

RESEARCH AND DEVELOPMENT

RICE IMPROVEMENT

Development of New Rice Variety: Tai-Keng 3

A *japonica* rice variety, Tai-Keng 3, was developed by crossing Taichung 189 to the F₂ progenies derived from [(Taichung Sen 3 x Taichung 65) x Tainung 67] x Toyonishiki. This variety was officially named and released as a recommended variety on June 13, 1990.

The agronomic characteristics of this variety are that it has 127 and 114 days of growing days respectively in the 1st and 2nd crops; approximately 102 cm in plant height in the 1st crop and 98 cm in the 2nd crop; 18 spikes in the 1st crop and 15 in the 2nd crop; the average grain yield in the 1st crop was 6,250 kg/ha and 4,190 kg/ha in the 2nd crop. Tai-Keng 3 has a shorter plant height, more spike number, and mature four days later in comparison with those compared with Taichung 67. Tai-Keng 3 is resistant to blast and stripe diseases, but less resistance to bacterial leaf blight, sheath blight and planthopper. As for the rice quality of this variety, the rate of white belly and eating quality is similar to that of Tainung 189 which is considered as a high quality rice variety. This variety is recommended to grow either at 1st or 2nd crop seasons in Taiwan. The fertilizer should be applied at the initial stage of growth i.e. on the 30th and 20th days, respectively after

transplanting in the 1st and 2nd crops. The proper draining is required to inhibit the ineffective tillers and the elongation of rice plants. In order to maintain the high quality of rice, irrigation should not be cut off too early. In the second crop, it should be transplanted as early as possible to avoid cold injury in the late period of growth especially in northern Taiwan.

Effect of Bacterial Leaf Blight on the Yield and Quality of Rice Breeding Lines

Bacterial blight was found to cause a significant decrease in yield components of rice i.e. panicle weight, spikelet number per panicle, the percentage of filled grain, and 1000-grain weight. The disease also cause to affect the grain appearance such as grain translucency, it also cause to increase the percentage of immature green and dead grains. However, the effects of this disease on the percentage of brown rice, total milled rice and head rice were not statistically significant. It is interesting to note that when the rice was infested at the stage of panicle formation, the gelatinization temperature in terms of the degree of alkali spreading for the grain was slightly decreased, also for percentage of amylose content. The crude protein was found to increase slightly. These changes of grain quality traits of the infested rice would result in the poor eating quality.

The new breeding *indica* lines obtained by crossing the Taichung Sen 10 or Tai Sen 1 to the Taichung Sen waxy 1, Tainung Sen 20, and Suweon 333 appeared to have higher yield potential, good quality as well as better resistance to the bacterial leaf blight. The promising lines of rice will be subjected for further selection with regards to their yielding potential, disease resistance, and grain quality.

RICE QUALITY

Effects of Protein Fractions on other Physicochemical Properties on the Palatability Evaluation in Low-Amylose Rice

The physicochemical properties are known to be the main factors affecting the eating quality of rice. The present studies are aimed to evaluate the effect of different protein fractions and other physicochemical properties on the eating quality of low amylose rice varieties.

Five varieties each of *indica* and *japonica* rice of low amylose content were used in this study. They were Taichung Sen 3, Taichung Sen 10, Tai Sen 1, Tainung Sen Yu 154, and Tainung Sen Yu 173 for *indica* type, Tainung 67, Tainung 70, Taichung 189, Kaohsiung 142, and Koshihikari for *japonica* type. The amylose content was found to be differed significantly from varieties. The application of nitrogen fertilizer in the later stage of plant growth will result in the increase of protein content, albumin

and globulin fractions which will cause to increase the hardness of cooked rice. The hardness of cooked rice which is measured as gel consistency is one of the most important factors controlling the eating quality of rice. It is implied that protein and amylose contents, as well as glutelin fraction of protein exert their effects the most on the hardness of cooked rice. Protein content was found to be correlated negatively with the eating quality of rice. *Indica* type varieties are generally considered to be poor in eating quality in Taiwan and Japan. However, some *indica* varieties, such as Taichung Sen 3, Taichung Sen 10 in the present study showed a good eating quality. These varieties showed lower protein content as well as lower amylose content. Taichung 189 which is a low amylose *japonica* variety always exhibited a good eating quality.

Studies on The Relationship between Eating Quality and Various Physicochemical Properties of Rice

The relationship between eating quality and various physicochemical properties of rice was studied with the use of 22 rice varieties involving *indica*, *japonica* and glutinous types.

Except the Taichung Sen 3, 10, and 20, all other *indica* varieties in this study generally had higher values of amylose content, cohesiveness, gumminess, springiness and chewiness, but had lower values of viscousness, adhesiveness, stickiness, balance degree

and sensory index. The appearance of cooked rice of *indica* type varieties had less gloss compared with that of the varieties of *japonica* type. However, these physicochemical properties of glutinous rice were quite different from those of the non-glutinous rices. A negative correlation was found between the sensory evaluation and the following traits: amylose content, iodine blue value of residual liquid of cooked rice, cold paste viscosity, hot paste viscosity, peak viscosity, consistency, hardness, springiness of cooked rice, gumminess, and chewiness. A positive correlation was observed between eating quality and the following traits: gel consistency, break down, viscosity, and balance degree of cooked rice. The effect of gel consistency on the eating quality was the most important trait, therefore, this could be used to evaluate the eating quality of rice. It contributed approximately 84.57% of physical properties of cooked rice to influence the eating qualities.

Genetical Studies on Physicochemical Properties of Rice Grains

General studies on various physicochemical properties of rice grains and the cooked rice were conducted with the F_2 plants derived from the cross between *indica* and *japonica* rice. High amylose content was found to be controlled by a single dominant gene *Am*, and the high gelatinization temperature by a single dominant gene *Gt*. The hardness,

gumminess and chewiness of cooked rice were also controlled by the respective single gene. Linkage was observed between genes of *Am* and *H* (hardness of cooked rice) with a recombination value of 8.08%. Linkage value between genes of *Gt* and *H* was estimated to be 37.04%. The order of the genes in a linkage group was assumed to be *Gt-Am-H*.

The Effect of Cultural Seasons on the Physicochemical Properties of Rice

Eleven varieties of rice were planted from the second crop in 1984 to the first crop in 1986 at Taichung DAIS to examine the seasonal stability of physicochemical properties of rice. In general, the rice qualities are influenced greatly by the varieties and cultural practices. The results of this experiment indicated that the rice in the second crop not only had better grain appearance but had higher content of amylose and crude protein in comparison with that in the first crop. The alkali spreading value and gel consistency was higher when growing in the second crop than those grown in first crop. The regression analysis was used to estimate the seasonal stability of physicochemical properties of rice. It was considered that the amylose content, alkali spreading and gel consistency might be controlled by a regulation system which stabilize the different quality characters. This system is further assumed to be independent to the stability of the other physicochemical characters.

The Effect of Different Milling Machines on the Quality of Embryoed Rice

The effect of different modes of milling machine on the embryoed rice (embryo-intact rice) was evaluated. The experimental materials included the rice harvested in the 2nd crop in 1987 and the 1st crop in 1988 at Taichung DAIS. The results indicated that the highest percentage of embryoed grains was obtained when the moisture content of rice grain was adjusted at 12% level, while the lowest percentage of that was obtained at the grain moisture level of 16%. The embryoed rice obtained by the milling machine of Yamamoto VP-30T had a better milling quality compared with that by the McGill No.2 in case of grain moisture content unconcerned. The former case was found to be much easier to control and operate than the latter one. In addition, a positive correlation existed between the theoretical rate of embryoed grains (at 27° of milling whiteness) and the actual rate of embryoed grains undergone the circulation of rice grains in 2-4 times. Therefore, using Yamamoto VP-30T miller in 2-4 times circulation is considered as a standard method to test the percentage of embryoed grains in the breeding program of rice.

WEED RESEARCH

The Growth Pattern of Bulrush (*Scirpus maritimus* L.) at First Cropping Season

Bulrush (*Scirpus maritimus* L.) is an awful perennial weed in paddy-field, and it grows widely in Pingtung, Tainan, Yunlin, Changhua and Taichung counties in Taiwan. Especially serious along the coastal areas of Changhua. The high density of weed population can cause severe yield reduction of rice. Bulrush is difficult to control due to its fast growing habit and high multiplication rate. It reproduces by bulbs and highly tolerant to herbicide. The growth pattern of bulrush was surveyed in the first cropping season at Taichung DAIS.

The plants grew rapidly after germination and reached 85 cm in height within 48 days after emergence (DAE), then maintained at 90-100 cm afterward. The average number of leaves was about 9-10. The maximum leaf area of bulrush was 3651 cm² at 55 DAE from one bulb and its color turned to yellow after 55 DAE. 130 maximum number of tiller per plant was recorded at 48 DAE. Flower stalks appeared at 20 DAE and bloomed completely at 41 DAE. The dry weight of aboveground part increased faster than that of underground part in the earlier growth stage, but the opposite result was true starting from 41 DAE, because the underground part of bulb appeared starting at 41 DAE. The total dry weight of bulrush reached the highest level at 69 DAE. A total of 266 small bulbs were generated at 90 DAE, and increased to 457 small bulbs at 120 DAE. Bulrush is a highly competitive weed in paddy field because of its vegetative growth.

Screening Herbicides for the Chemical Control on Bulrush (*Scirpus maritimus* L.)

Although bulrush (*Scirpus maritimus* L.) has been found in a few areas in Taiwan, it is a trouble weed in the paddy field. Bulrush is difficult to control due to its fast growing rate, high multiplication rate and high tolerance to herbicides. A series of herbicide trials were conducted in Taichung DAIS beginning from 1987. All chemicals used in the experiment could inhibit the growth of bulrush temporarily. Several newly developed herbicides applied at low dosage such as bensulfuron-methyl (Londax 10 W.P., 10% a.i.) pyrazosulfuron-ethyl (Sirius 10 W.P., 10% a.i.) etc., exhibited in a better efficiency in the control of this weed. In the first crop, the treatment of herbicide consisting of bentazon (Basagran 44.1 S., 44.1% a.i.) and bentazon + quinclorac (Bacet 54.7 W.P., 54.7% a.i.) resulted in the highest control rate of 76%. The treatment of herbicide consisting of bentazon, bentazon + quinclorac and bensulfuron-methyl + butachlor (Londax-B 2.583 G., 2.583% a.i.) showed the best control rate of 75-90% in the second crop. The rice treated with the bensulfuron-methyl plus pretilachlor (Londax + Rifit 1.8 G., 1.8% a.i.) obtained the highest yield about 89-95% in the first-crop and the rice treated with the bentazon plus quinclorac obtained the highest yield about 95-98% in the second-crop when compared with the treatment of

hand weeding for once. When the economy of weed control and rice yield was concerned, herbicides applied twice was better than once, for instance, using butachlor (Machete 5G., 5% a.i.) first then followed by bentazon.

UPLAND CROPS

Relationships among the Yield, Physico-chemical Property of Soil, Diseases, and Insect Pests on the Rotation System in Paddy Field

The objectives of this study were to evaluate the optimum rotation systems of upland crop in paddy field, and to examine the relationships among the physicochemical property of soil, diseases, insect pests and crop production on four cropping systems. The cropping patterns were: 1) Rice-rice (treated as a check), 2) Corn-rice, 3) Rice-peanut, and 4) Sorghum-ratooned sorghum. A continuous field experiments were conducted in Taichung DAIS in 1986. Rice (Tainung 70), maize (Tainung 351), peanut (Tainan Sel. 9), and sorghum (Taichung 5) were used for this experiment. The results were as follows:

1. The total density of soil followed by the cultivation pattern of rice-rice was higher than that followed by upland crop cultivation. No significant trend was found in the pH value of soil sampled when each crop was harvested. The organic matters tended to decrease slightly when the rotation cropping pattern was

intensively adopted. The amount of available phosphate, potassium oxide, calcium oxide, and magnesium detected was found to be stable in the system of alternative cropping.

2. The largest amount of weed was found in sorghum field, but the smallest amount of weed was observed in the rice-rice field which serve as a check.

3. In this experiment, all diseases and insect pests were under control, except the aphid and corn borers.

4. The less labor was required in the pattern of sorghum-ratooned sorghum, but intensive labor was needed in the cultivation of peanut in the pattern of rice-peanut. In general, if the agricultural practice is more mechanized it would be in more labor saving.

5. The yield and profit were evaluated for each crop in each cropping. The highest yield and profit were obtained from rice culture only, and sorghum culture only came to next, and corn culture only was the lowest in the first cropping. The highest benefit was gained from peanut culture only, and ratooned sorghum came to next, and rice was the lowest.

6. As far as the total net profit was considered, the rice-peanut was the best pattern in all cropping patterns studied which was followed by sorghum-ratooned sorghum, rice-rice, and corn-rice patterns.

Studies on the Strategies for Increasing Yield of Buckwheat

In order to increase the yield of buckwheat (*Fagopyrum esculentum*

Moench) grown in fall and winter season as a catch crop, an experiment was carried out in the crop season of 1989-1990. Entries consisting of the large grain varieties were planted to evaluate their yield potential and performance and some other important agronomic traits. Two newly introduced lines, Hajikamiwase and Miyazakiotsubu showed a good performance and yield. These two varieties matured 20-21 days earlier than Toyoda #1 (check variety). The large grain varieties of buckwheat were suitable to plant from October to early November in fall season of which late October was considered to be the optimum planting time for most varieties. The optimum planting time in spring season was during January. The seeding rates of large grain and medium-grain varieties were 90 kg/ha and 70 kg/ha, respectively. Both large grain and medium grain varieties can be planted in rows with the densities of 30x10 cm or 35x10 cm. They also can be planted by broadcasting either by hand or machines.

Effect of Nitrogen Fertilizer and Planting Density on Forage Maize

This experiment was conducted in spring cropping season in 1990. The objective was to examine the effect of planting density plus the different rates of nitrogen fertilizer on the forage yield of two forage maize varieties. A split plot design was used in this experiment. Nitrogen level was main plot, and planting density was mid-plot, and variety was

small plot. The nitrogen levels were 150, 200, 250, and 300 kg/ha; the planting densities were 70x15 cm (95,238 plants/ha), 70x20 cm (71,428 plants/ha), and 70x25 cm (57,142 plants/ha). Two new forage lines, H7 and Si4, were used in this experiment.

Results of the experiment indicated that the forage yield of maize was apparently affected by different amount of nitrogen applied. An amount of 250 kg/ha nitrogen resulted in the highest yield of forage. No significant effect of plant density on the forage yield was found. The treatment of 70x20 cm (71,428 plants/ha) resulted in the highest yield forage than the other two treatments. No significant differences in forage yield was found between two newly developed lines of forage corn.

VEGETABLE CROPS

Breeding of New Snap Pea -- Taichung 13

Taichung 13 is a new snap pea variety developed by Taichung District Agricultural Improvement Station using pedigree breeding method from the cross "Sugar Snap" x "Knight". It was registered and released in January, 1989.

The plant is of the tall type, generally reaching 165 to 248 cm in height with smaller leaves and lesser branches than Sugar Snap. White flower begins blooming at node 15 which is about 57 cm above the ground compared with 108

cm for Sugar Snap. This lower pod setting position is beneficial to the picking in trellis cultural practices. Number of days to edible pod maturity is 63-71 days which is 15-20 days earlier than Sugar Snap. Due to this characteristic of early maturity, it can be planted in winter catch cropping season.

Pods, borne singly per node, are crispy and sweet with the sugar content of 13.8° Brix which is well suited to fresh market and quick freezing. Pod shape of Taichung 13 is more uniform and larger than Sugar Snap, and is favored by local market. Pods are picked very easily because it possesses loose abscission layer. (Fig. 1)



Fig. 1. New snap pea — Taichung 13.

The pod yield of Taichung 13 is lower than the Sugar Snap because of lesser branches. It is recommended to sow more seeds in the field in order to increase the yield per unit area.

This variety is tolerant to Fusarium wilt (*Fusarium oxysporum* f. sp. *pisi*), but is not resistant to seedling rot (*Rhizoctonia solani* Kuehn), powdery mildew (*Erysiphe polygoni* DC.) and Fusarium root rot (*Fusarium solani* f. sp. *pisi*).

Yield Trial of the Newly Bred Lines of Green Peas

Twenty newly bred lines of green peas together with the check variety "Dark Skin Perfect" were grown in field on November 7, 1989 to evaluate the productivity and important horticultural traits. The results indicated that Taichung Ren-Shih 4, 8, 10, 11, 12, 13, and 15 had high yielding potential, resistance to powdery mildew, and good quality. These elite lines will be used as experimental materials for next year trial.

Establishment of the Color Illustration of Mineral Disorders in Hydroponic Vegetables

For the hydroponic vegetable, misleading and negligence of nutrient preparation and management can cause the mineral disorders and reduce marketing capacity of product. A three year experiment was conducted in the Taichung DAIS. This study was to set up a series of color illustration of mineral disorders in hydroponic vegetables. Five kinds of leafy vegetables were grown in DRF hydroponic system with different deficient nutrients in mono-element. Seedlings in 14-day old for each of 40 vegetables were

transplanted to each treatment, and then all were harvested in three weeks later. Photo prints and chemical components of young leaf blade were analyzed to identify its symptom. The results indicated that chlorophyll a and b apparently reduced in N deficient treatment. The contents of Ca and Mg in leaf blade increased in P deficient treatment. The K deficient treatment could induced more content of N and P in leaf blade. The contents of N, P, and K in lettuce leaf increased in Ca deficient treatment. The contents of Ca and P in leaf blade increased in Mg deficient treatment. On the basis of color illustration, the symptoms of macro-element deficient is also described.

Yield Performance of Vegetables in Different Hydroponic Systems

In order to evaluate the yield performance of hydroponic vegetables, four kinds of hydroponic systems with the culture space in 2x1 m² and seven kinds of vegetables were used in the experiment for a year round. The nutrient film technique (NFT), deep flow technique (DFT), dynamic root floating technique (DRF), and aeroroot type DRF technique (AR-DRF) were used in the hydroponic systems. Seven vegetables were divided into four groups which were three Pai-tsai varieties, two lettuce varieties, water convolvulus, and muskmelon. During the hot summer season, the warmest nutrient temperature (NT) was found in NFT system and the lowest dissolved oxygen concentration (DO) was measured in DFT

system. The coldest nutrient temperature in NFT and the lowest DO in DFT were also detected in the cold winter season. The yield performance of leafy vegetables in different hydroponic systems was AR-DRF > DRF > DFT > NFT in the summer season, and AR-DRF > DRF = NFT > DFT in the winter season. A better yield performance could be obtained in a special design of AR-DRF which was developed to facilitate the activity of root. Several lines of evidence were shown in the experiment of muskmelon. 2.19 kg in weight for each fruit and six fruits in total number for each plant were obtained and 12° Brix of sugar content was found in AR-DRF system. The growth characteristics of hydroponic vegetables and its function mechanism of NT, DO and aeroroot are discussed.

FLORAL CROPS

Chemical Fertilizer Application and Flowering Regulation on *Phalaenopsis*

Phalaenopsis seedlings were transplanted at the leaf length less than 0.5 cm after seed germination on the agar media consisting of Hyponex (7-6-19) commercial fertilizer in different concentration for three months. The growth rate of plantlet on the treatment of 4 g/l Hyponex(7-6-19) was found to be better than that of 2, 3, or 6 g/l treatments. Plantlets obtained from above experiment were transplanted from flask for two months and treated with five commercial

Hyponex fertilizers and one slow release Osmocote fertilizer (14-14-14). The growth rates of leaf length, width, area, and dry weight were investigated.

By using Osmocote (14-14-14) once in three months or Hyponex (20-20-20) 1000x twice a week, the growth rates were better than that using Hyponex (7-6-19) 350x, (10-30-20) 500x, (25-5-20) 1250x and (30-10-10) 1500x twice a week. Three concentrations and three feeding intervals of using Hyponex (20-20-20) were then tested on *phalaenopsis* young plants. 500x Hyponex (20-20-20) applied once a week or 1000x twice a week in three months had a superior response of plants to the other treatments. 250x applied twice a week exhibited a phenomenon of salt injury.

Phalaenopsis flowering could be regulated by chilling in a cooling room. The flower stalks of plant in summer season generated in 85-95% when they were treated with 25°C at day and 22°C at night for 45-60 days. Plant with flower stalks were then transplanted to the shading house in a natural condition. From a series of experiments, flowers could bloom in one month, and 4.6-6.4 flowerlets in average could formed per inflorescence. Usually, the flowering time of *Phalaenopsis* in Taiwan is from January to May. By using the technique to force flower, the flowering time can be advanced about four months. This approach may have a great potential to

produce flowers of *Phalaenopsis* year around.

Effect of Mulching on the Growth of Chrysanthemum

Field experiment was conducted to study the effect of different mulching materials on the growth of winter chrysanthemum. Results indicated that only silver and black plastic film mulching could significantly enhance the growth and improve qualities of 'Yellow Shuho' chrysanthemum. Mulching treatment

could reduce the lighting period for 5-7 days and harvest earlier about 10-12 days than that treated with either ricestraw or non-mulching. Good weed control was found in the plots treated with three mulching materials. A few spotted spider mite could be found in the plot treated with silver plastic film mulching. Soil temperature slightly increased by mulching plastic film. No significant differences of soil moisture were found between treatments except the top soil areas. (Table 1.)

Table 1. Mean values of 12 characters in chrysanthemum variety 'Yellow Shuho'.

Treatment	Days to harvest	Days to full blooming	Stem diameter	Stem length (cm)	Number of node (cm)	Inter-node length (cm)
Black PE film	97.1 c	109.8 c	0.694 a	105.64 a	23.4 a	4.529 a
Silver PE film	95.9 c	108.1 c	0.683 ab	105.73 a	23.0 ab	4.643 a
Rice straw	104.0 b	116.4 b	0.662 b	93.57 b	21.8 b	4.296 b
Non-mulching	107.9 a	120.1 a	0.562 c	83.25 c	22.0 b	3.795 c

(Cont. Table 1.)

Treatment	Flower diameter (cm)	Number of florets	Number of leaves	Area of leaves	Neck length (cm)	Shelf life (days)
Black PE film	11.48 b #	231.1 b	41.8 a	1017.38 a	5.55 a	20.6 a
Silver PE film	11.97 a	281.3 a	42.2 a	1059.98 a	5.45 a	21.1 a
Rice straw	10.38 c	191.8 c	40.5 a	972.32 a	4.95 b	16.5 b
Non-mulching	10.01 c	196.9 c	36.5 b	614.87 b	3.44 c	15.3 b

#: Values within the column followed by the same letter are not significantly at 5% level by Duncan's multiple range test.

Effect of Daylength on the Growth of Gladiolus

The growth and quality of inflorescence of three cultivars of gladiolus were studied under two daylength re-

gimes. The daylength treatments were the natural short daylength in winter (8-9 hrs) and lighting extra 2 hours at midnight as night-break for long daylength. Long daylength had more profound effect on

the enhancement of stem elongation, number of florets per spike, flowering percentage, flower weight and vase life when compared with that in short daylength. Under the treatment of long day, 'Fidelio' had the longest stalk length,

and 'Wig's Sensation' had the largest diameter of flower stalk, but the flowering time for both varieties delayed about 7-12 days. Cultivar 'Nova Lux' was not very sensitive to the treatment of long daylength. (Table 2.)

Table 2. The effect of photoperiod on characters of three gladiolus cultivars.

Character	Day length	Cultivar		
		Wig's Sensation	Fidelio	Nova Lux
Day to flower	LD	86.0**	90.1**	78.8
	SD	74.9	79.6	78.7
Day to harvest	LD	92.5**	93.4**	82.5
	SD	82.3	82.2	81.9
Spike length (cm)	LD	112.5**	126.1**	105.7
	SD	93.2	98.3	104.0
Inflorescence length (cm)	LD	45.3	47.5*	45.8
	SD	38.6	39.0	44.4
Stem diameter (cm)	LD	1.0*	0.9	1.0
	SD	0.9	0.8	1.0
No. of florets (per spike)	LD	17.5**	14.8**	16.1
	SD	13.4	13.0	16.1

1. Planting date: October 22, 1989.

2. *, **: Significantly different from SD plant at the 5% or 1% level.

Effect of Chemical Fertilizers on the Growth and Quality of Gladiolus Flower

Gladiolus is deemed to be an important cut flowers with high economical value in Taiwan. Up until now, however, little data of using adequate chemical fertilizers on the plants have been documented. The experiment was conducted to test the response of gladiolus (variety AO13) on the application of

nitrogen and potassium fertilizers at Houli in Taichung county. The basic data of soil analyzed in the experiment plot were obtained as follows: pH value 5.5 of soil, 2.5% of organic matter, 95 ppm of P, 106 ppm of K, 437 ppm of Ca, and 87ppm of Mg. A factorial design with 4x3 factors involving four levels of N (100, 200, 300, and 400 kg/ha) and three levels of K₂O (200, 300, and 400 kg/ha) was used in this experiment. The amount

of P_2O_5 applied in this trial was fixed in 200 kg/ha.

The results of this experiment indicated that no significant effect of fertilizer on the number of leaf and plant height was found. In addition, both the length and weight of peduncle as well as the number of floret per peduncle were not significantly different between each treatment. However, the weight of corm increased as the rates of nitrogen and potassium increased. For the aspect of flower, low levels of nitrogen (100-200 kg/ha) would result in more flowers and led to some good characteristics such as heavier in weight, longer in vase life, and more intensive in flowering time. An opposite result of flowering characteristics was obtained by using high rate of nitrogen (400 kg/ha).

FRUIT TREES

Studies on Using of Budforcing Chemicals to Promote Flowering on Grapevine

This study was conducted to evaluate the effects of using budforcing chemicals to promote flowering on grapevine and its cuttings in the field. The budforcing agents, calcium cyanamide, hydrogen cyanamide and ethylene chlorohydrin, were used as major treatments. In addition, the foliar fertilizer, the extracts of cytokinin and IBA were added into above agents to evaluate their impact on budbreak enhancement. The results indicated that calcium cyanamide, hydrogen cyanamide and ethylene

chlorohydrin could promote budbreak. These positive effects could be enhanced by adding foliar fertilizer, BA, or IBA. It suggests that calcium cyanamide plus plant growth regulators such as BA, IBA or natural extracts of plants could be used to facilitate budbreak and to enhance flower growth.

Influence of Simple Facility Environment on the Growth of Grapevine

Two cultural models, delayed winter cropping and advanced summer cropping, have been used in facilitated culture of grape in Taiwan. These approaches of using a framed house covered with PE or PVC films were very simple and cost less. This facility could augment much more heat during sunny days, but it could not sustain enough heat for the minimal growth in the cold days. However, several factors such that the fluctuation of humidity, the formation of dew, and the elimination of light were created by the covered films could lead to a great difference in microclimate between inside and outside framed house. Consequently, the growth of shoot and fruit on grapes suffered a great damage due to above unfavorable conditions.

For the winter grapes, when compared the characteristics of grape grown under framed house and in the conventional environment, the growth of shoot delayed in former case was similar to that in the latter. The number of flowering bunch of the former one was slightly higher than the latter whereas the

length of bunch and fruit-set was not significantly different between two environments. After fruit-setting, the rate of shoot regrowth was higher and the regrowth was continuous for a longer period, so that the shoot was longer and the degree of lignification was deeper. In addition, the weight of bunches harvested was slightly lighter, but the weight of berry, sugar contents and acidity were higher if grapes were grown under framed house protection. (Fig. 2)

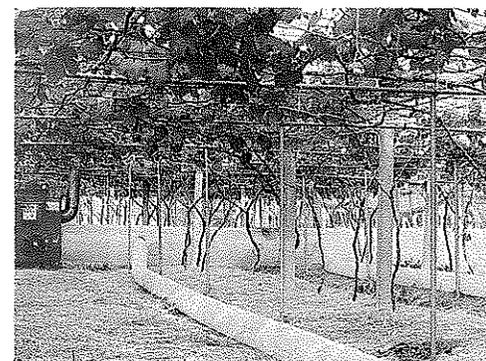


Fig. 2. Simple facility environment for grapevine.

For the advancing summer grapes, the shoots were shorter than that grown in normal summer, and the number of leaf, length of 7-node, leaf area and leaf color were poor. The length of bunch was shorter and the number of flowering bunch was about half of the normal grape. Most of the shoots would stop growing in the latter period of fruit growth and led to the matured grapes having both smaller bunch and berry, lower sugar contents as well as higher acidity.

Studies on the Bud Breaking of Oriental Pear

The study was to examine the effects of using different chemicals on the bud breaking of Oriental pear. The shoot of top-grafted Shinkou pear was treated with 1%, 2%, 4% of hydrogen cyanamide, 0.5%, 1% of ethylene chlorohydrin and 50% upper stock solution of calcium cyanamide during late-January, early-February and late-March. The results indicated that ethylene chlorohydrin had no effect on bud breaking, but 1% or 2% of hydrogen cyanamide and calcium cyanamide could enhance the bud breaking of Shinkou pears during February.

Evaluation on the Approaches of Propagating Oriental Pear (*Pyrus serotina* Rehd.) by Using Stion

As a great number of trees per unit area are required, an important aspect of the cost per unit of a nursery tree is highly concerned. Unfortunately, except that a few stock cultivars are easy to root, most scion cultivars of Oriental pear are generally difficult to root from cuttings. In order to meet the demand of high density orchard, therefore, much more researches on developing an efficient way to obtain volumes of nursery plantlets of pear are greatly needed. For most Oriental pears, the callus formation is much easily observed. Thus this study was to examine the possibility of developing propagation methods on Oriental pears by

using stions. For instance, one of the major approaches was to graft an one-bud scion on a hardwood cutting, and then to force the grafted union and fuse them in a cold room with 4°C. Finally, the roots of cutting are enhanced by using bottom-heat.

Some highlights in the study are as followed: 1) Callus formation of stion was associated with the period of chilling at 4°C. The highest rate about 91% of callus formation was found in the combination of Shinko/Chyli at 40 days of chilling treatment. 2) The rooting capability of stion was enhanced when the stock and scion were treated with alternative temperature of 4°C and 22°C. 3) Owing to the variation existing within scion 2cultivars, the rooting of stion was apparently facilitated when all buds were removed or remained one bud on the stock cuttings. 4) The survival rate of stions was greatly correlated with the cultivar combination of scion/stock. The highest rooting rate in 69.5% was found in the Changfu/Niauli stion within four combinations of stions. 5) The rooting rate was enhanced about 71.5% when the basal stions of Shinseiki/Niauli incubated in a solution consisting of 133 ppm of humic acid and 10 ppm of IBA at 22°C.

For the conventional propagation method of Oriental pear, one year is required to establish rooted stocks and the following year is also needed to manage the grafted stocks in field. However, the approach of propagation by using stions only needs about four months from the

initiation of grafting to the formation of plantlet. For the reasons of time saving and easy manipulation of above propagation method, much more studies on the developing propagation technique by using stion for Oriental pear is needed.

SOIL AND FERTILIZER

Response of Sorghum to P and K Fertilizers

Experiments were conducted in field and pots to study the response of sorghum to P and K fertilizers in slate alluvial. The results revealed that the application of P or K fertilizers could increase the contents of P and K in soil or in plant tissues. The applications of P fertilizer apparently affected the contents of P in plant tissues during the early growth stages. For the K fertilizer treatments, the contents and uptakes of Ca and Mg in plant tissues decreased while the rate of K applied increased. Statistical analysis indicated that a negative linear correlation existed between the concentrations of K and either Ca or Mg in plant tissues at different stages of growth. Therefore, with the high application rate of K fertilizer, the ratio of K/Ca and K/Mg in soil would increase, and result in the reduction of uptakes of Ca and Mg by plants. The optimum ranges of P and K application were determined as 60 kg/ha for P₂O₅ and 80 kg/ha for K₂O.

Effect of Slow-release Nitrogen Fertilizer on Bitter Gourd

The effect of new slow-release nitrogen fertilizer on the growth and yield of bitter gourd was studied on alkaline soil at Pitou, Changhua county. The result indicated that the full amount of CDU (crotonylidene diurea as the starter) had the best growth and the highest yield of bitter gourd in this experiment. The yield of bitter gourd treated with CDU

was 48,875 kg/ha which was higher than that treated with ammonium sulfate in 7.9%. The total benefit estimated was about \$NT 31,000/ha. Application of slow-release nitrogen could promote plant growth, enhance the uptake of nutrient, and lead to an increase in the contents of nitrogen, phosphorus, calcium, and magnesium in leaf tissues. (Table 3.)

Table 3. The growth and yield of bitter gourd as affected by different N sources.

N Source (350 kg/ha)	Plant height (cm)	Yield of bitter gourd	
		kg/ha	index(%)
1. Ammonium Sulfate	196 ^{b1}	45,292 ^c	100.0
2. CDU	199 ^a	48,875 ^a	107.9
3. Meister 100	197 ^{ab}	45,764 ^c	101.0
4. Meister 104	197 ^{ab}	46,981 ^b	103.7

¹. Means in each column with the same letter are not significantly different at 1% level by Duncan's multiple range test.

The Content of Heavy Metals in Soil Affected by Using Fertilizer

The purpose of this study was to survey the heavy metal contents affected by continuously using fertilizer. The data were collected from 35 plots of vegetable field in Taichung area in 1990. The results indicated that the contents of heavy metal such as Cd, Cu and Ni were higher in soil before planting. The contents of Pb and Zn increased in soil while vegetables were harvested and the content of Cr in soil sampled in all plots also increased from low level to medium. The results from the analysis of plant leaf in maturity

stage indicated that fertilizer applied to soil was associated with the contents of heavy metal in plant tissues. For instance, the over use of nitrogen would lead to an increase in the content of Cu and Pb in leaf. In addition, increasing application of phosphate would increase Cd content in plant leaf. As a matter of fact, the trend of increasing heavy metal content in the soil of vegetable field has been found lately. For the results of this survey, it suggest that farmers have to concern the content of heavy metal in edible part of vegetable which may be harmful for the health of human. The

content of heavy metal in fertilizer also needs to be certified.

Studies on the Amelioration of Red Earth in Central Taiwan

Nine field experiments were conducted on the amelioration of Red Earth in central Taiwan during the period of 1972-1990. Results indicated that the application of liming materials could ameliorate soil acidity by increasing soil pH and exchangeable Ca and Mg contents. However, in order to reduce the interaction of soil nutrients, the liming materials should not be applied to exceed the recommendation rates. Through ameliorating the soil with organic amendments and green manures, the contents of soil organic matter could be increased, soil fertility could be enhanced, and soil physical textures could be improved as well. Application of microbial fertilizers could promote the uptake of nutrients in plants, and thus eliminate the amount of application of chemical fertilizers and prevent the deterioration of soil properties. By using above soil reclamation, it suggests that amelioration can result in a good response on the yield and quality of crops.

Survey on the Growth Retarded Factors in Soil of Vegetable Farm in Central Taiwan

In order to evaluate the growth retarded factors in soil of main vegetables such as sweet pea, cabbage, eggplant and Chinese chive, soils were sampled and analyzed from the vegetable cultivated area in the central Taiwan. Results indicated that 9.4% of the surface soil (0-20 cm) sampled from neutral to slightly alkali slate alluvial areas revealed a strong acid (below pH 5.5) and 18.8% of that exhibited slightly acidic (pH 5.6-6.5). 4.7% of the subsoils (20-40 cm) were strongly acidic and 17.2% were slightly acidic. In the total area surveyed, 28.2% of surface soils and 21.9% of subsoils revealed acidic reactions. The specific electrical conductivity (EC) of soil solutions (extracts of soil and water in 1:5 ratio) was examined. 30% of surface soils in these areas were found to have higher EC than 0.6 mmhos/cm. Among them, 14.2% of that had higher EC reaching 1.0 mmhos/cm. For the subsoils, 10% of soils sampled had EC higher than 0.6 mmhos/cm. The amount of fertilizer applied is usually higher than the recommended rate and it may be the main factor of acidification and salination in soil. (Table 4.)

Table 4. The soil pH in vegetable survey farm.

Crop	Surface soil(0-20cm)				Sub-soil (20-40cm)			
	Mean	Max.	Min.	SE	Mean	Max.	Min.	SE
Pea	6.7	7.8	4.6	0.89	6.9	7.8	4.7	0.92
Cabbage	6.9	7.7	5.2	0.91	7.0	7.8	5.3	0.85
Eggplant	7.2	8.0	4.8	0.89	7.3	7.9	5.1	0.44
Chinese chive	7.2	7.7	6.2	0.43	7.2	7.7	5.9	0.51

Effect of Soil Amendment on the Yield of Radish and Soil Fertility in Acid Soil

In order to understand the effect of using soil amendment on the yield of radish and soil fertility in acid soil, the field experiments were carried out at Puli and Nantou. Results indicated that a significant effect on the growth and the yield of radish was found by applying organic compost and soil amendment. For the yield of radish, using S-H mixture (800 kg/ha) and slag (2,000 kg/ha) were the best treatments which could increase 6.4% and 5.3% in yield, respectively. By amending the soil with soil amendment, the pH value and available P, K, and Ca in soil could be increased, but content of Fe was decreased. Soil fertility was apparently well improved by soil amendment in this experiment.

Cadmium Content in the Soil and Its Uptake and Distribution in the Different Parts of Rice Plant

This experiment was conducted in a cadmium-polluted paddy soil at Huatan in Changhua Hsien. As all of the

cadmium-gilting factories in this area has been forced to close, no more cadmium-polluted water can flow into the experiment plot. However some other polluted water with zinc, nickel, chromium, and copper etc., occasionally appear in the irrigation ditch. Moreover it now has very rare chance for these polluted water to get into the paddy field because all of the farmers in this area are now adopting deep-well water to irrigate their paddy fields.

In this experiment, it was found that the soil at the inlet area of irrigation water was the most seriously polluted, showing 5.8 ppm cadmium in the top soil, but it gradually decreased to about 1 ppm with an increase in distance from inlet to 30 meters. As to the vertical distribution of cadmium, the highest cadmium was usually found in the top soil (0-15 cm layer), and was significantly decreased with the increase in depth. However, in some spots of the plot, the cadmium in 15-30 cm layer was similar to those in the 0-15 cm layer. This results suggest that

in some areas of the plot, the cadmium has moved down to the subsoil.

The content of cadmium analyzed in rice plants indicated that 11-38 ppm was the highest in root and stubble; 3-17 ppm in stem next to it; 1-7.5 ppm in leaf was the third; 0.5-2 ppm in brown rice was the fourth; and 0.2-1.2 ppm in rice hull was the lowest. Although cadmium in brown rice tended to decrease with the decrease of cadmium content in the soil, its trend was not sharp enough. The cadmium content in brown rice was 1-2 ppm in the spot with 4-5 ppm cadmium in the soil; and 0.5-1 ppm in the spot with 1-2 ppm cadmium in the soil. This level of cadmium was still higher than the critical level of 0.5 ppm stipulated by the Environmental Bureau. However, it was still unharmed to the growth and yield of rice plants growing in the soil with 4-5 ppm cadmium.

A Survey on the Nutrient Deficiencies and Excess in Fruit Trees in Central Taiwan

An investigation was conducted to study the nutrient deficiencies and excess in the fruit trees in central Taiwan. It mainly consists of the four parts: (1) description of the symptoms of nutrient deficiencies or excess in the fruit trees, (2) analyses for the plant samples, (3) analyses for the soils in the disordered area, (4) recommendation to prevent the deficiency or excess. For the convenience of reference, it was presented separately with the kinds of fruit trees, and only

three fruit trees, citrus, grapevine, and pear were involved in this survey. Citrus was mainly deficient in the single element of either magnesium, zinc, manganese or iron, but deficiency in the dual elements of manganese and zinc was found in grapefruit, pomelo, and valencia in Changhua Hsien. Grapevine was deficient in the single element of either potassium, magnesium, manganese, iron, or copper, but deficiencies in the dual elements of magnesium and copper or potassium and copper was easily found in the diluvial soil area, and fluorine toxicity was found in the brick factory area. Potassium deficiency was a widespread problem of Heng-Shan pear at Tungshih. The above symptoms of deficiencies or excess were described on the spots in the orchard. The recommendations for the prevention of disorders are made based on the data of the previous workers and the experience of the author.

Effect of Pyrogallol on the Catalysis of Mn Oxide in the Abiotic Transformations of Amino Acids

Abiotic transformations of selected amino acids as catalyzed by Mn oxide and the role of pyrogallol in the abiotic transformations were studied. Among the systems studied, the decarboxylation of the Mn oxide-cysteine system was the most pronounced, while that of the Mn oxide-methionine system was the least. The amount of CO₂ released from the former was 1.5 times of that released from latter. The deamination of the Mn

oxide-cysteine system was the most pronounced, while that of the Mn oxide-proline system was the least. The amounts of NH₃(NH₄⁺) released from the former was 3.4 times of that released from the latter. Mn oxide catalyzed the desulfurization of methionine and cysteine to release SO₄²⁻ in the supernatant of the reaction systems. The amount of SO₄²⁻ released from the Mn oxide-cysteine system was 140 folds of that from the Mn oxide-methionine system. The data indicated that the role of pyrogallol in the deamination, and desulfurization of selected amino acids as catalyzed by Mn oxide was inhibition, and nil, respectively.

Organic Fertilizer and Its Use in Crop Production

In this paper, the authors mainly describe the chemical components, the composting methodology, and utilization of the organic manures that are commonly used in Taiwan. The chemical analyses of the organic materials or manures were conducted by the authors themselves. They are classified into ten categories based on the difference in sources as follows: 1) crop residues, 2) green manures, 3) common compost, 4) mushroom compost, 5) cattle feces, 6) hog feces, 7) chicken feces, 8) municipal refuse, 9) oil extracted residues, 10) animal residues. All of these materials have their advantages and disadvantages, and the authors have made some suggestions or recommendations for the proper improvement

and utilization of the materials for the users.

A traditional way of composting method so far conducted in Taiwan has been described in detail in the paper, however some current ways of composting are also mentioned shortly in the other parts of the report. The application methods and rates of organic manures, and their effects are mentioned here based on the experiences of the authors and the data from other workers in Taiwan.

PLANT PROTECTION

Fluctuation of Aphid Population and their Control Time on Sorghum Taichung No.5

Sorghum aphids (*Melanaphis sacchariu*) is one of important insect pests of sorghum. They usually appeared in a large number at the stage from booting to soft doughy, and greatly affected the growth, yield and quality of sorghum. Results of investigation on the seasonal fluctuation of aphid population in sorghum indicated that the distribution peak of population was found in the period of 40-70 days (from booting to soft dough) after sowing for spring season, and 60-100 days (from heading to harvesting) for fall season. Several chemicals applied to evaluate their efficiency on pest control for sorghum indicated that the best efficiency was obtained by using 25% carbophenothion W.P. and 40.64%

carbofuran W.P. The optimum time for applying chemicals to control aphid in sorghum was determined to be ten days intervals with five sprays during 40-80 days after sowing. In the aspect of grain yield of sorghum, approximately 21% and 11% increment of grain yield were obtained in spring and fall cropping, respectively, when compared the sorghum grow-

ing under chemical control and under natural condition. Results suggest that the suitable time for controlling sorghum aphids is at the 50th, 80th days after sowing for spring cropping and the 60th, 90th days for fall cropping while the aphid distribution reach the peak of population density. (Table 5.)

Table 5. Economical evaluation for control of sorghum aphids on the variety Taichung 5 by different intervals and times of insecticidal application.

Treatment	Grain yield (kg/ha)		Cost of insecticide and application (NT\$/ha)		Index(%)			
			Spring crops	Autumn crops	Yield		Net profit	
	Spring crops	Autumn crops	Spring crops	Autumn crops	Spring crops	Autumn crops	Spring crops	Autumn crops
Treated on 40, 50, 60, 70, and 80 DAS	6677	8408	9920	9920	121	111	108	101
Treated on 40, 60, and 80 DAS	6433	8108	5952	5952	116	107	109	101
Treated on 50 and 80 DAS	6379	8008	3968	3968	116	105	111	102
Treated on 60 DAS	6225	7650	1984	1984	113	101	110	99
Control	5504	7564	0	0	100	100	100	100

1). DAS: Days after sowing.

2). Same as table 1.

3). Cost of insecticide: 40.64% Carbofuran 0.82 NT\$/ml x 1,200 ml/ha/times = 984 NT\$.

Cost of application: 100 NT\$/1 hr. x 10 hrs/ha/times = 1,000 NT\$.

4). Net profit = Gross profit - Cost of insecticide and application.

The Injury by Broad Mite (*Polyphagotarsonemus latus*), and Its Chemical Control

Broad mite (*polyphagotarsonemus latus*) can attack not only citrus and tea plants but many kinds of vegetables and floral plants as well. The growth of meristem would terminate when plants was injured. The symptoms, wrinkling

and wrenching on young leaves, narrowed and thickened leaf blades would be obviously observed. In addition, the leaf would become pale with a waxy appearance on the underside, and some flowers and fruits would turn brown in color and eventually drop off. Because these mites are too small to be observed, their injury is often fallaciously recognized as a dis-

ease or being caused by other pests. When the symptoms of damage are very conspicuous, it is usually too late to control with chemicals and the injured plants are unable to recover. Data of recent survey indicate that sweet pepper, hot pepper, African mums, tomato, aqua-cultured lettuce, eggplant and some leguminous crops have been seriously injured. Plants growing under protection were more susceptible to broad mite and their damages were more serious than that in open fields. (Fig. 3)



Fig. 3. Symptom on sweet pepper caused by broad mite.

Among 15 chemical compounds evaluated in laboratory and field against this mite, five insecticides such as Dienochlor 50% WP (1,500x dilution), Dursban 40.8% EC (1,500x), Neoron 25% EC (500x), Peropal 25% WP (1,500x), and sulfur 80% DF (400x) were found to be quite effective. As the life cycle of this mite was very short, mite could multiply very rapidly. Chemical control must be applied when the population of mite on the new leaves of crop just

initiates to form and the injured symptoms on plants have not been found yet. This result also suggests that twice applications of the insecticides with an interval of 5-7 days are needed, and more sprays are required after 10-14 days.

The Occurrence of Aphid (*Aphanostigma piri* Cholodkovsky) on Top-grafted Pear, and Its Preliminary Test for Chemical Control

The aphids (*Aphanostigma piri* Cholodkovsky) multiply on the fruits (Fig. 4). It is one of the most important pests on top-grafted pears in recent years (Fig. 5). Nine insecticides were selected from 25 chemical compounds in the laboratory and subsequently tested to evaluate their control in the field. Preliminary results indicated that the chemical compounds, such as Sulfur 80% DF (800x dilution), Marshal 48.34% EC (1,200x), Dursban + MIPC 50% WP (1,000x), Hokbal 40% WP (800x), Mesurool 50% EC (1,000x), Diazinon 60% EC (12,000x), and MIPC 20% WP (800x) were quite effective against both adults and nymphs of aphids. These insecticides must be sprayed directly onto the aphids to expend their action. Except Sulfur, Mesurool and Diazinon, these compounds lacked function of terminating the ovicidal activity. The aphids usually could remain under the dried and cracked bark after pear harvesting. However, further work with determining the life cycle of aphids on the pear and under-

standing its migration as well as how to live over winter need to be done.

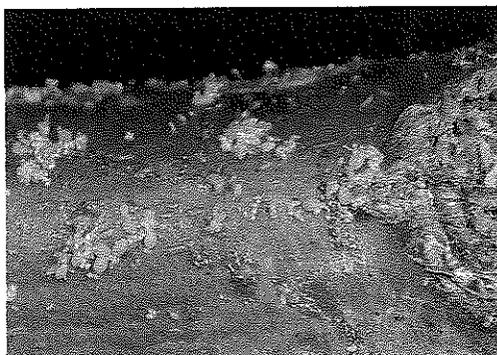


Fig. 4. Adults and eggs of *Aphanostigma piri*.



Fig. 5. Symptom on top-grafted pear caused by *Aphanostigma piri*.

Physical Trapping and Insecticides Screening for *Liriomyza trifolii*

Liriomyza trifolii has now rapidly spread over this island, since its first occurrence was reported in February 1988 in central Taiwan (Fig. 6). It can attack various varieties of plants and cause serious damages. Through a series of tests, five insecticides were screened to have rather effect against this pest. These insecticides are Trigard 75% WP (5,000x dilution), Cartap 50% SP (1,000x), Thioayclam Hyarogenoxalate 50% WP

(1,000x), Methamidophos 50% LC (1,000x) and Parathion 47% EC (1,000x). In addition, Triazophos 40% EC (1,000x) was also effective, but its effectiveness only lasted for 2-3 weeks after twice successive applications.

From a physical trapping experiment in field, it exhibited that light traps with three different colors were not effective to catch the adults. However, yellow water pan and yellow sticky board could attract a large number of adults, and these tools could be adopted for monitoring the occurrence of this insect pest in field. Yellow sticky boards (18 x 25 cm) placed in field in a distance of 2 m between adjacent two boards for 2 months gave approximately 30% control of this pest, but the efficiency of these boards for monitoring the pests was affected by the number of boards placed and the cultural environment.

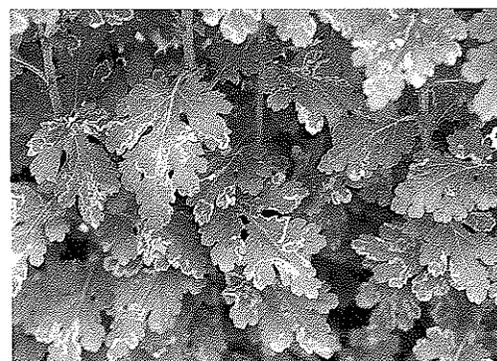


Fig. 6. Symptom on chrysanthemum caused by *Liriomyza trifolii*.

Thrip Transmission of Tomato Spotted Wilt Virus from Watermelon

The tomato spotted wilt virus (TSWV) can cause a serious damage on watermelon in Changhua area of central Taiwan. The symptoms of narrowing, crinkling, mottling and yellow spotted on leaves, shortened in internodes, upright growth of branch tips, top-necrosis and dying back have been found to be prevailing on watermelon (*Citrullus vulgaris* Schrad.) since 1987 (Fig. 7). This disease was deemed to be associated with the occurrence of the insect, *Thrips palmi*. Thrip transmission of TSWV was the critical pathways that could induce a serious damage on watermelon (Fig. 8).

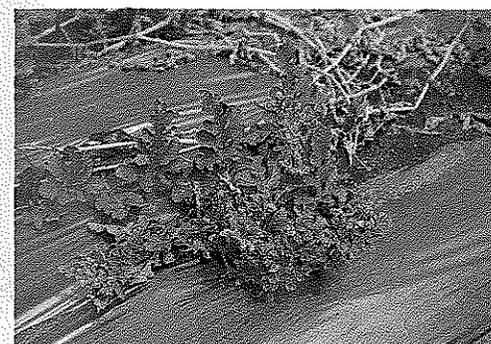


Fig. 7. Symptom of TSWV on watermelon.

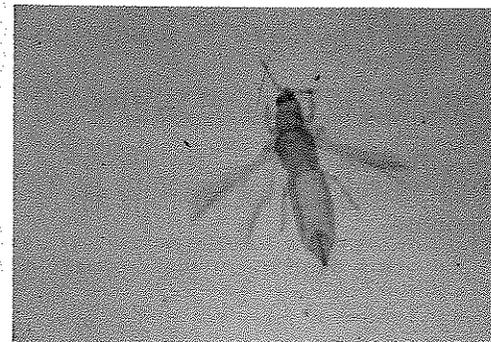


Fig. 8. *Thrips palmi*, a vector of TSWV.

The adult thrips collected from disease plants of watermelon in field were fed on healthy plants of *Datura stramonium* at 3-4 leaf stage. Each plant tested was fed on 5, 10, 15, and 30 thrips for 2 days and additional noninfective colonies were used as a check. The adult thrips collected from field were also reared on healthy watermelon (*C. vulgaris* var. Know-you 610) with 10 thrips on each plant. The results revealed that 25 out of 45 plants of *D. stramonium* and 10 out of 15 plants of *C. vulgaris* were infected. In another experiment, noninfective thrips rearing on healthy eggplant were examined for their transmission ability. *D. stramonium* plants that with single lesion by mechanical infection were isolated from TSWV-W and confirmed by leaf dipping electron microscopy were used as the acquisition feeding source. Thrips at the first nymphal stage were fed on the disease plants and 6-8 days later the adults were used to feed on *D. stramonium* and *C. vulgaris* var. Know-you 610 with 10 insects for each plants. The results indicated that 6 out of 11 plants of *D. stramonium* and 7 out of 13 plants of *C. vulgaris* were infected. Plants inoculated by noninfective thrips was not infected. Except the *T. palmi*, both *Thrips tabaci* collected from onion and *Franklinell intonsa* collected from rose were also used for further experiments. The results indicated that those thrips failed to get transmission of TSWV-W.

Studies on the Ecology and Control of *Phyllotreta striolata* (Fab.) — The Morphology, Rearing Method, Behaviors and Host Plant

The striped flea beetle, *Phyllotreta striolata* is considered as a serious pest of cruciferous vegetables, especially on the Chinese cabbages and radish in Taiwan. The eggs of *P. striolata* are mainly deposited dispersally on the basal part of leaf stalk or in the soil of root zone, which always adhered on the surface of the roots. The larvae pupate after the third ecdysis and before the final ecdysis. There is a resting period called prepupal period. The prepupal larvae pupate in the self-building soil cave. After emergence, the adults crawl to the surface of the soil and damage the foliage of vegetable. Both larva and pupa are inhabitant in soil. About 80% of the insects including larvae, pupae and emergent adults inhabited in soil of 0-10 cm in depth and others were distributed in soil of 10-20 cm in depth. The distribution of larvae and pupae in underground may be associated with the characteristics of soil, vegetable species or cultivars, and the environmental factors around the plants. When *P. striolata* fed with six different preferential vegetables such as radish etc., the average durations of larvae and pupae were about 14 and 5-6 days, respectively, but no apparent difference of that among vegetables could be observed. Under the temperature of $25 \pm 1^\circ\text{C}$, however, the longevity of adult was the longest in *B. chinensis*, and followed by Pak-choi (33

days), *B. oleracea* var. capitata (23 days), *B. juncea*, mustard (16.4 days), *Raphanus sativus*, radish (16.2 days), and Ching-geeng Pak-choi (13 days). When the adults fed with nonpreferential species of crop such as pumpkin, cucumber etc., the average longevity was longer than 10 days and some of them could survive to 32 days. It suggests that the nonpreferential plants may be used as a temporary survival host plants instead of the preferential host plants. The rearing method, morphology and life habit of *Phyllotreta striolata* are also described in detail (Fig. 9).



Fig. 9. Adults of *Phyllotreta striolata* (Fab).

AGRICULTURAL MACHINERY

Modification of Rice Combine to Adly Combine

This experiment was focused on the improvement and modification of rice combine to adly combine while the minimum cost was concerned. The improved components of rice combine are: (1) to

increase concave mesh from 13 m/m to 19 m/m; (2) to increase the speed of throwing back vanes of No. 2 auger from 1150 rpm to 1270 rpm; (3) to replace the oscillation straw sieve of grate type by net type sieve. From the results, 2.1-2.5% of dust loss and 1% of damaged rates of kernel were obtained by using 2-row rice combine (YANMAR TE-750K) under 0.39 m/sec operation speed, whereas less than 1% of dust loss were obtained by using 4-row rice combine (YANMAR TE-2,200 K) under 0.47 m/sec operation speed. (Fig. 10).



Fig. 10. Adly Combine Used for Harvesting Job's Tear.

Development of Gladiolus Corm Harvester

Gladiolus is one of very potential cut flowers in Taiwan. Basically, two types of gladiolus fields have been adopted for the purpose of corm breeding and cut flower production. The breeding field is established by farmers themselves to generate gladiolus corm in order to decrease both the cost of domestic production and the amount of corms imported.

The goals of this study was to develop a corm-harvest machine which can be used in breeding field.

The operation conditions and the specification of the machine are as follows: 110 cm row width and 30 cm furrow width; tractor horsepower about 40-50 Hp; three-point hitch system and rotating speed of P.T.O. drives with 540 rpm; 200 cm machine body length with 132 cm track width. The structure of the machine can be divided into two parts: one is a vibration plow connecting with P.T.O. by a 2.5 cm biased eccentric plate, and the other is a conveyor with two-speed rod-chain. The first part has 5 cm swing amplitude for cutting, loosening in soil, digging corms out, and then pre-separating corms from soil. The function of the second part is to work the secondary separation and to convey the corms to the rear side. However, much more tests on the field performance of this machine need to be studied. (Fig. 11).



Fig. 11. Gladiolus corm harvester.

Study on Multipurpose Pneumatic Cultivator and Its Fertilizing Efficiency on Hent-Shan Pear

A multipurpose pneumatic cultivator which blows high pressure air and liquid in deep soil has its functions in cultivation, fertilization and pest control. Experiments were conducted to investigate the growth properties of Heng-Shan pear, fertility of the orchard, shearing force of pear roots (Fig. 12). In addition, soil penetrating resistance between subsoil fertilizing area and traditional fertilizing area.



Fig. 12. Multipurpose pneumatic cultivator.

Results provided the experimentation data of subsoil fertilizing techniques and indicated that the growth of the orchard in each subsoil fertilizing area was better than that of the traditional fertilizing area. For the Heng-shan pear growing, the fertility of subsoil fertilized was higher than that of the traditional fertilizing area. The products of Heng-shan pear treated by fertilizing in subsoil area was higher about 20% than that treated by traditional

fertilizing method, while the amount of fertilizer used for former was only 5/6 of latter. The quality of pear was not significantly different between two fertilizing treatments.

AGRICULTURAL ECONOMICS

Economic Analysis for Vegetable Production under Protected Structure in Taichung Area

The goal of this study was to estimate the revenue and cost of vegetable production under either protected or non-protected structure in the current situation in Taichung area, and to evaluate the potential of developing technique for vegetable production under protected structure. The data obtained from 26 farmers dealing with vegetable production under protected structure and 24 of that under unprotected structure were analyzed. The results indicated that the highest profit was obtained from the vegetable culture under net-house, and the next one was from the culture under plastic-film greenhouse, and the lowest one was from the culture under plastic tunnel. However, if the annual economic efficiency per hectare was concerned, the water convolvulus cultivated under plastic tunnel had the highest benefit in NT\$ 46,520, and the next was under net-house with NT\$ 36,387, and the lowest one under plastic-film greenhouse with NT\$ 24,004. The pay-back period of facilities established was about two years for plas-

tic-film greenhouse and less than one year for net-house.

The protected structure for the production of vegetables has a relative potential in Taichung area. However, the first priority should be concerned of developing cultural techniques for vegetable production under protected structure in either a preexisted and specialized or suburb area. Finally, in order to maintain the steady development of vegetable production cultivated under protected structure, it is suggested that: 1) the unified brand of products should be adopted and both the trademark and credit should be established; 2) the materials of facility for construction should be specialized and standardized; 3) the related cooling facilities and marketing systems of products should be established; 4) the grading standards should be determined and implemented exactly; 5) the instrument and machine used for packaging should be developed; 6) the negotiation ability for price should be enhanced under the cooperative spirit.

A Preliminary Study on the Quality Grading of Kyoho Grape

A preliminary study was conducted to find the adequate grading technique on the quality of Kyoho grape based on the quality and taste panel test. The items of quality test included color, size, weight, hardness, sweetness, acidity and sweet/sour ratio of grapes. The items of

taste panel test consisted of fruit appearance and eating quality.

Totally, 250 samples of grapes were randomly collected from Tatsuen, Tungshin, Cholan, Hsinshu, and Hsinyi in the summer production of 1988. Results indicated that the quality and taste panel test could be used to classify the good, fair and poor groups of Kyoho grapes. Color, size (or weight), hardness, sweetness, and sweet/sour ratio could be used as an indicator of determining the quality of Kyoho. The grading method of Kyoho grapes described in this study may be applicable, but much more researches need to be done to precisely determine the quality of grapes based on the data of quality and taste panel test and to set up the exactly grading system of Kyoho grape.

Status Analysis of Grape Production under Protected Structure in Taiwan

The production cost and revenue of grape under protected structure condition were analyzed and the feasibility of cultural techniques was evaluated as well. The data were collected from 20 grape farmers. The results indicated that the cultural techniques of grape production under protected structure need to be established and some existed miscellaneous problems need to be solved. In addition, significant differences of cultural techniques occur among these grape farms. A relative higher loss was generated in grape farms under protected structure. At

this point, thus, the revenue was lower compared with that under unprotected structure. Therefore, it is not advisable to demonstrate the grape cultivated under protected structure. An economic evaluation for further extension is needed, although the cultural practices are well established in grape farm.

AGRICULTURAL EXTENSION

Studies on the Field Performance of the Awarded Outstanding Farmers in Taiwan

The performances of professional farmers awarded with their outstanding on farm management were surveyed. Additionally, their attitude of farming management and the other related factors were investigated. Various analyses based on the data obtained from the special reports for outstanding farmers in 1983-1990 issued by the Department of Agriculture and Forestry, Taiwan Provincial Government. The results indicated that three majors factors could elucidate how a farmer can get a successful management in the farm. These factor are: 1) farmers have the innovative mined personalities; 2) farmers get supports and assistance from other members in family in the aspect of moral, financial, technological and labor supports; 3) farmers acquire full exogenous aids such as farm technology, labor supply, and farm inputs. The supervision, assistance and guidance are mostly offered from Farmers' Associations and the farming technology is mostly

provided by the specialists of the District Agricultural Improvement Stations and universities.

Roles and Functions of Agricultural Extension Work of the District Agricultural Improvement Station

In the period of the post World War II, the main characteristics of the extension work in Taiwan was carried out at the Farmer's Association (FAs). With the matter of subject, the extension service was emphasized in the dissemination of new technology among farmers. To meet the needs of economic development and social change, the domain of agricultural extension work may extend to the development of food markets, improvement of farming managements, cultivations of young farmers, improvement of rural community and enhancement of farmers' living standards, etc. The extension work was considered as a multi-purpose approach and played an active role on the agricultural and rural development in this country.

To cope with the situation of above changes, and to view the importance of current rural development, an agricultural extension system is now emphasized by each District Agricultural Improvement Station (DAIS). Whereas DAIS can offer services to the extension colleagues of local FAs and farmers. In the future, the Government has made a great effort in helping the operations of 'The Law of the Agricultural Extension'. In order to establish the system of the

agricultural extension, the following two prerequisites need to be concerned. Firstly, how to determine the roles and functions of extension works between the FAs and the DAIS. Secondly, how to raise the amount of matters associated with the extension works for specialists in each DAIS.

Analysis on the Approaches of Garbage Handling in Farm Families

With the beginning of 1988, totally, 43 villages were randomly selected to deal with garbage handling in different ways. Three approaches, classifying, burning, and composting of garbage handling were categorized in this study to evaluate their feasibility. Local farmers were interviewed in order to find the best way to improve the rural living environment and solve the problem of garbage handling. The results indicated that the classification of garbage was necessary because the recycle and reutilization of garbage was deeply concerned. Unfortunately, no good strategy on garbage classification has been used so far. The burning method of garbage handling could reduce the amount of garbage in 29.4%, but a drawback was that air pollution was generated and a higher cost was needed for labors to manipulate the garbage burning. The composting method of

garbage handling could reduce the amount of garbage in 34.8%, and the compost could be used as fertilizer on field or horticultural crops. From the experiment of using those composts on Chinese cabbage, the rate of germination was 85.8% and the survival rate was 89.5%. It indicated that the garbage composts could be used on crop cultivation, but the question is that a large space is needed to make composts. Generally speaking, the garbage handling in farm families needs to be demonstrated because a great advantage will be earned from reducing the amount of garbage and beautifying the environment of farm by using the strategies of garbage handling mentioned above.

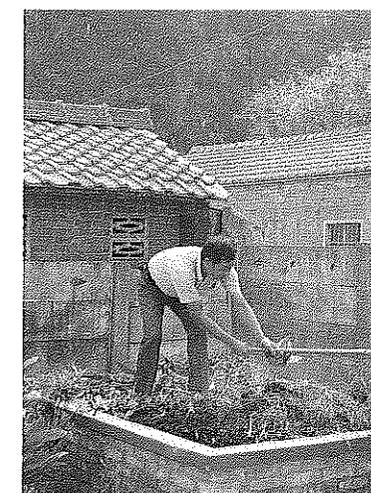


Fig. 13. Composting of garbage handling in family farm.