carbon dioxide flushing or storing it at low temperature may provide the best result in prolonging the fresh quality of milled rice.

Effects of Intermittent Drying on the Growth and Quality of Rice During Vegetative Growth Stage

A field experiment was conducted in 1993 and 1994 on Taichung District Agricultural Improvement Station to investigate the effects of early intermittent soil drying on the growth and quality of three rice cultivars, Tainung 67, Taichung 189 and Taichung sen 10. Soil drying to 0.06 millibar moisture tension were practiced at 30, 40 and 45 days in the spring, and 20, 25 and 35 days in the fall, respectively, after transplanting.

Experimental results showed that intermittent drying imposed on the spring crop at early growth stage significantly decreased rice tillering, and also the grain yield. Cultivar Taichung 189 responded to early soil drying more sensitively than that of Taichung sen 10. In the fall crop, early intermittent soil drying increased 1000 grain weight and seed setting

percentage, in spite of the decrease in tillering. The volume weight, translucence of rice were then promoted and percentage of white center and belly grain were decreased. And thus enhanced the quality of rice.

The results suggests that in the fall crop, intermittent soil drying in 20 to 25 days after transplanting that helped increase rice grain weight, is essential to a better quality of rice. Taichung sen 10 showed a better yield and quality than Taichung 189 while imposed to early soil drying.

Studies on the Identification of Wet Rice Quality

In order to develop a method for rapid grading of wet rice after harvest, an experiment by using microwave to dry wet rice was studied at Taichung DAIS in the first and second crop of 1994. The results indicated that it is not easy to inspect the grain quality of fresh wet rough rice, due to the difficulty in husking and increase in cracked kernel. But it can be solved when the grain moisture content is reduced to 18% or less by using microwave. At that grain moisture condition, the rough rice is easy to dehusk and the ratio of cracked kernel during process is also decreased. It takes about 4, 3, 2.5, 2 and 1.5 minutes with the microwave power of 260, 325, 520, 585, and 625w to reduce the moisture content of wet rough rice by normal harvest down

to 18%. Therefore, this fast drying method by microwave can be practiced for detecting wet rice quality, when rice was sold in the form of fresh and wet type.



Fig. 2. The comparison of brown rice appearance between the rice before and after drying. Upper: husking after drying, Middle and lower: husking before drying.

UPLAND CROPS

The Studies on the Stability of New Lines of Job's-tears

This regional yield trial was conducted in the Spring crop Season both in 1992 and 1993 at four locations in Taichung district. Seven newly developed lines, including Chingyang, Chintes, Kuangchou, Taichung Shuen yu No. 3, 4, 5 and Taiwan Native line, Kangsan Native line as check variety were tested for their yield potential and adaptability. The preliminary results were Summarized as follows:

Among eight tested lines, Taichung Shuen yu No. 5 have better stability in all environments with higher yield potential.

Its average grain yield was 3183 kg/ha, that were 26.2% higher than that of the check variety - Kangsan Native line. Its plant number per m², spikelet number per plant, ripening grain and 1000 grain weigh were better than those of the check variety. This new line will submitted for naming and registration in the late January, 1995.

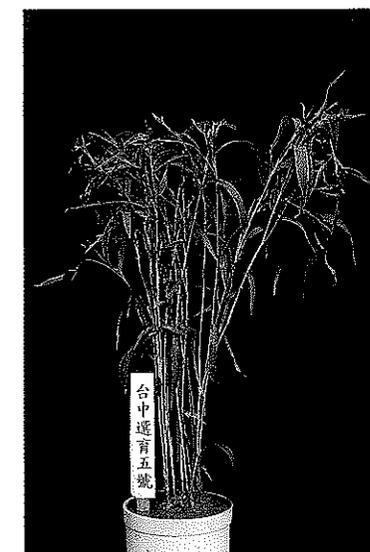


Fig. 3. Plants of job's-tears "Taichung shuen yu No. 5".

VEGETABLE CROPS

Study on the Newly-risen Leafy Vegetable for Summer Season

In order to exploit new summer leafy vegetables, ten varieties of seven kinds of new vegetables were evaluated and results showed that Senpotsai, Shiau-Song-Tsai and leafy radish possessed the good characteristics such as rapid growth rate, heat and wet tolerance and could be harvested 20 - 25 days after sowing. They

are more suitable for planting in summer season than other leafy vegetables. Among them, the quality of Senpotsai is the best and it is recognized the most promising.



Fig. 4. Newly-introduced leafy vegetable "Senpotsai No. 2".

Cultural Practices of New Vegetable - Jew's Mallow

Jew's mallow is a vegetable originated from mediterranean area for frying or making soup. The first year of variety trial indicated that the best sowing time is from April to June, having high yield. Early or delay sowing will be affected by short day-length and low night temperature and resulted in bolting and flowering, slender and short leaves without any commercial value. The trial of young shoot harvesting indicated that the young shoot of 20cm in length have the best performance, but in term of speed of harvesting, the young shoot of 10 cm is more recommendable.

The Collection and Trial of Leek Varieties

This experiment is aimed at collecting the local varieties of leek (*Allium tuberosum*) for conducting their comparison experiment for the classification and preservation of leek germ plasm. The results are summarized as follows: (1) six year-round flowering varieties of flower leek are collected from the flower leek growing area, and graded in accordance with their bolting rate, flower stalk size and length. (2) 29 lines of the Tenwei dark green leaf lines of leafy varieties of leek are selected and classified into large leaf varieties and small leaf varieties based on the leaf size. They are also divided into dark leaf varieties and light leaf varieties based on the leaf color, and classified into hard-stem varieties and soft-stem varieties based on the plant type, and the length of stalk, the size of stem, quality, taste and its easiness in cultivation are also recorded as a reference for the growers. (3) 199 plants are selected from the leek growing area and multiplied vegetatively into 199 lines, Among them 11 unbolted lines seems to be suitable for being used as the leaf leek, From the bolting character, the leek may be divided into three types: year-round flowering, seasonal flowering, and non-flowering.

The Effect of Non-woven Material on the Growth of Leaf Vegetable

The higher temperature was obtained by inceasing the base weight of non-woven material for mulching especially it was helpful to improve the growth of crop in cool weather. Therefore, either in autumn or winter crop Chingken cabbage or cabbage under non-woven waterial mulching grew, faster than those without mulching. The spreading of plant, the width of out side leaf, the average weight of plant, the head weight of cabbage were improved under non-woven material mulching. In spring crop, the base weight of 42 g or mulching obtained the lowest head weight, head size and head diameter. It seemed to be affected by the high temperature caused by the non-woven material during the late period of heading. Increasing in chlorophyl was found in Chingken cabbage or cabbage under non-woven material unlching, especially more increase in chlorophyl B. The tip-burning was serious on cabbage under non-woven material mulching due to the deficient of calcim in spring crop. The insect damage was serious in the plots without non-woven material mulching. However, it was improved in non-woven material mulching. No difference was found among the various methods of mulching.



Fig. 5. Using nonwoven material can control insect pests on vegetable cultivation.

Economic Analysis for Vegetable Production under Protected Structure in Taichung Area

This study was aimed to analyze the current situation, production cost, revenue and economic efficiency as well as to find the suitable structure type for the summer leafy vegetable production under simple protected structure in Taichung area. The data was obtained from 35 sample famers from 1991 to 1993. It was found that most of the summer leafy vegetable cultures under simple protected structure were located in Changhwa county and of them, the major structure was net-house, followed by the plastic-film greenhouse. The products were mainly sold to the country assemblers or the Taiwan Sugar corporation. The gross revenue, the net revenue, the return to family labor and the farm earnings were all the highest for summer leafy vegetable production under mixed structure type of net-house and plastic-film greenhouse

among all structure types. The next one was the culture under net-house. For the production cost, the summer leafy vegetable culture under mixed structure type and plastic-film greenhouse would be the highest and the culture under net-house would be the lowest. However, for annual economic efficiency per 10 ares, culture under the net-house was the highest with NT\$146460, followed by culture under the mixed structure type with NT\$134305. Generally speaking, the pay-back periods for facilities investment were about 0.3 year for the net-house and 1 year for the plastic-film greenhouse and 1.3 year for the mixed structure type. According to the above analysis, the net-house and the mixed type house would be most suitable for the summer leafy vegetable production under simple protected structure in Taichung area.

FLORAL CROPS

Study on New Techniques of Cut-flower Production in Rose

The production of high quality of cut-flower in rose could achieve under the following condition. The rose is grown under greenhouse facility using rockwool and nutrient culture method. By arching and twisting techniques, the branches are separated into vegetative growing system and cut-flower growing system, resulted in greater sunlight at base area, reducing disease occurrence, convenient in mana-

gement operation. The high quality cut-flower can produce from the dominant basal shoot. The nutrient solution was adjusted to maintain the balance of nutrition supply. The cut-flower grew rapidly and evenly, 80% of cut-flower belonged to 1st grade, higher than the traditional soil culture of 48% by 67%. The automatic heating and shading control could avoid unfavorable weather conditions and produce cut-flower all year-round. The development of local facility material could reduce the high production cost of protected cultivation.

Studies on Enhancing the Sprouting Rate of Axillary Bud on Rose

Rose is one of the most important cut flower in the world. It is of importance in Taiwan as well. Approximately, 530 - 1600 thousand rose seedlings are needed every year in Taiwan. In several propagation ways of rose, cutting is the most popular one. However, cutting is relative more difficult for axillary bud sprouting. In order to improve the sprouting rate of axillary buds, several treatments including cooling, dark, acadian seaplant liquid concentrate, BA and GA plant growth regulator were adopted to treat rose 'Samantha' cuttings which contain 2 nodes and 2 leaves for each cutting. After 15, 25, and 35 days, the sprouting of axillary bud and the length of new shoot were investigated.

The results indicated that though BA

could promote the sprouting rate of axillary bud, high BA concentration would lead the sprouted buds deficient in nutrition in 35-day's treatment. In general, cooling, dark treatment, and acadian seaplant liquid concentrate were available to enhance the sprouting rate of axillary buds. Plant growth regulator, GA could increase the length of shoot.

Studies on the Growth Efficiency of Chrysanthemum Cuttings after Different Storage Treatments before Rooting

The cuttings of Chrysanthemum (*Dendranthema grandiflorum* cv. 'Yellow Shiou-Farn') were collected from field, immersed in Benlate solution of 50% WP 1000 ppm, and then treated with NAA 1000 ppm talc powder reagent at the base of stem. These treated cuttings were then put into a growth chamber with 95% relative humidity under 12, 15, and 18°C for 4, 7, and 10 days. This pre-rooting storage was conducted in a dark condition through out the experiment. After storage in particular time intervals, cuttings were planted on rooting bench. The cuttings collected from field at the same time were planted directly without storage and were used a control.

The results indicated that the cuttings after storage treatment had better growth. The root length was longer than that of without storage. Through anatomic observation by using paraffin

method, root primordia were found differentiated and developed in the cuttings after pre-rooting storage. It was estimated that pre-rooting storage could save 2 - 3 days of bench time. This suggested that the pre-rooting storage method can be utilized to save bench time and promote the production efficiency of cuttings in a particular time and in a specific area.

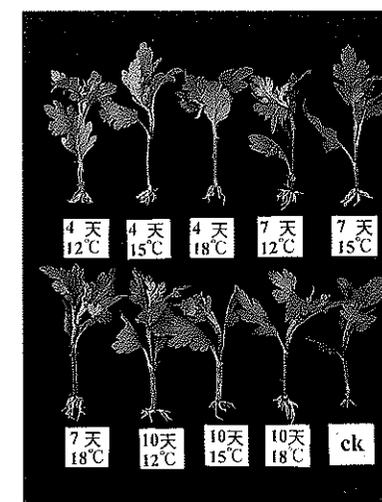


Fig. 6. Using pre-rooting storage method could promote the rooting of chrysanthemum.

Chrysanthemum Cut Flower Bud Viscoelasticity Property

The force relaxation and creeping behavior characteristics of chrysanthemum cut flower were predicted by a Generalized Maxwell model which consisted of three parallel Maxwell elements and four-element Burgers model. According to force relaxation equations of chrysanthemum cut flower bud, it was predicted that the relaxation force of chrysanthemum

cut flower buds would become "0" after 15 hours. Thus, the beginning deformation would become permanent after 12 days. Therefore, for the lowest layer packages of chrysanthemum cut flower, its allowable amount of deformation should be the added value of the beginning deformation and its deformation during the saving period caused by its creeping behavior. In the case of chrysanthemum cut flower with an average weight of 60 g, its deformation caused by its creeping behavior was 1.52mm after saving for 12 days. Since the allowable deformation for chrysanthemum buds was 5mm, the beginning deformation should be less than 3.84mm. So, for a package of 200 pieces of chrysanthemum cut flower, the best height of its package should be 26.8cm.

Study on Cultivation and Management of Ornamental Plants in Common Family

An automatic drip irrigation system was suggested to use for saving time and water resource to take care of the plants for common family. It included a timer, electrically controlled valve, pump, and a linkage pipe channel to transport water. It was automatically controlled by timer, and can supply different amount of water for different kinds and size of plants.

The result indicated that the potted foliage plants should be irrigated to one third or half of the volume of the potted

growing media by automatic drip irrigation system once or twice every day, and respectively 200ppm of N and K₂O should be added to the irrigated water once per every two weeks.

There is no difference among the compound media, but the plants generally grew better when lighter and higher absorption material were used.

The Fertilization Technique of *Cymbidium sinense* in Soil Culture

A sandy loam soil mixed with 2% of fully fermented organic materials (such as tree bark manure, cattle manure and peat moss) was used as the cultural medium for *Cymbidium sinense*. The foliar spray of liquid fertilizers No. 1 and 2 was applied at two weeks interval. The results showed that the pH, P₂O₅, K₂O and CaO in the three organic treatments were increased, the soil total bulk density and hardness is decreased, and therefore it rendered significant effect on the root growth of orchid. Besides the flower stem length, flower number, flower width as well as the bolting percentage and flower stem number were also increased. Among them, tree bark manure was the best in performance.

The Effect of Growth Regulator on the Micropropagation of Liliium 'Casablanca' and *Cymbidium ensifolium* from Tissue Culture

For establishing a prolific micropro-

pagation method for tissue culture, liliium and cymbidium were used to study their responses to the added growth regulators in the medium.

Bulb scales of lily were tested on MS basal medium supplemented with various concentrations of BA (2, 4, 8 mg/l), 2,4-D (0, 0.2 mg/l), and NAA (0.2, 0.5 mg/l) to confirm the proliferation capacity of shoots and bulblets. Bulblets were rapidly induced from scales cultured on MS medium containing 0.2 mg/l NAA and 4 mg/l BA. The growth rate of new shoots increased much faster in a medium containing 0.5 mg/l NAA and 8 mg/l BA.

Seed germination of *Cymbidium ensifolium* was promoted in Knudson C medium supplemented with 20 g/l sucrose and 4g/l activated charcoal. Adventitious roots were induced by 1/2 MS medium containing BA growth regulator. Shoots in a cluster were formed from rhizomes which were cultured in a liquid medium by shaking. After one month, the proliferation of shoots and roots seemed to perform better in a liquid medium. These rhizomes then could be transferred to a MS solid medium for regeneration. The growth of plantlet was enhanced through tissue culture with 2 mg/l NAA, 3 mg/l activated charcoal, and 30 g/l sucrose.

FURIT TREE CROPS

Prediction of the Optimum Timing of Top-grafting of Pear Tree

Top-grafting high chilling pears on Hengshan pear tree was a successful industry in lowland of Taiwan. Although the price of product was acceptable, growers were interested in making earlier top-graft due to the higher price of the earlier products. The results were always a failure. Therefore, how to identify the optimum timing of top-grafting by predicting the time of budbreaking of Hengshan trees was a key point in the improvement of cultural techniques. This prediction was difficult in field form the appearance of trees. Internal changes of trees may provide an available guide. Based on this idea, the trials were conducted to compare the changes of specific gravity, content of starch, and activity of dehydrogenase of Hengshan pear dormant branches before and after budbreaking. Staining branch section with KI was also conducted. The results showed that the rate of budbreaking was 6.8% on February 15, 1993, then increased rapidly. Sixteen days before the above date (January 31), the activity of dehydrogenase reached the peak at O.D. 1.82, specific gravity was the lowest at 1.048, the content of starch was at the lowest of 299 μ g/g D.W., and the content of soluble protein was also at the lowest

level of 512 μ g/g D.W. In addition, KI staining obtained a positive response to the starch content inside the branch. It could be a good guide to predict the budbreaking.

The Application of Horticultural Practices in Inducing Off-season Flowering of Ponkan (*Citrus reticulata*)

This study was conducted to survey the off-season flowering of ponkan and the possibility to regulate production season artificially. The growth of the Summer-flush was inhibited by ringing and root-pruning since June, and the induction of Summer-Autumn flushes was followed by pruning, fertilizing and irrigation during September and October. The results showed that ringing and root-pruning at June had better effect on shoot-inhibition and off-season flower induction, the treatments in August and latter had no difference to that of the controls. The trunk healing were slower in those ringed after October and the leaves were weakened to drop in the winter, which caused the flowers formed earlier but the fruitsetting were poor. It seemed that the off-season flower rate of the Autumn-flush could be promoted by means of ringinng, root-pruning and fertilizing according to the results of this year, whereas the huge difference among the trees and low fruitsetting revealed that the economic production by off-season flower is still a long way to go.

The Feasibility to Produce Two Crops of Oriental Pear in a Year

Taichung DAIS have developed the "Twice Bud-forcing Cultural Practice" to replace the "Top-grafting Method" in high quality Oriental pear production at low elitude area. In forcing stage of fall season, some buds have already formed the flower-bud and started to flower or fruit-set. In order to increase the production value, some study on the flowering and fruit-setting condition was conducted to make it possible to harvest two crops in a year.

Application of 0.6% hydrogen cyanamide on "Hosui" and "Shinko" pear trees was made on Aug. 23, Sept. 2 and Sept. 12. The buds emerged in 8 - 10 days after treatment, the bud bursting percentage was over 89%, then bloomed after 14 - 16 days. The blooming rate for "Hosui" and "Shinko" were 22.5%, 37.8%, 61.3% and 10.1%, 28.5%, 42.6%, respectively. The fruit-setting rate for "Hosui" and "Shinko" were 30.7%, 35.5%, 49.1% and 16.8%, 29.1%, 42.2%, respectively. After fruit-thinning, 20 leaves was maintained for each fruit. The fruit development in each treatment plots is very good, the fruit can be harvested in late January to perform the idea of harvesting two crops in a year.

The Effects of Trellis-training Systems on the Growth and Cultural Labor of Grape

This experiment was conducted to clarify the influence of some trellis-training systems on the growth and production labor of grapes. The trellis systems were: (1) 2-stories Duplex V-shaped two-armed umbrella system, (2) 2-stories Duplex two-armed fence system, (3) 6-wire vertical single-armed fence system, (4) 3-harvest V-shaped treellis and (5) horizontal trellis. The results indicated that the amount of fruiting cane of summer crop was lower than that of winter crop, whereas the budburst of summer crop was higher than winter crop. The vertical single-armed fence system had the least number of fruiting cane, and consequently, the number of budburst as well as flower cluster were lowered down. Meanwhile, all shoots in this trellis system grew vigorously resulted in the lowest rate of cease of shoot-tip growth during blooming period. The number of flower cluster in summer crop appear to be higher in (4) 3-harvest V-shaped, (1) Duplex umbrella and (5) horizontal trellis systems. The Duplex umbrella trellis also had highest amount of flower cluster in winter crop. The longest flower cluster were found on the vigorous shoots of summer crop on vertical single-armed fence. However, the fruitset was poor, the rate of shoot

re-growth was high and the lignified shoot was short. The climate during the experimental period was unstable, some natural disasters such as drought and typhoon were harmful to the growth of shoot and fruit in winter crop. The largest fruit cluster were found in summer crop of Duplex umbrella system. On the contrary, the smallest was found in winter crop of vertical single-armed fence system. The sugar contents and acidity of summer fruits were not significantly different among all system. In winter crop, the sugar contents of fruits was the highest on vertical single-armed fence system. An estimation of labor demand indicated that the working hour in 3-harvest V-shaped and Duplex fence trellis were 17.4% and 18.5% higher than that of horizontal trellis system. Duplex umbrella system and vertical single-armed fence system saved 2.3% and 25.6% of labor, respectively, because of their low productivity.

SOIL AND FERTILIZER

An Experiment on the Possibility of Organic Farming in Central Taiwan

The results of the experiments suggested that organic farming is workable in central Taiwan, and upon the implementation of organic farming the yield and quality of many crops as well as the soil fertility may be greatly promoted. The main methods and results are

summarized as follows:

1. Combine rice hull charcoal with useful microorganism in organic manures and apply immediately to the soil soon after the combination may greatly promote the effect of organic manures.
2. Sometimes it is necessary to apply proper rate of manganese to the organic plots to prevent serious manganese deficiency of some crops.
3. Under this series of experiment, sugar-vinegar or sugar-woodvinegar was used as the routine spray. Different kinds of natural expellants such as garlic, hot pepper, tobacco, neem, wormwood, citronella, peppermint, wine, kerosene, castor bean oil, camphor oil, and useful microorganism etc. were added to the spray depending on the difference in crops and pest to promote its effect of pest control. As for the night moths, *Bacillus thuringiensis* usually performs a very nice job of control.
4. The rotational cropping system with three crops a year, i.e., grow heat-tolerant crops in the summer, cold tolerant crops in the fall-winter, and rice or other suitable crops in the spring seems to be a good system helpful to promote the economic efficiency of organic farming.

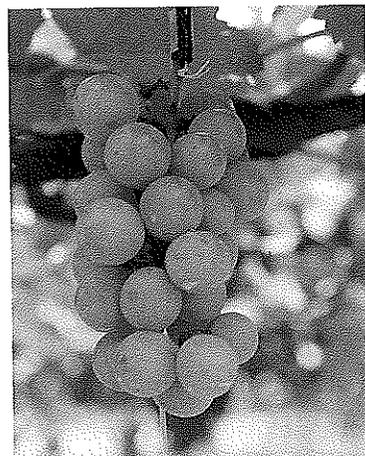


Fig. 7. Attaching magnet to the grape cluster would increase its fruit sugar content.

One of the Sery Studies of Sustainable Agriculture Techniques

II. The Effect of Magnetic Force on the Crop Cultivation

In order to develop some techniques for the sustainable agriculture, a series of experiment has been conducted at Taichung DAIS to Study the effect of magnetic force on the seed germination potential, root elongation and product enhancement since 1994. The preliminary results showed that the germination potential, root elongation and nutrient absorption of corn, and the berry quality, sugar content, acidity, balance of sugar to acid and rind color of grape, could be enhanced by the magnetic force. It is assumed that application of magnetic force to crop cultivation have a good future in view of environment protection and soil conservation.



Fig. 8. Maize root treated with magnet (in the left) is much more denser, than that treated with no magnet (in the right).

Effects of Different Organic Wastes and Aeration Rates on the Nutrients Contents in Composts

In order to control the nutrients contents in composts derived from organic wastes, it is necessary to understand the changes of C, N, P and K during composting. Experiments with two ingredients (A: chicken-sawdust-rice straw, B: dairy-sawdust-rice) and three aeration rates (6.6 ± 0.5 l/min, 13.8 ± 0.9 l/min, and 25.4 ± 1.9 l/min) were conducted to study the effects of organic wastes on the changes of C, N, P and K after composted. The results showed that the concentration of C decreased and the concentrations of N, P and K increased during composting. The loss rates of the total amounts of N, C and dry weight in

compost were 31.4%, 58.7% and 48.8%, respectively, in B ingredient, and 37.1%, 64.9%, 52.1%, respectively, in A ingredient. Results derived from aeration treatments showed that the loss rates of the total amounts of N and C were 22.0% and 61.6%. There were not significantly losses on the total amounts of P and K during composting.

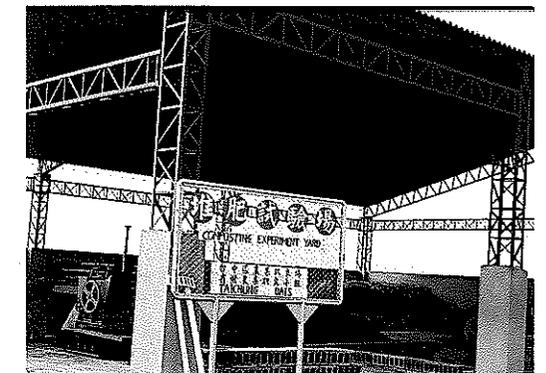


Fig. 9. Composting experiment yard in Taichung DAIS.



Fig. 10. Organic wastes in composting.

Effect of Manure on Vegetable Yield and Soil Fertility under Protected Culture

The experiment is conducted at slate

alluvial calcaeous soils under protected PE film pipehouse at Yungchin, Changhua county to study the effect of different manure on the yield of vegetable crops and the soil fertility under protected facility. The result indicated that the yield in organic rice straw plot is increased by 4.3 and 0.5% for Pai-tsai and amaranth, respectively, under same total nitrogen condition. The effect of organic fertilizer on soil fertility is that it could increase soil pH value by 0.03 - 0.37 and increase soil organic matter by 0.2 - 0.3%, available phosphorus by 11 - 149 ppm, exchangeable potassium by 11 - 230 ppm. After two crops of fertilizer management, soil electric conductivity is increased by 0.64 - 0.83 dSm than pre-experiment and it will not affect crop germination and growth.

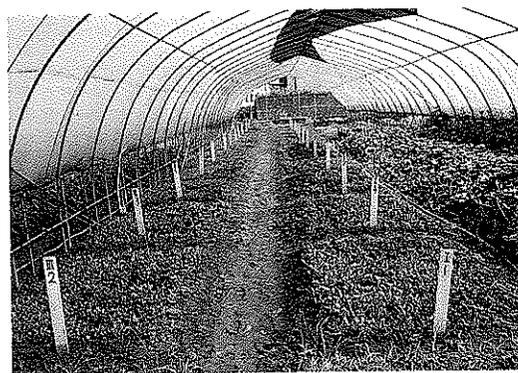


Fig. 11. Plots for the experiment of manure effect on protected vegetable.

The Application Status of Organic Fertilizer for Citrus Orchard in Central Taiwan

Citrus is an important fruit tree in central Taiwan, the cultivation acreage is 10360 ha. The major citrus species is Pon-kan, naval orange, tangerin and Wen-tan, covering 25% of the total cultivated land. The citrus in central Taiwan is mostly grown in the slope hill region with very low organic matter. The government subsidy program for organic fertilizer have been carried out recently, in order to improve soil fertility and increase productivity. The result of questionnaire made for citrus growers in central Taiwan to study the application status of organic fertilizer in citrus orchard are as follows:

The commercial organic materials mostly popularly used by citrus grower in central Taiwan are mushroom compost, tree bark, saw dust, poultry manure, soybean extracts, feather, rice hull, sugar cane extract, tobacco stem and fermented fungi. The application time is after fruit harvest as basal fertilizer. Manual application method is the most common, due to slopeland situation. The application rate is different with tree ages, yield and fertilizer component, but the average is about 8000 kg/ha.

There is 64.1% of citrus growers, receiving the service of soil fertility test for their orchard, and 52.3% of them receiving the service of leaf nutrition diagnosis from experiment agency. 94.9% of them said the organic fertilizer

organic fertilizer, 57.2% of them said it is acceptable, 42.8% said the price is too high and hope to get subsidy from government. After Taiwan join GATT, 83% of growers said it will have strong impact on citrus industry, 14% of growers said the affection will be mild, 3% of growers said no effect. The counteract policy is not to increase the citrus cultivation acreage, but to improve management efficiency, reduce production and marketing cost and increase fruit quality.

Studies on the Utilization and Planning for the Composting of Household Garbage of Rural Communities in Taichung Area

According to the concepts of rural development planning and community development, the rural communities is used as an operative unit that may consider the specific aspects of the respective surroundings including ecological, social, institutional and economic settings. A total of four communities were selected to execute the composting project of household garbage in central Taiwan during July, 1993 to June, 1994. The present paper describes the integrated planning, practice procedures and composting technology for the composting utilization of household garbage, based on the results of this preliminary research. In addition, the feasibility and ensuing extension of this model to the inhabitants

of rural communities is also reported.

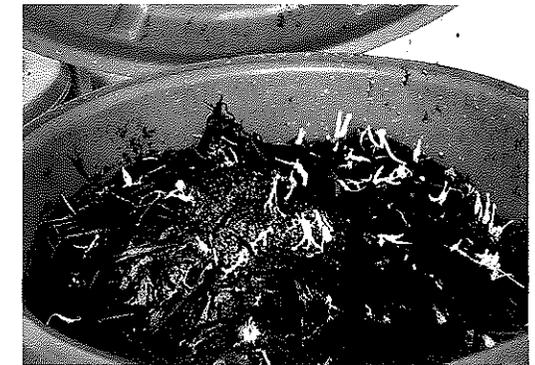


Fig. 12. The maturation of organic wastes.



Fig. 13. One of the locations for composting household refuse in Taichung County.

PLANT PROTECTION

Occurrence and Effect of Grey mold on Loquat

Grey mold is the major disease of loquat. The optimum temperature for spore germination is 20 - 28 °C, for mycelium growth is 24 - 28 °C. As the production area of loquat is located at slopeland district, during Jan. - April and Oct. - Nov., the average temperature is

around 20°C, that is not suitable for the germination of spore and the growth of mycelium while during May - Sept., the mean temperature is 25 - 29°C, that is very suitable for disease occurrence, and the infection rate could reach 50%. Within 10% disease infection rate, the leaf number during fruit enlargement stage maintained 15 leaves, blooming rate was 80%, fruit weight and sugar content was normal. When disease infection rate was higher than 20%, the leaf dropped immaturely or yellowed, the leaf number was only 5, the blooming rate was less than 60%, the fruit weight per cluster was 80g, low sugar content, and therefore, the yield and quality of loquat was significantly reduced.



Fig. 14. The grey mold of loquat.

Chemicals Screening Test for Control of Rice Stem Blight

The stem blight is used to infected 2nd rice crop, but in recent years, the 1st crop is also infected seriously. There have been recorded that no rice varieties is resistant to stem blight, so the control of stem blight is mainly depending on chemicals. There are 27 chemicals being released for commercial application since 1958. However their chemical effects were significantly different after long term of use. The chemical screening test for control of rice stem blight in 1st crop, 1994 at Minchieng village showed that two applications of 25% Pencycuron W.P. 2000x, 23.2% Pencycuron F. 2000x, and three applications of 10% Hexaconazole E.C. 1500x, 20% Flutolanil F. 2000x, 24.9% Difenoconazole E.C. 2000x showed better control of stem blight than other chemicals or control plot in term of stem infected rate or spot rate. The chemical screening test in lab conducted by TARI showed that the chemicals with control and prevention effect were 75% Carbendazim + Mepronil W.P. 750x, 10% Hexaconazole E.C. 1500x, 20% Flutolanil F. 2000x; the chemicals with good prevention effect were 25% Pencycuron W.P. 2000x, 23.2% Pencycuron F. 2000x, 40% Mepronil W.P. 1200x, 50% B-enomyl W.P. 1500x, 55% Carbendazim + Iprodione W.P. 1000x. The chemical with

good control was 6.5% MAFA S. 2000x.



Fig. 15. The soaking symptom of rice stem blight.

Water-melon silver mottle virus transmitted by *Thrips palmi*

During the growing season of 1988, a virus-like disease which causing significant losses in watermelon occurred in Ellin and Tacheng area of Changhua county. Later it was identified as a tospovirus and demonstrated it is serologically related to watermelon silver mottle virus (WSMV) in Okinawa. When allowing the larvae of *Thrips palmi* to feed on the WSMV-infected leaves of *Datura stramonium*, either the larvae and adults could transmit the virus. But if exposed the adults on the diseased leaves, none of them transmitted the virus. The threshold period for acquisition feeding was determined as 30 min and it required a latent period about 2 - 3 days before transmission. Efficient transmission was obtained by exposing the 1st and 2nd instar larvae of *T. palmi* on diseased *D. stramonium* for 24 hr and each plants received 5 adult thrips, reaching rate of

30 and 20%, respectively. When the seedling of *D. stramonium* received 1, 5 and 10 adult thrips inoculation which had exposed to feed on the diseased plant for 24 hr during larvae stage, 8, 30 and 40% of the inoculated plants developed typical symptom of WSMV. The infected efficiency seem to be increased with the increase of inoculated thrip number. The viruliferous adult thrips initiated to infect plants at the 2nd days after emergency. In order to determine the viruliferous thrips after acquisition feeding, the thrips using for experiment were allowed to feed on diseased leaves for 1, 6, 12 and 24 hr and detected by ELISA immediately. The results showed 10, 24, 20 and 19% of the test individual gave positive reaction, respectively. On the other hand, the percentage of viruliferous thrips had no increase when allowed the larvae to feed on diseased plants for 1 hr and detected by ELISA at adult stage. When using 5 adult thrips which had feed on diseased at larvae stage as mechanical inoculation virus source to inoculate the seedling of *D. stramonium*, it exhibited typical ring symptom on *Benincasa hispida* and the tospovirus about 70 - 90 nm could be observed by electron microscope. Extra thin section of the viruliferous *T. palmi* revealed spherical particle about 70 - 90 nm distributed in the abdomen region.

Effect of Soil Amendment and Disease Infection of Bulbs on the Occurrence of Bulb Mites

Gladiolus and lily plants were grown in potted peat or soils amended with tree bark, cow excretion, seabird excretion, fish powder or organic fertilizer. The occurrence, with or without inoculation, of mites on the bulbs was determined after one month. Under natural conditions, only 0.2 - 8.5 mites/bulb was observed on bulbs grown in peat or soil amended with bark, which was considerably lower than 29 mites/bulb on bulbs grown in unamended soil. Addition of organic fertilizer to the soil increased the occurrence of bulb mites to 56.6 mites/bulb. With inoculation of the same number of mites, significantly fewer mites were found on bulbs grown in peat or soil treated with bark. The numbers of mites on the bulbs were increased by 1.5 to 3.1-fold when the plants were grown in soils with fish power, organic fertilizer or cow excrete. In addition, 7.9 to 10.1-fold more mites occurred on diseased bulbs or bulbs inoculated with *Pseudomonas* spp. pathogens as compared with healthy bulbs. Under inoculation of mite source, slightly more mites were found on unhealthly bulbs than on healthy ones.



Fig. 16. Bulbs infested by root mites.

Field Observation on the Use of Sex Pheromone to Control *Spodoptera litura* on Soybean in Indonesia

The Agricultural Technical Mission-Republic of China to Republic of Indonesia (Surabaya) introduced a total of 35,000 lures of sex-pheromone from the Taiwan Agricultural Chemical and Toxic Substances Research Institute to test and demonstrate the use of sex-pheromone for controlling *Spodoptera litura* in soybean field in East Java, Indonesia. The field observation and demonstration activities were carried out in 1989 - 1992. The comparison test of pheromone + chlorpyrifos and chlorpyrifos alone was employed in 1989 at Jombang. Both treatments had very good results on the controlling *S. litura*, but the application of chlorpyrifos was decreased from 7 times to 4 times when pheromone was used together with chlorpyrifos. The leaf damage by insect was about 15 - 16% for both treatments. Large scale field observation test was conducted at Gresik and Lamongan in 1991, and Ngawi and

Jombang in 1992 with a total acreage of about 270 ha. Three sex-pheromone traps were installed one week after seeding and renewed about 35 days later. An average of 417 - 615 insect/ha were attracted and killed by these sex-pheromone traps. About 65 - 75% of insects were captured in the first 5 weeks after sex-pheromone trap installment. The test on the effects of number of traps was employed in 1992 at Jombang. It was found that the insects killed increased from 289 insect/ha in the treatment of 2 trap/ha to 1044 insect/ha in the treatment of 10 trap/ha. The economic analysis also indicated that the use of sex-pheromone could significantly reduce the input of pesticides on soybean production. The cost of pesticide was decreased from NT\$ 869/ha of check farmers to NT\$ 599/ha of demonstration farmers. The net income on the sex-pheromone demonstration farmers was about 15.7% higher than that of the check farmers.

Population Fluctuation of Major Insect Pests in Asparagus Bean and Optimal Chemical Control Time

Investigation of the population fluctuation of major insect pests that occur during growth period of asparagus bean is as follow. The insect pests that occurred at early growth stage were *Melanagromyza phayaeji*, *M. sojae*,

Edwardsia flarescens and *Aphis cyaccivora* that were high in population density during fall crop that were usually sowed during August - September. Therefore it may influence the further plant development. The recommended chemicals after screening test is 2.8% Deltamethrin E.C. 1000x, one to two application. The insect pests that occurred at flowering stage (about 50 days after sowing) were *Liriomyza bryoniae*, *Tetranychus urticae*, *Frankliniella intonsa*, *Ostrima furnacalis*, *Maruca testulalis*, *E. flarescens*, *A. cyaccivora*. The most common in spring crop were *O. furnacalis*, *M. testulalis*, *L. bryoniae*, while the most common in fall crop were *L. bryoniae*, *T. urticae*, *F. intonsa*, *E. flarescens*. Recommended chemicals for control the insect pest at flowering stage is 3% *Bacillus thuringiensis* W.P. 1500x, 20% Ethofenprox W.P. 1500x, 75% Cyromazine W.P. 5000x, 2.8% Bifenthrin E.C. 2000x, 2.8% E.C. 2000x, Cyhalothrin, 2.8% Deltamethrin 1000x, for 2 to 3 times continuous application. At bean harvesting stage, that is 90 - 110 days after sowing, the major insect pests that occurred were *T. urticae*, *L. bryoniae*, *M. testulalis*, *F. intonsa*, *E. flarescens* and *A. cyaccivora*. The selection of chemicals for application should be based on the field actual situation.



Fig. 17. Asparagus bean damaged by corn borer.

Investigation of Insect Pest of Rice in Central Region

The result of insect trapping at high air in three years showed that the immigration amount of brown hopper and white-back hopper was very low. The year capture by insect lamp showed that the peak stage of brown hopper was in Oct. - Nov., for white-back hopper was in June and September, spot hopper was in June. The peak stage of adult Chilo suppressails was in June - July. The trapping by sex pheromone was better than insect lamp. At monitor field, the rice plants infected by Chilo suppressails only 0.73% showed dead heart, 1.40% showed white spikelet. The density of brown hopper in the 2nd crop of 1991 was higher which was 10.2 per tiller, and was lower 1992 - 1994 in that was less than 2 per tiller, and white-back hopper was less than 1 per tiller, that was still below the

control threshold. The spot hopper and white-back hopper captured by insect net was 2.6 per net. The 3-year field survey indicated that the density of hopper was decreasing gradually and the infection was very mild. Only Hsiu-sui, Tatusen and Huatan of Changhua county showed severe infection by Chilo suppressails, the other areas in Taiwan was only slightly infected.

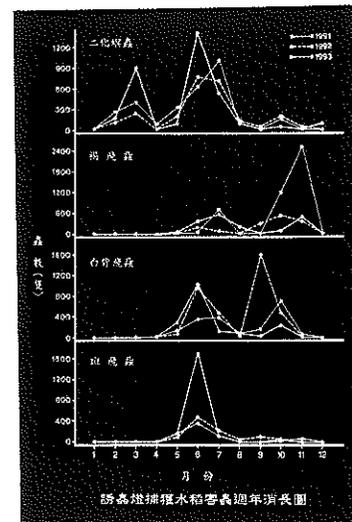


Fig. 18. Annual fluctuation of rice insect pests captured by insect lamp.

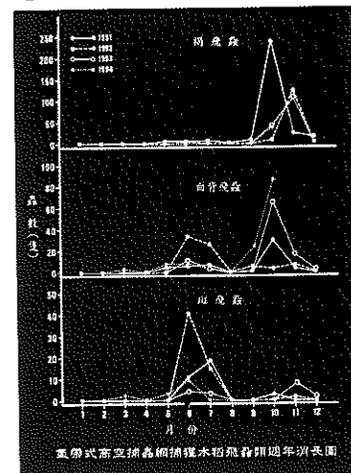


Fig. 19. Annual fluctuation of rice insect pests captured by high-air net.

Insect Species Investigation and Control for Eggplant

The insect species of eggplant is slightly different with plant parts. The insects that feed on leaf are *Tetranychus kaneawai* Kishida, *T. urticae* Koch, *Amrasca biguttula* (Ishida), *Thrips palmi* Karny, *Aphis gossypii* Glower, *Spodoptera litura* Fabricius, *Porthesia taiwana* Shiraki, *Henosepilachna uigintioctopunctata* Fabricius, *Bemisia tabaci* (Gennadius), *Trichoplusia ni* Hubner, and *Leucinodes orbonalis* Guene. The former 5 insects caused severe damage to eggplant. The three insects: *Amrasca biguttula* (Ishida), *Thrips palmi* Karny and *Aphis gossypii* Glower not only invade leaves, but also damage flower buds and fruits, the percentage of those insects damage on fruit, flower bud, matured leaf and axillary bud, from *Amrasca biguttula* (Ishida) is 0.87, 2.39, 66.77 and 29.97%, respectively; from *Thrips palmi* Karny is 25.62, 53.72, 12.69 and 7.97%; from *Aphis gossypii* Glower is 2.61, 2.42, 88.65 and 6.32%. The results Using the chemicals that registered in "Plant Protection Manual" to control *Tetranychus* spp., *Aphis gossypii* Glower, *Amrasca biguttula* (Ishida), *H. uigintioctopunctata* Fabricius and *Thrips palmi* Karny. In Chihu and Tatsuen, Changhua county showed that 40% Pyridaphenthion E.C. 800 X plus 2.8% Cyhalothrin E.C. 1000 X had good effect to control *Aphis gossypii*

Glower, *Amrasca biguttula* (Ishida) and *Tetranychus* spp., 48.34% Carbosulfan E.C. 700 X plus 40% Pyridaphenthion E.C. 800 X or 2.8% Cyhalothrin E.C. 1000 X could control *H. uigintioctopunctata* Fabricius, 3% Bacillus thuringiensis W.P. 1000 X plus 85% Sulphur W.P. 500 X and using two yellow sticky card (15m²) could control *Tetranychus* spp. All tested chemicals showed no effect on *Thrips palmi* but it is the most important insect pests in eggplant, that have great effect on the growth, yield and quality of eggplant. The effective control chemical or method should be further studied.

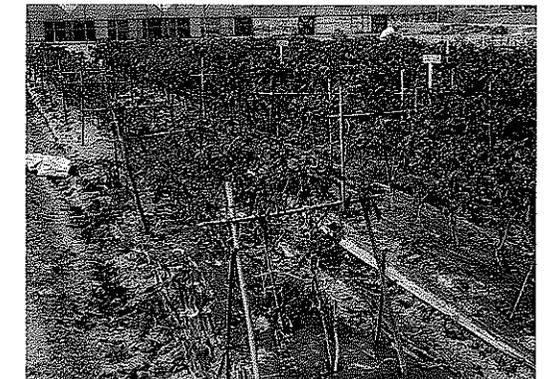


Fig. 20. Wilted eggplant infected by two-spotted small green leaf hopper.

Effect of Different Insecticide Spray Intervals on the Spider Mites on Roses

The toxicity of three insecticides against the two-spotted spider mite (*Tetranychus urticae* Koch) and kanzawa spider mite (*Tetranychus kanzawai*

Kishida) on rose plants was evaluated using two different application intervals. For the kanzawa spider mite, the control effect of 68.1% propargite EC (2000-fold dilution) with a spraying interval of 3 days was better than that with an interval of 1 week. However, two sprays of 38% dienochlor F (1500-fold) with 1 week interval gave better control of the same spider mite, with the exception of the larvae. Two sprays in 3 days with 68.1% propargite EC (2000-fold), 2.8% bifenthrin EC (1000-fold) and 38% dienochlor F (1500-fold) resulted in better control than two sprays in 1 week of the adults, larvae and nymphs of the two spotted spider mite. Only 2% abamectin EC (2000-fold) gave better control of this mite when the two sprays were made in 1 week.

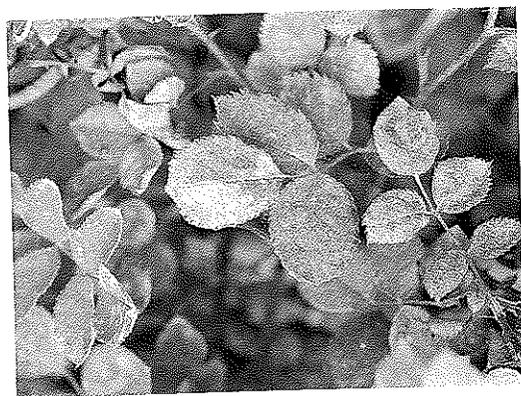


Fig. 21. Rose leaves infested by spider mites.

AGRICULTURAL MACHINERY

The Development and Improvement of The Ring-Furrow Digger with Manure Applicator for Orchard

Long term fruit trees like orange, lichee, mongo and wax apple in Taiwan need to apply manure once or twice a year for improvement of fruit quality. Since manure spreading in orchard is unsuitable, farmers use ring or radiant type furrows around each tree for applying manure into soil to save fertilizer and increase the efficiency of fertilizer. This method needs a lot of labor and is very troublesome, therefore it is urgent to develop a machine to do the job. A self-propelled ring-furrow digger with manure applicator is developed in this project under this circumstance. The machine uses a small four-wheel-driven and four-wheel-turning chasis for the convenience of doing work under fruit trees. It uses 16 Hp diesel engine and a chainsaw type digger mounted on right side. Capacity of manure tank is 1.02 m³ with a scraping system at the bottom. Also a hydraulic soil scarper at rear side can be up and down for pushing soil back into furrow. Testing results showed that the machine has 1.7 m turning radius and can dig a minimum of 135cm diameter of 33cm depth, 20cm width ring furrow, then force manure into the ring-furrow. Each ring furrow can be worked out in about 2min, working efficiency is over 4 - 6 times than labor. The machine is still in testing and need to improve the mechanism of soil scarper.



Fig. 22. Field operation of the ring-furrow digger with manure applicator.

Development and Improvement of the Chainsaw-type Digger and Ridger for Soft Ginger

Soft ginger is an important crop planted in the Ba-Gwa mountain for about 500 hectare. A lot of 10 m long by 40 cm deep and 15 cm width of furrow are needed for the growing of ginger, but these furrows are usually digged fully by labor before planting. This digging work is very hard and in low efficiency, usually taking over 30% of the total production cost. For mechanizing the work to increase the efficiency of this farming operation, a small model machine has been developed in this project. The machine uses chainsaw type digger with ridger on a 8.5 Hp cultivator, also uses a new developed double speed coaxial planet gear set to slow down the field speed to 0.29 km/hr. Another over-load protection gear box is added in power line for prevention from damage. Two sets of

independent-suspension wheel are mounted on both left and right side of the chain-saw to support the machine. When moving on road, the machine can drive faster to 4.91 km/hr speed by shifting the planet gear set to normal speed. Testing results showed that the machine can dig up to 44cm depth by 15cm width, and a 10m long furrow can be made in about 2.27 min. Preliminary estimation showed the efficiency of the machine is about 6 - 8 times better than labor, but the machine still needs further testing and further improvement of the ridger's shape.



Fig. 23. Digging experiment of the chainsaw-type digger and ridger for soft ginger.

Automatic Control Driving Device of Multiple Protected House for Agricultural Production

Use good facilities can carry out job on time, improve product quality, save cost, and get better chance in the competition of market. The study of automatic control driving device of

multiple protected house is an extended research of auto-spraying equipment for improving its driving function. The single force source could drive ϕ 3mm cable wire by several winches and a shaft, and the cable wire give working devices a linear movement, then the working devices could work in any shape such as spraying, ventilation, lighting, feeding, cleaning, shading and environment control. The driving power is controlled by several mechanical/electric clutches at the driving shaft, and the multiple working devices would work in sequentially by activating each clutch. The experimental driving device is in the facility field, 55m length, 8.5m width. It is tested by 7-grade water sensitive paper under 28.7 m/min driving speed. The pump pressure is 25kg/cm², liquid flow from pump to nozzles by 100m ϕ 10mm hoses. There are 20 nozzles fixed on 5 vertical stainless steel pipes. Nozzles can be moved between 18.7 m/min and 36.8 m/min, the spraying volume also can be changed from 60.6 liters to 30.8 liters, and the flow rate of nozzle is 20.6 l/min. So the spraying volumes are changed between 129.6 l/10a and 65.9 l/10a.

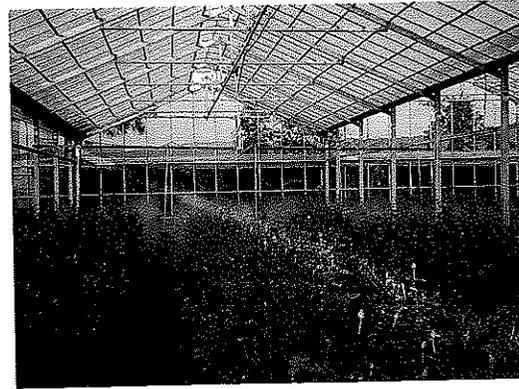


Fig. 24. The automatic control driving device of multiple protected house.

AGRICULTURAL MANAGEMENT

A Comparison Study on the Differences of Sino-Japanese Agricultural Extension System

Our Agricultural Extension Act was passed in the first talk process under the agreement of the joint committee of economy and education in the Legislature, ROC on 21, October, 1991. Basically, this Act is set up to shift the agricultural extension works back to public sectors, especially to the district Agricultural Improvement Station. After world war II, the modern agricultural extension of Taiwan, ROC was followed by the organizational flow which was set up in the Japanese occupied era, ; then improved by the JCRR in which the concepts of 4-H club, home economic education and farm education were introduced from USA. Eventually, our agricultural extension works were conducted cooperatively both by public

sectors and private sectors. In Japan, the "Law Concerning Improvement and Promotion of Agriculture" was legislated in 1948, and modified 5 times since then. Therefore, government is obligated to conduct the agricultural extension service for farmers. It is owing to the similarity of the agricultural background, situation, and developing process between two countries, therefore, this study is focused to compare the differences between the two agricultural extension law for being used as the reference to improve our Agricultural Extension Act.

Crop Diseases and Insect Pests Diagnosis Service

The "Crop Diseases and Insect Pests Diagnosis Service Station" was established on Nov. 1990 under plant protection and technique information data bank project. The farmers received the service mainly came from central region, some of them are from the outside parts of the central region. There were 881 cases in two years within the 10 service items. Among them, 297 cases (about 33.7%) were related to information or booklet distribution; 243 cases (27.6%) belonged to diseases and insect pests diagnosis. In term of district, 109 cases (46%) from Changhua county, followed by 83 cases (35.1%) from Taichung county. In term of service method, the cases by telephone and mail were 76 (32.2%) and 73 (31.0%) ,

respectively. In term of crop category, the cases of vegetable and rice were 64 (33.7%) and 58 (30.5%), respectively. The diagnosis cases, 89 cases (46.8%) were related to diseases, 39 (20.5%) cases belonged to insect pest.



Fig. 25. Identification of complex symptoms of rice sheath blight and small black sclerotial.

Studies on the Operation of Farmers' Association in Taichung Areas

A survey on the organization, services and management performance was conducted basing on 3 mountainous area types, 44 rural types and 14 city types Farmers' Associations. The results indicated that in city type full members was slightly higher than associate members, but in mountainous area type, more than 93% of them were full members. As to the distribution of employees, farm credit department had the highest number of staff than others department, followed by supply and marketing department, administrative department or agricultural extension

department. In city type over 50% of employees were graduated from college or university, and in others types most of them were graduate from high school and vocational school.

As to services income, both rural type and city type depended on the farm credit services as the main income source, but in mountainous area type, economic services was as important as farm credit services. In profit and loss of economic services, the mountainous area type had some profit, others didn't, but in management performances, the city type had highest capital-profit ratio. In the management of farm credit department, the mountainous area type had higher deposit loan ratio, this result also indicated that there were more potential in service management. Because the rural type had more services on supply, marketing, entrust and others service, so they have the highest cross margin ratio. The city type had better management on livestock insurance service, so that they had the highest insurance ratio and lowest payment ratio.

AGRICULTURAL INFORMATION RESEARCH

A Study on the Treatment of Agricultural News in Six Major Newspaper in 1993

This study was carried out from January to December, 1993 to understand

the behavior of Central Daily, United Daily, China Time Daily, Taiwan Hsing-Sen Daily, Taiwan Daily and Economy Daily on the treatment of agricultural news. The content analysis method was employed in the study. It was found that about 1.33 times or 800 - 1200 letters of news were published on each daily every day. The percentage of agricultural news published by newspaper was quite low compared to other news. The analysis on the news content indicated that crop production and crop improvement (17.9%), agricultural extension (15.6%), agricultural problems and farmers opinions (20.5%), and farmers welfare and rural living (19.9%), were the major items to be published by newspapers. It was also found that most agricultural news was published on local news edition (50.2%), and next was social news edition (17.4%), or general news edition (15.3%). The distribution of agricultural news on each month was between 4.4 - 12.6% of total agricultural news.

Analysis of Rural Youth in Joining the Agricultural Professional Training Program

The research is to study the motive of the young farmers in joining the "Agricultural Professional Training Program". A total of 119 sampled trainees were selected for questionnaire, the analysis of the result of their answers

was described as follows. The trainees are mostly at the age from 31 to 35, and then followed by the group from the age of 36 to 40. The 82.6% of the trainees are high school or professional high school graduates and above. The satisfactory degree in term of overall training related items, the trainees in "Protected Vegetable Class" have the highest percentage of trainees showing satisfaction, which is 54.5%; then followed by "Flower Production Class", which is 39.3%. For the individual training item, the training environment received the highest percentage of satisfactory degree, which is 52.5%, followed by training subject arrangement, which is 45%, then followed by training facility and instructor level, which is 40.5% and 36.9%, respectively. The training materials received the lowest satisfactory degree in term of percentage of trainees, which is 29.7%.



Fig. 26. Study trip to observe the composting of agricultural waste.



Fig. 27. Field trip to rice organic farm of young farmers training class.

Investigation on Health Problem of Old People in Central Taiwan

The study was sampled from the 1189 trainees of "Class Improvement of Living for High Age People" under the project of rural living improvement in 1994 from 43 towns or villages, of which 16 from Taichung county, 20 from Changhua county, 7 from Nantou county. The data collected from the trainee physical exam result and questionnaire before class. The sample included 918 male and 771 female. The trainees are mostly at the age from 65 to 69, comprised of 43.3%, the age of over 75 also comprised of 13.4%. About 44.0% of trainees are illiterate. The trainees live with spouse and their offspring have the highest portion, which is 40.6%, those only live with spouse only 26.9%. The 44.5% of old people feel themselves is healthy, 43.4% feel all right, 12.2% of them feel unhealthy. There is 47.7% of

trainees didn't have any painful and trouble emotion, but 52.3% of them say yes. The emotion most bother 57.0% of old people is illness, followed by 14.0% of no money, 12.5% of no children around, 11.3% of them feel lonely and lonesome. Blood test result indicated that 453 trainees, comprised of 39.4%, have higher than normal value of uric acid; 244 trainees (20.5%) have high cholesterol value; 294 trainees (24.9%) high triglyceride value; 160 trainees (13.5%) have high fasting blood sugar value; and more than half of tester (52.9%) have abnormal blood pressure. There are only 18.5% of trainees showed normal physical test result, and 81.5% of old people at least have one item is abnormal. The above result indicated that rural old people have high percentage of chronic

illness. The recommendation for improvement of health is: (1) educate the old people to realize the importance of healthy life, (2) through insurance policy, having regular physical exam, (3) establish community clinic and service network.



Fig. 28. Closing ceremony of "Improvement of Living for High Age People Workshop".