農業研究

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本省水稻田土壤之陽離子交換性質研究[1]

黎 靜 韻[2]

一、導 言

陽離子交換爲土壤膠體中之一陽離子與卄壤溶液中另一陽離子之交換現象，亦爲土壤化學反應中最普通與最重要之一種反應（15），尤以陽離子交換能量（Cation Exchange Capacity 簡寫爲C.E.C.），每認爲可推知營養分穩藏之可能或對作物之可供應之營養分量，亦即土壤肥力之厚薄，由此可證明其梗概，再從各種所交換性陽離子含量多寡，可計算該土壤之飽和度與某項可交換養分之數量及養分間之比例關係、對土壤肥力或植物營養方面瞭解之增進至有助益（16），水稻田土壤爲本省最主要之農田土壤，凡四十餘萬公頃（1）包括各種不同母質來源之冲積土、紅壤及黃壤等，其固有隱藏積蓄能量之豐瘠，或可爲各類稻田產量之指標。過去此項研究不多，或僅報導其數值，散見於土壤調查報告與少數專題內，鮮有研討其間之關係者，此爲本研究之緣起。

二、前人之研究

有關本省水稻田土壤陽離子交換性質之研究資料甚少，土壤分析結果，僅散見於土壤調查報告書，或附列於某項專題內。爲瞭解一般情況，經搜集全省各縣土壤報告書，查出各類土壤分析之結果，按照不同地區，不同土類及不同母質之來源，統計 C.E.C. 之平均結果（2,3,4,5,6,7,8,9,10,及11），列成表一以明概況。

表一 過去分析本省水稻田土壤之 C.E.C. 資料統計結果

Table 1. The statistic result of C.E.C. of paddy soils that have been analysed since 1948 in Taiwan.

土類 Soil group	母質 Material	中部 Central part 樣本數 *S.a.n.	中部 C.E.C. 平均值 Average	南部 Southern part 樣本數 S.a.n.	南部 C.E.C. 平均值 Average	北部 Northern part 樣本數 S.a.n.	北部 C.E.C. 平均值 Average	東部 Eastern part 樣本數 S.a.n.	東部 C.E.C. 平均值 Average	合計 Total 樣本總數 **T.s.a.n.	合計 C.E.C. 總平均值 average
冲積土 Alluvial soils	砂岩頁岩質 Sandstone & shaly	23	6.2	15	8.9	19	8.1	—	—	57	7.5
	粘板岩質 Slaty	6	20.2	22	7.8	1	20.2	—	—	29	10.8
	片岩質 Schisty	—	—	—	—	—	—	7	9.5	7	9.5
合計 Total		29	9.03	37	8.2	20	8.7	7	9.5	93	8.7
紅壤或黃壤 ***R.B.L. or Y.B.L.		5	7.9	—	—	13	10.7	—	—	18	9.9
總計 Sum total		34	8.9	37	8.2	33	9.5	7	9.5	111	8.9

* S.a.n.——Sample analysed number. ** T.s.a.n.——Total sample analysed number

*** R.B.L. or Y.B.L.——Reddish brown latosols or Yellowish brown latosols

本研究獲國家科學委員會之研究補助，關於C.E.C.之推算荷洪昆煌教授，李蘭帝先生之鼓勵與協助，文成並承陳振鐸教授及梁鉅榮主任核正，統此誌謝。 1.試驗報告農試字第五五四號。 2.臺灣省農業試驗所技士。

自上表知水稻田土壤可分爲兩大類，一爲冲積土類，一爲紅棕壤及黃棕壤類，前者之陽離子交換能量（C.E.C. m.e./100g）含量較後者稍低。冲積土類水稻田復分爲三亞類，即砂岩頁岩質，粘板岩質及片岩質，就中以粘板岩質冲積土之 C.E.C. 平均值較高，片岩質冲積土次之，砂岩頁岩質冲積土較低，搜集已有之樣本爲111個，其 C.E.C. 之總平均值爲 8.9m.e./100 克，其中最高爲粘板岩質冲積土，最低爲砂岩頁岩質冲積土，均屬於中部地區。以地區言之，東部及北部土壤 C.E.C. 平均值相同，並較高於中部及南部兩地區，而中部亦較南部稍高，此爲綜合前人研究本省水稻田土壤陽離子交換能量之梗概。

三、研究範圍及目的

本研究從新採集土壤樣本，包括不同母質來源之冲積土，紅棕壤及黃棕壤外，並分別採集不同期作後之土壤樣本，及選擇高低產量不同地區採樣，進行分析與研究，目的有：

（一）研究全省各類水稻田土壤之陽離子交換特性與產量之關係，以討論其固有隱藏之能量。

（二）繼而研討其陽離子交換特性與其主要理化性質及稻米生產之相關。

四、試驗內容及結果

（一）分析項目及方法

1.陽離子交換性質方面：

採用 Brown 氏法（14）非鈣質土用

Mehlich 氏法（13）鈣質土用

（1）陽離子交換能量（C.E.C.）

（2）置換性鹽基總量（T.E.B.）

（3）置換性鉀、鈉、鈣、鎂及氫

（4）鹽基飽和度百分率

2.主要理化性質（14）

1.機械成分：浮秤法

2.PH.：玻璃電極法，水土之比（1:1）

3.有機質：Walkley-Black

4.全氮量：Kjeldahl法

（二）樣本採集之數目

1冲積土類	132個
1.砂岩頁岩質	37個
2.粘板岩質	52個
3.片岩質	22個
4.安山岩質	21個
2紅棕壤	25個
3黃棕壤	26個
合計	183個

（三）分析結果

各項分析結果詳見附錄。限於篇幅，未及印出。

五、討論

1.本省稻田土壤種類及其陽離子之交換性

本省水稻田土壤大部爲冲積土，小部份屬於紅棕壤或黃棕壤，分佈於臺地，凡水源可達之地區亦用作水田，冲積土因其母質來源不同，可分爲四亞類：

（1）砂岩頁岩質冲積土。

（2）粘板岩質冲積土。

（3）片岩質冲積土。

（4）安山岩質冲積土。

以砂岩頁岩質冲積土分佈面積較廣，安山岩質冲積土分佈面積較少，僅見於北部大屯山彙之冲積谷地。茲統計不同土類或各不同母質來源之冲積土各土層之陽離子交換能量如下表：

表二　本省水稻田土壤陽離子交換能量概況

Table 2. The Cation Exchange Capacity of the Soils of Paddy Field in Taiwan (m.e./100g.)

土類 Soil groups	母質 Parent materials ＼ 層次 Horizons	表土 Surface soils 樣本數 Sample number	表土 Surface soils 平均 Average	亞表土 Sub-surface soils 樣本數 Sample number	亞表土 Sub-surface soils 平均 Average	底土 Sub-soils 樣本數 Sample number	底土 Sub-soils 平均 Average	小計 Total 樣本數 Sample number	小計 Total 平均 Average
冲積土 Alluvial soils	砂岩及頁岩 Sandstone & shale	15	7.6	12	7.2	10	7.6	37	7.4
	粘板岩 Slate	22	8.1	18	7.0	12	6.2	52	7.3
	片岩 Schist	6	10.2	6	10.3	10	7.5	22	9.0
	安山岩 Andesite	9	24.8	5	24.6	7	21.1	21	23.5
紅棕壤 Reddish brown latosols	洪積層 Dilluvial deposite	6	9.4	6	10.2	13	11.4	25	10.4
黃棕壤 Yellowish brown latosols		6	12.6	6	11.7	14	11.0	26	11.5
合計 Total		64	10.7	53	9.7	66	10.2	183	10.4

自上表知陽離子交換能量（C.E.C.）之含量，就冲積土言之，因母質來源不同而異，以安山岩質冲積土之 C.E.C. 含量各層之總平均值爲最高 23.5m.e./100 克，表土、亞表土相差不遠，底土略遜；片岩質冲積土次之，平均值爲 9.0m.e./100 克，表土、亞表土至爲相近，底土平均較少；砂岩頁岩質冲積土又次之，表土與底土平均值相同，而較高於亞表土；粘板岩質冲積土之 C.E.C. 總平均值稍遜於砂頁岩冲積土，全剖面亦以表土爲高。紅棕壤或黃棕壤之 C.E.C. 平均值，則以後者之總平均值略高，爲 11.5m.e./100 克，兩者與冲積土比較，除安山岩質冲積土外，其餘三種母質之冲積土壤均較低。全部樣本183個之 C.E.C. 總平均值爲 10.4m.e./100 克。

茲將過去資料（表一）與現在分析結果（表二）比較之，其最大差異爲粘板岩質冲積土，過去之結果較高，29個樣本之平均值爲 10.8m.e./100 克，現在52個樣本之平均值爲 7.3m.e./100 克。此種差異原因或係由於樣本來源不同有以致之，其餘尚多吻合。

（二）本省水稻田土壤剖面各層陽離子交換能量（C.E.C.）之實況。

茲將本省水稻田土壤剖面各層 C.E.C. 之差異，就其剖面本身之各層含量範圍以爲比較，統計如表三：

表三　本省水稻田土壤剖面各土層陽離子交換能量高低概況

Table 3. The Cation Exchange Capacity of the Separate Horizon of the Paddy Soil Profiles in Taiwan.

土類 Soil groups	剖面層數 Number of Horizons	層次名稱 Name of Horizons	C.E.C. 範圍 Range of C.E.C. m.e./100g. Min.	Max.	剖面個數 Number of Profiles	各層平均數 Ave. m.e./100g.
冲積土 Alluvial Soils	1	表土 Surface	4.89	37.14	11	16.76
	2	表土 Surface	4.90	9.02	11	6.99
		亞表土 Sub-surface	4.16	8.81		6.17
	3	表土 Surface	3.74	31.56	21	9.87
		亞表土 Sub-surface	2.51	33.33		9.86
		底土 Sub-soils	1.47	21.61		8.65
	4	表土 Surface	4.40	27.17	9	12.99
		第二層 2nd layer	5.07	24.64		12.06
		第三層 3rd layer	6.27	24.46		11.89
		第四層 4th layer	5.20	25.79		11.39
紅棕壤或黃棕壤 Reddish Brown latosols or yellowish Brown latosols	4	表土 Surface	7.47	12.57	9	9.82
		第二層 2nd layer	9.32	11.36		9.96
		第三層 3rd layer	8.47	12.45		10.55
		第四層 4th layer	9.11	13.83		11.31
	5	表土 Surface	9.89	21.01	3	13.80
		第二層 2nd layer	10.20	20.57		14.06
		第三層 3rd layer	10.31	12.32		11.31
		第四層 4th layer	10.48	12.04		11.17
		第五層 5th layer	10.27	14.60		12.89

由表三觀之，本省冲積土水稻田土壤剖面中各層 C.E.C. 含量之平均數，皆以表土偏高，亞表土次之，底土偏低，即剖面四層者亦由表層依次下降；在紅棕壤或黃棕壤剖面觀之，剖面四層者之平均數，適與冲積土類者相反，即含量由表層依次增加，剖面五層者更爲複雜。一般言之，底層含量較高。

（三）本省水稻田土壤一般土壤性質與陽離子交換性之關係。

1.土壤質地與陽離子交換能量（C.E.C.）含量之關係，就土壤學之理論言，含粘粒成分愈高者，C.E.C. 含量愈高，(15)換言之，質地愈粘重者，含 C.E.C. 量愈高，質地愈輕鬆者，含 C.E.C. 量愈低。本省稻田土壤之質地與含 C.E.C. 量之實況，就分析結果統計之如表四。

表四　本省水稻田土壤之質地與陽離子交換能量

Table 4. The Soil Texture and C.E.C. Content of the Soils of Paddy Field in Taiwan (m.e./100g.)

質地名稱 Name of texture	冲積土 Alluvial soils		紅黃壤 Latosols		小計 Total	
	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average
粘土 Clay	24	19.3	33	11.0	5.7	14.5
粘質壤土 Clay loam	31	11.0	2	11.5	33	11.0
坋質粘土 Silty clay	10	8.7	15	11.3	25	10.3
坋質粘壤土 Silty clay loam	14	8.3	—	—	14	8.3
砂質粘壤土 Sandy clay loam	5	6.8	—	—	5	6.8
壤土 Loam	19	6.3	1	9.1	20	6.5
坋質壤土 Silty loam	14	6.0	—	—	14	6.0
砂質壤土 Sandy loam	12	5.9	—	—	12	5.9
壤質砂土 Loamy sand	1	5.5	—	—	1	5.5
合計 Total	130	10.2	51	11.1	181	10.4

由上表知冲積土質地愈粘重者如粘土，C.E.C. 含量愈高，反之質地輕者如壤質砂土 C.E.C. 量愈低。粘土24個之平均值爲 19.3m.e./100 克，壤質砂土則爲 5.5m.e./100 克，兩者之差幾達四倍。中間質地之土壤相差並不大，平均數多在 6 —11m.e./100 克間；至於紅黃壤質地多偏於粘質，C.E.C. 平均值多在 11m.e/100克左右，與冲積土略異。

（2）土壤有機質與陽離子交換能量之關係：土壤有機質含量與 C. E. C. 之關係，理論上早有論定，即成正比例之關係 (16) 本研究所採之183個土壤樣本之平均數統計如表五。

表五. 本省水稻田土壤之有機質與陽離子交換能量

Table 5. The Organic Matter and C.E.C. Content of the Soils of Paddy Field in Taiwan (m.e./100g.)

土類 Soil groups	有機質% Organic matter%	層次 Horizons 1 樣本數 Sample number	1 平均 Average	2 樣本數 Sample number	2 平均 Average	3 樣本數 Sample number	3 平均 Avarage	4 樣本數 Sample number	4 平均 Average	5 樣本數 Sample number	5 平均 Average	小計 Total 樣本數 Sample number	小計 Total 平均 Average
冲積土 Alluvial soils	<1	—	—	18	6.7	20	7.0	5	7.5	—	—	43	6.9
	1—3	35	8.5	19	10.3	7	13.0	4	16.2	—	—	65	10.0
	>3	17	16.5	4	16.2	3	19.2	—	—	—	—	24	16.8
紅棕壤 Reddish brown latosls	<1	—	—	—	—	5	11.3	5	11.9	1	10.3	11	11.5
	1—3	6	9.4	6	10.2	1	11.3	1	11.4	—	—	14	10.1
黃棕壤 Yellowish brown laotosools	<1	—	—	3	10.2	6	10.1	6	10.8	2	14.2	17	10.8
	1—3	3	9.2	3	13.2	—	—	—	—	—	—	6	11.2
	>3	3	15.3	—	—	—	—	—	—	—	—	3	15.3

上表顯示冲積土水稻田土壤剖面之各層有機質含量愈高，其 C.E.C. 值愈高，反之則愈低，黃棕壤亦然，惟紅棕壤之平均數值稍有差異，即含有機質1—3%者反較1%以下者爲低，此則有待查考其原因，但相差並不顯著。

（3）土壤之 PH 值與鹽基飽和度之關係

本省稻田土壤之 PH 值與鹽基飽和度之關係，爲易於瞭解，繪成圖1：A 與 B 及 C與D，以便於觀研，圖1：A所稱之冲積土包括粘板岩質與砂頁岩質者外，安山岩質及片岩質者均在其內，其反應與鹽基飽和度（簡稱 B.S.）關係相當廣泛，難以概論，例如 PH 5.2 之三土樣，其 B.S. 幾集中於42%左右，PH 6.6 之八土樣，B.S. 自54—67%，PH 6.1 之 B.S. 自5.1—8.1更爲寬廣。

圖1：B 紅棕壤或黃棕壤均係酸性土壤，PH 自4.5至6.1，多集中於5.5左右，鹽基飽和度偏低，自12%至37%，多集中於20%或30%左右。

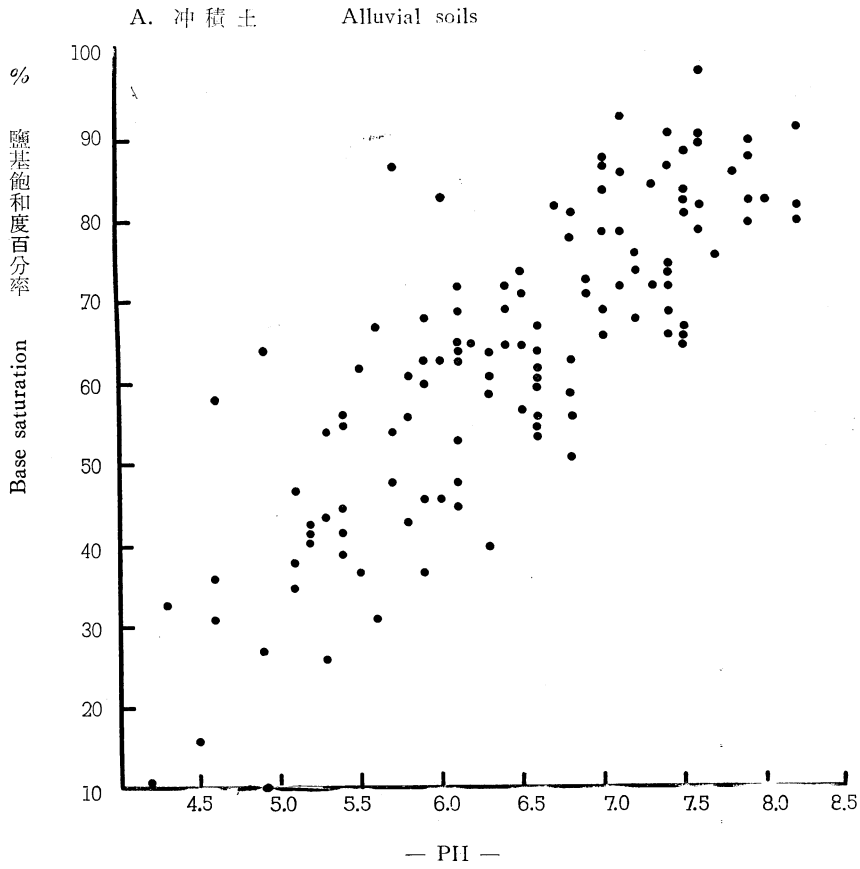
茲更就冲積土不同母質來源之土樣，繪成圖1C 與 D，以顯示其趨向關係。

圖1：C 粘板岩質冲積土之反應，多呈微鹼性，其鹽基飽和度多在 82%；呈酸性者，B.S. 多在65%左右，中性者之 B.S. 範圍較寬，自71%以至93%均有。

圖1：D 砂岩頁岩冲積土之反應，與鹽基飽和度可以用一曲線表示之圖中以 PH 值6.5，B.S. 65%爲中點，分向左右彎曲，接近對稱。前者 PH 降至5.3，B.S. 至54%，後者 PH 高達 7.6 B.S. 至82%；其中亦有例外者，如 PH6.8接近中性之土樣六個，其 B. S. 範圍至寬，自56%至84%不等。

圖1. A與B 不同稻田土壤之反應與鹽基飽和度

Fig. 1. A&B Soil reaction & base saturation of different paddy field soils



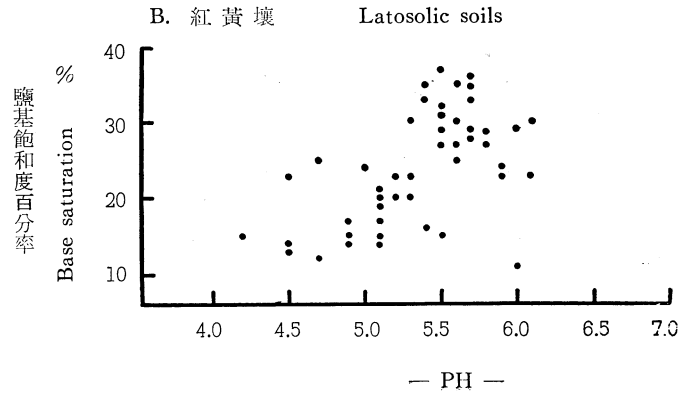
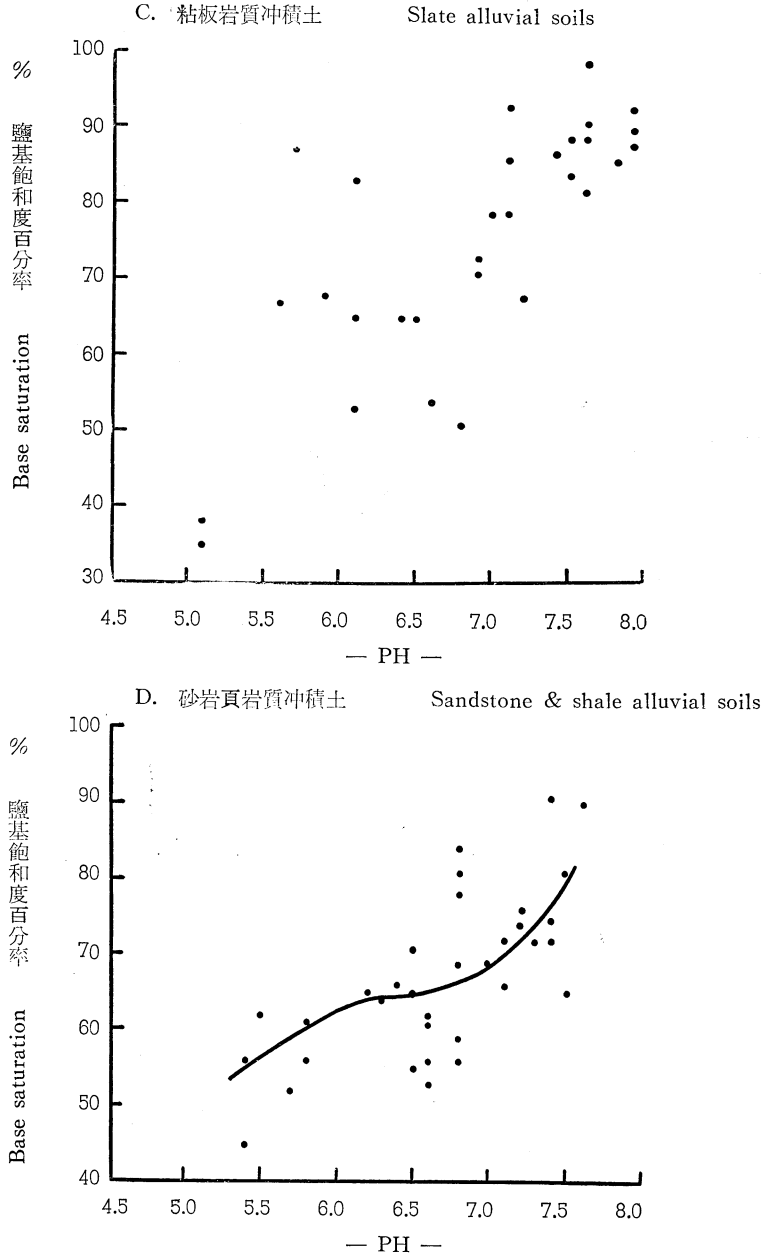


圖1. C 與 D 不同稻田土壤之反應與鹽基飽和度

Fig. 1. C & D Soil reaction & base saturation of different paddy feild soils



（四）本省水稻田土壤之陽離子交換能量（C.E.C.）與第一、第二期作間之關係

本省稻田產量，就每年兩期作而言，第二期作產量每較第一期作爲低（12）。論其原因，有謂因稻作生長期較短而影響第二期作之產量，或由於兩期作之氣候有別。第二期作在生長時間氣溫由高而低，不利於水稻之生殖生長，日照由長而短，使營養生長縮短。亦有謂第一期作後，接着第二期作利用，土壤毫無休閑機會，亦受影響，同時第二期作適逢高溫多雨時期，稻田排水不良，氧氣供應不足，此亦阻礙稻作之生長。本研究從肥力之隱藏觀點統計第一期作後與第二期作後所採土壤樣本陽離子交換能量（C.E.C.）之平均值加以申論。

表六　本省不同採集期之水田土壤之陽離子交換能量

Table 6. The C.E.C. Content of Soils Collected in Different Period (m.e./100g.)

期作別 Period	土類 Soil Groups / 層次 Horizons	冲積土 Alluvial Soils								紅棕壤 Reddish Brown Latosols		黃棕壤 Yellowish Brown Latosols	
		砂岩及頁岩 Sandstone & Shale		粘板岩 Slate		片岩 Schist		安山岩 Andesite					
		樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average
一期作後 After harvest of 1st crop	表土 Surface soils	9	7.4	15	7.9	—	—	1	19.8	3	9.2	3	13.9
	亞表土 Sub-surface soils	7	7.2	12	7.0	—	—	1	20.9	3	10.6	3	13.4
	底土 Sub-soils	5	7.1	6	7.5	—	—	1	19.5	3	11.7	3	10.0
	小計 Total	21	7.3	33	7.6	—	—	3	20.1	9	10.5	9	12.4
二期作後 After harvest of 2nd crop	表土 Surface soile	6	7.9	7	8.3	6	10.2	8	25.4	3	9.6	3	10.5
	亞表土 Sub-surface soils	5	7.1	6	7.0	6	10.2	4	22.1	3	9.9	3	10.1
	底土 Sub-soils	3	8.4	5	5.8	6	7.4	4	19.5	3	10.9	3	10.5
	小計 Total	14	7.7	18	7.2	18	6.5	16	23.1	9	10.1	9	10.4

就上表六自表土言之，除黃棕壤外，其他不同母質之各種冲積土與紅棕壤第一期作後陽離子置換能量（C.E.C.）之平均值均較第二期作後者爲低，即指第二期作後土壤之可交換性陽離子能量較第一期作後者高，因而影響其後作之產量，似有理由。但細察其高出之數值，除安山岩質冲積土較多外，各高出之數值不多，由此以爲減產之影響原因，尚不足爲據。要之，影響一、二期作產量之因子頗多，且各因子之變化亦大，產量乃各因子綜合之結果，C.E.C. 或亦其因子之一。

（五）本省水稻田土壤之陽離子置換能量（C.E.C.）與其產量之關係

本研究於採樣前，即先參考農林廳調查高低產量稻田報告（1），根據其第一、二期作高低產量地區分佈圖，選擇地區前往採樣。茲所謂高低產量稻田，係指第一期作未滿2,500公斤／公頃者爲低產量，超過3,500公斤／公頃者爲高產量；第二期作未滿每公頃2,000公斤者爲低產量，超於3,000公斤者爲高產量，採樣時並查詢當地農民核對，參照分析結果與高低產量之關係統計之如表七。

表七　本省水稻田土壤之 C.E.C. 含量與其產量

Table 7. The C.E.C. Content and Rice Yield of Paddy Soils in Taiwan (m.e./100g.)

層次 Horizons	高產量 High yield		低產量 Low yield	
	樣本數 Sample number	平均 mean	樣本數 Sample number	平均 mean
表土 Surface soils	34	11.9	30	10.2
亞表土 Sub-surface soils	27	9.5	26	10.1
底土 Sub-soils	21	9.9	21	10.6
小計 Total	82	10.4	77	10.3

表內如以表土之 C.E.C. 爲比較高低產量兩種稻田土壤之規範，則兩者平均值，養分隱藏力確有差異，高產量稻田土壤之 C.E.C. 高出低者約 1.7m.e./100 克，但就亞表土或底土或各層之總平均值比較，則並不顯明，然則以表土之含量或可據以解釋其間之關係，其他各層未必盡然。

（六）本省水稻田土壤之陽離子交換能量（C.E.C.）與地區性之關係。

本省水稻田土壤之陽離子交換能量與地區性之關係，前人研究中曾有論及，茲更就本研究所採用之土壤樣本分析結果，分別將各地區之表土統計之見表八。

表八　本省水稻田土壤之陽離子交換能量與其地區性之關係

Table 8. The Relationship between the C.E.C. of the Paddy Soils and Their Locality (m.e./100g.)

土類 Soil groups ＼ 母質 Parent materials ＼ 地區 Locality		北部 Northern part		中部 Central part		南部 Southern part		東部 Eastern part	
		樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average	樣本數 Sample number	平均 Average
冲積土 Alluvial soils	砂岩及頁岩 Sandstone & shale	—	—	3	6.9	12	7.7	—	—
	粘板岩 Slate	10	7.4	5	9.1	7	8.3	—	—
	片岩 Schist	—	—	—	—	—	—	6	10.2
	安山岩 Andesite	9	24.8	—	—	—	—	—	—
	小計 Total	19	15.7	8	8.3	19	7.9	6	10.2
紅壤及黃壤 Latosols	洪積層 Diluvial deposite	12	10.8	—	—	—	—	—	—
	小計 Total	31	13.8	8	8.3	19	7.9	6	10.2

由上表數據以地區言，北部之 C.E.C. 最高，三十一個土壤樣本之平均值爲 13.8m.e./100g，東部次之，六個樣本之平均值爲 10.2m.e./100克，中部再次之，以南部爲最低。各地區高低差異之原因仍以母質之影響爲最大，安山岩質冲積土稻田土壤爲最高，片岩質次之，粘板岩質又次之，砂岩頁岩質爲最低，而與有機物含量多少關係亦切，北部及東部稻田有機物含量較中部及南部者爲多，足以證實之。

（七）有關土壤陽離子交換能量推算之研擬。

（1）本研究對 C.EC. 推算式之推薦

就學理言，C.E.C. 與土壤性質間之關係最密切者爲粘土與有機質含量，前者粘土礦物因其型式之不同，C.E.C. 之差異至大，硅石（Vermiculite）最大，150m.e./100克，其次爲蒙特石（Montmorillonite）100m.e./100克，依來石（Illite）更次之，爲 30m.e./100克，高嶺石（Kaolinite）最低，8m.e./100克，後者腐植質爲 200m.e./100克。土壤學者在不明其型式前，對 C.E.C. 之一般粗略估計，係以1%之粘粒可有 0.5m.e./100克之 C.E.C.，1%之有機質可有 2m.e./100克 C.E.C.（15），係採其平均數而估計其概數，已沿用頗久。土壤粘土礦物之種類與 C.E.C. 之分析，非一般實驗室可輕易舉辦，因而土壤之陽離子交換能量之推算仍爲實用上所需求。本研究分析之土壤樣本，包括全省農田，數目雖然不多，亦不爲少，因擬應用之，以作估計之基礎。試以假定 C.E.C. 與粘粒及有機質含量有正相關之關係，應用統計原理，設下列方程式，x，y 爲測定值，應用最少自乘法，可求出該公式（$Z=ax+by+c$）內之

a, b 及 c 值；換言之，由測定粘粒及有機質含量，可依該公式推算 C.E.C. 含量之梗概。

公式：Z=ax+by+c

Z （C.E.C. 含量）　　X （粘粒含量）

Y （有機質含量）　　C （常數）

應用本研究附錄之分析結果資料，將各種冲積土類之粘粒含量、有機質含量及 C.E.C. 含量代入上式，經統計計算而求出 a, b 及 c 值等如表九。

表九　應用本研究資料計算 C.E.C. 公式之 a.b.c. 值

Table 9. Calculated value conduced by the recommendation formular

土類 Soil groups	a	b	c	r	F*	F 5% 1%	s**	S.N.***
粘板岩質冲積土 Slate alluvial soils	0.114	0.970	2.33	0.72	26.40	3.19 5.08	2.13	52
砂岩頁岩質冲積土 Sandstone & shale alluvial soils	0.123	−0.079	3.75	0.61	9.98	3.28 5.29	1.64	37
片岩質冲積土 Schist alluvial soils	0.058	0.054	7.46	0.19	N.S.	3.59 6.11	3.05	20
安山岩質冲積土 Andesite alluvial soils	0.014	0.018	22.13	0.13	N.S.	3.55 6.01	71.08	21
紅黃壤 Latosols	0.044	0.835	6.52	0.22	N.S.	3.19 5.08	2.42	51

F*: Coefficience of correlation. 相關係數

s**: Standard error. 標準誤差

S.N.***: Samples number. 樣本數

照公式算出上表，砂頁岩質冲積土中之有機質結果爲負數，似顯示該類土壤之有機質對 C.E.C. 無影響；常數高除顯示有機質及粒粘外，尚有其他因子所影響。在相關係數中，除粘板岩質及砂頁岩質冲積土外，其他冲積土及紅黃壤無顯著相關，尚有其他不明原因，有待進一步之研究，故推薦式僅適用於粘板岩及砂頁岩兩種冲積土。照上表將粘板岩質冲積土及砂頁岩質冲積土之實際演算，推薦估計公式如下：

（A）粘板岩質冲積土

C.E.C.=0.114×粘粒含量%+0.97×有機質含量%+2.33

（B）砂岩頁岩質冲積土

C.E.C.=0.123×粘粒含量%+（−0.079）×有機質含量%+3.75

（2）推薦式與通用式之比較

應用粘粒含量及有機質含量之百分數以估計 C.E.C. 之結果，茲述既有通用之估計法與本研究之伸算法茲就附錄分析結果中，隨意抽樣 20個，分別以兩種方式計算，比較實際分析之 C.E.C. 值，如表十。

表十　推薦式與通用式比較實例

Table 10. Some examples of C.E.C. conducted from the formular by recommendation or by current method.

土樣號碼 Sample number	土類 Sub-groups	土質 Soil Texture	粘土 % Clay %	有機質 % Organic matter %	陽離子交換能量 C.E.C. m.e./100g. A*	B**	A—B	C***	C—B
1	砂岩頁岩質冲積土 Sand-stone & shale alluvial soils	C.L.	34.74	2.32	8.84	5.70	+ 3.24	22.01	+16.31
5		L.	25.70	0.61	6.86	6.90	− 0.04	14.07	+ 7.17
23		C.	45.04	3.07	9.09	9.90	− 0.81	28.84	+18.94
26		S.L.	19.70	1.31	6.07	4.90	+ 1.17	12.47	+ 7.57
30		S.L.	11.64	0.81	5.12	4.00	+ 1.12	7.44	+ 3.44
47		C.L.	33.04	1.68	7.68	7.67	+ 0.01	19.88	+12.21
50		C.L.	35.04	1.33	7.75	5.90	+ 1.85	20.18	+14.28
52		L.	19.04	1.06	6.00	5.63	+ 0.64	11.64	+ 6.28
53		L.	23.04	0.77	6.52	5.14	+ 1.38	13.06	+ 7.92
59		C.L.	32.64	2.38	7.75	7.64	+ 0.11	21.08	+13.44
10	粘板岩質冲積土 Slate alluvial soils	C.L.	30.74	2.38	8.24	10.09	− 1.85	20.13	+10.04
35		L.	19.82	1.60	6.14	4.20	+ 1.94	13.11	+ 8.91
40		Si. C.	42.82	2.08	9.34	9.00	+ 0.34	25.57	+16.57
42		S.C.L.	37.82	1.73	8.32	6.18	+ 2.14	22.37	+16.19
63		C.L.	39.40	1.81	8.58	9.16	− 0.58	22.32	+13.16
66		C.L.	32.70	1.94	7.94	8.36	− 0.42	20.23	+11.87
90		C.L.	33.40	2.74	8.79	6.30	+ 2.49	22.18	+15.88
96		Si.C.	41.40	2.69	9.66	9.02	+ 0.62	25.08	+16.06
102		Si.C.L.	38.40	1.70	8.36	7.90	+ 0.46	22.60	+14.70
105		Si.C.	40.40	1.93	8.97	4.69	+ 4.28	24.06	+19.37

* A:由推算公式所計算之結果 (results from calculating by recommendation formula)

** B:原分析結果 (result from chemical analysis)

*** C:通用估計法計算結果 (result from calculating by current estimated methods)

表十中抽樣共20個，包括砂岩頁岩質冲積土及粘板岩冲積土各10個樣本，以原分析結果 C.E.C. 值與推薦式計算法及通用估計法之比較結果，說明如下：

（1）一般言之，應用推薦式伸算之結果與原分析之結果相差不多，二十個土壤中有十六個土壤樣本差異均少，均在 ±2m.e. 以下。

（2）應用通用式推算結果，與原分析結果相差頗大，在 10m.e. 以上者佔四分之三土壤樣本。

換言之，由推薦式計算之 C.E.C. 結果數值較小，與化學分析之結果較爲接近；由通用法推算結果之數值較大，與化學分析之結果較爲遠離。

本省稻田土壤之有機質含量多偏低，而粘土礦物中以依來石 (Illite) 及高嶺石 (Kaolinite) 較多（9），因而 C.E.C. 分析結果多偏低，與本研究之推算結果，較爲接近。

茲爲確認該推薦式之能否實用，試就省農業試驗所各土壤調查報告中，隨意選出粘板岩質冲積

土之土壤樣本四個，砂岩頁岩質冲積土之土壤樣本十二個，該項樣本有分析記錄及土型之記載，將其代入上列之公式（A）及（B）計算其結果，而與原分析結果，及計算通用式之結果比較之，如表十一

表十一　推薦式與通用式計算與其他分析結果之比較

Table 11. Other analysis example of C.E.C. conducted from the formular by recommendation or by current method

土樣號 Sample number	亞土類 Sub-groups	土型 Soil types	粘粒% Clay %	有機質% Organic matter %	陽離子交換能量 C.E.C. m.e./100g A*	B**	A—B	C***	C—B	資料來源 Data based on
A 1—006—1	粘板岩質冲積土 Slate alluvial soils	S. L.	5.74	1.15	4.10	3.94	+0.16	5.17	+ 1.23	(3)
A13—004—1		S. L.	8.60	2.18	4.46	9.80	−5.34	8.68	− 1.12	(5)
A13—006—1		C. L.	17.00	1.31	5.54	5.40	+0.14	11.20	+ 5.80	(5)
A13—012—1		C. L.	20.90	1.19	5.90	6.50	−0.60	12.83	+ 6.33	(4)
A 5—006—1	砂岩頁岩質冲積土 Sandstone & shale alluvial soils	S.C.L.	15.55	1.57	5.54	5.06	+0.48	10.92	+ 5.88	(3)
A 5—005—1		S. L.	5.97	1.73	4.35	8.10	−3.75	6.65	− 1.85	(3)
A 5—010—1		C. L.	15.31	1.67	5.50	5.57	−0.07	11.00	+ 5.43	(3)
A 5—011—1		C. L.	32.52	1.39	7.64	2.51	+5.13	15.04	+12.53	(3)
A10—006—1		C. L.	17.10	1.41	5.74	6.00	−0.26	11.37	+ 5.37	(5)
A28—011—1		S. L.	14.60	1.83	4.10	5.00	+0.90	10.96	+ 5.96	(8)
A33—001—1		S. L.	14.00	0.93	4.74	8.90	−4.16	8.89	− 0.01	(7)
A33—001—2		S. L.	21.70	0.63	5.92	7.80	+1.88	12.11	+ 4.31	(7)
A33—001—3		S. L.	22.40	0.56	8.30	6.90	+1.40	12.32	+ 5.42	(7)
A35—001—3		S. L.	11.70	0.23	5.00	5.60	−0.60	6.11	+ 0.51	(7)
A35—002—1		S. L.	5.00	0.52	3.95	7.70	−3.75	2.76	− 4.94	(7)
A36—002—3		C. L.	20.10	0.27	6.01	5.50	+0.51	10.59	+ 5.09	(7)

*,**,***, 與表十同

上表係在農試所之土壤調查報告中所抽出樣本16個，其原分析結果與推薦式計算比較，C.E.C. 值相差 ±1m.e./100 克以下者佔九個，與通用式比較在 ±1m.e./100 克以下只兩個 5m.e./100 克以上者九個樣本，亦即推薦式較通用式之推算爲接近實際。

六、結　論

本省稻田土壤之 C.E.C. 含量均不高，都在 25m.e./100克 以下，總平均值約爲 10m.e./100克左右，最低者爲 1.47m.e./100克，高低間差異以冲積土爲顯著，隨母質之不同而顯有區別，母質屬安山岩質者較高，片岩質次之，粘板岩質又次之，砂岩頁岩質最低，紅棕壤或黃棕壤水稻田，質地多屬粘重，影響不大。有機質之影響亦以冲積土隨其含量有正相關之關係，紅棕壤或黃棕壤稻田則影響不大。本研究從分析各土樣之粘土與有機質含量演繹爲二簡單方程式：

（A）C.E.C.=0.114×粘土含量%.97×有機質含量%+2.33（粘板岩質冲積土）

（B）C.E.C.=0.123×粘土含量%+（−0.079）×有機質含量%+3.75（砂岩頁岩質冲積土）

自上兩式推算 C.E.C. 之含量，以簡化對水稻田土壤 C.E.C. 之估計，尚適合於實際應用。

七、摘　要

本研究先整理過去本省土壤調查有關稻田土壤陽離子交換能量資料統計於表一，續就本省稻田根據其土類，亞類分別期作後，採集土壤樣本，進行其陽離子交換性質之分析，包括之項目計有C.E.C.置換性鉀、鈉、鈣、鎂及氫，與數項主要理化性質分析，如 PH 有機質及全氮量等，分析之樣本共183 個，包括64個土壤剖面。研究之目的有二：

（一）討論本省稻田土壤之 C.E.C. 與其產量之關係。

（二）申述 C.E.C. 與稻田土壤暨其他主要理化性之關係，進而推論本省稻田土壤肥力隱藏之梗概。

試驗結果詳見附錄之各項分析實績，摘錄如下：

1.本省稻田土壤，大部屬冲積土類，小部份屬紅棕壤或黃棕壤。各類土壤之陽離子交換能量（C.E.C.）見表二。以安山岩質冲積土之 C.E.C. 最高，黃棕壤次之，紅棕壤又次之，片岩質冲積土再次之，粘板岩質冲積土及砂岩頁岩質冲積土均較低。

2.稻田土壤剖面各層之 C.E.C. 含量見表三。一般言之，冲積土以表土偏高，亞表土次之，底土較低；至紅棕壤或黃棕壤則適相反。

3.稻田土壤之質地與 C.E.C. 含量見表四。各平均值之趨勢，以質地愈粘重者 C.E.C. 含量愈高，反之則愈低。

4.稻田土壤有機質與C.E.C.含量見表五。其間之關係冲積土係爲正相關，即有機質愈高C.E.C.含量亦高，反之則愈低。

5.稻田土壤 PH 值與鹽基飽和度，見圖1：A 與 B，C 與 D，因土類不同，PH 值與鹽基飽和度之相關趨勢略異，紅棕壤或黃棕壤稻田土壤屬强酸性，其鹽基飽和度較低，PH 與飽和度之升降均較窄；冲積土稻田土壤 PH 與飽和度之升降則較寬。

6.稻田土壤因採集期不同，C.E.C. 含量見表六。一般言之，一期作後之土壤 C.E.C. 較二期作後者爲低，惟高出之平均值則有限。

7.稻田土壤 C.E.C. 與產量之統計如表七。就表中之表土平均值言，高產量稻田之 C.E.C. 含量較高，反之低產量者較低，惟其相差數值不大，尚難據以作爲闡釋產量之關係。

8.本省稻田土壤 C.E.C. 含量與地區性之關係，見表八。一般言之，北部稻田土壤 C.E.C. 含量最高，東部次之，中部再次之，以南部爲最低。

9.根據本研究全省稻田土壤之分析結果，由其粘粒與有機質含量與 C.E.C. 之關係，應用統計原理之最少自乘法，推薦 C.E.C. 之粗略推算公式，計算結果見表九。可採用者有二：

A. C.E.C.=0.114×粘土含量%+0.97×有機質含量%+2.33（粘板岩質冲積土）

B. C.E.C.=0.123×粘土含量%+（−0.079）×有機質含量%+3.75(砂岩頁岩質冲積土)

10.比較本研究之推薦式與通用之統計方式，無論應用本研究之 C.E.C. 分析結果或過去之分析結果，均係推薦法較通用法爲優，見表十與表十一。

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STUDY ON THE CATION EXCHANGE PROPERTIES OF THE PADDY SOILS IN TAIWAN

Ching-yuan Lai

SUMMARY

This study starts with the general review on some evidences being found from the soil survey data and recent studies on cation exchange capacity of the paddy soils in Taiwan. The data in table 1. is based on the study on 64 of soil profiles and 183 of soil samples which were classified according to great soil groups, sub-groups and time of sampling. The properties of cation exchange include C.E.C., exchange K, Na, Ca, Mg and H, other physico-chemical properties such as mechanical analysis, PH value, organic matter and total nitrogen are also taken into consideration. There are two main purposes of this study : 1. To discuss the relationship between C.E.C. of the paddy soils of Taiwan and the yield of rice. 2. To explain the C.E.C. in relation with other properties of the paddy soils and to understand its fertility status. The results are shown on the tables in the appendixes. They may be summarized as follows :

1. The paddy field of Taiwan is largely belonging to alluvial soils and a small part is belonging to reddish brown latosols or yellowish brown latosols. The C.E.C. of those soils are shown on table 2. The C.E.C. 's of different soils come in descending order as following : andesite alluvial soils, yellowish brown latosols, reddish brown latosols, schist alluvial soils, slate alluvial soils and the sandstone and shale alluvial soils.

2. The C.E.C. of the separate layers of the soil profile of the paddy field is shown on the table 3. In general, the surface soils of the alluvial soils have higher C. E. C. However this is not true for the reddish brown latosols and yellowish brown latosols.

3. The relation of C.E.C. to the texture of the paddy soils is shown on table 4. It reveals a rough relation between the texture and the C.E.C., i.e. higher C.E.C. is related ot

fine texture.

4. The C.E.C. and organic matter content of the paddy soils is shown on table 5. There is a proportional relationship between them. In other word, the C.E.C. increases with organic matter content.

5. The correlation between the percentage base saturation of the paddy soils and their pH is shown on Figure 1 : A& B, C & D. It shows different trends as in different soil groups, the percentage base saturation of the reddish brown latosols and the yellowish brown latosols have smaller variation, in the alluvial soils the variation is usually greater.

6. The C.E.C. 's for the different times of sampling are shown on table 6. Generally speaking, the C.E.C. measured after the first corp is lower than after the 2nd crop, but the difference is very limit.

7. The C.E.C. with the yeild of rice is statistically analyzed as table 7. It reveals that C.E.C. tends to increase yeild of paddy soils but the difference is not apparent, so it hardly explains their correlation between them.

8. The C.E.C. 's for the different localities are shown on table 8. In general,it shows that the soils of the northern part have high content of C.E.C. the eastern part the second, the central part the third, and the southern part the lowest one.

9. Two experimental formulars are recommended based on the analysis results of this study they are :

(A) C.E.C.=0.114×Clay% +0.97×organic matter%+2.33 (for slate alluvial soils)

(B) C.E.C.=0.123×Clay%+ (−0.079) ×organic matter%+3.75
(for sandstone and shale alluvial soils)

10. The recommendation method is better than the current method by comparison of the two system whatever use of the results of this study or the published data. The result is shown on table 10 and 11.

THE EFFECT OF WEEDS ON RICE IN PADDY FIELD

III. TIME OF WEED ERADICATION[1]

W. L. Chang and C. P. Mao[2]

INTRODUCTION

In the previous experiments, the effects of weed species and population density (Chang, 1970a) and stage of weed emergence (Chang, 1970b) have been investigated. Recently, the shortage of farm labors in Taiwan has made hand weeding in paddy field increasingly difficult to proceed on schedule which may substantially affect the growth of rice plant. However, the degree of damage from this prolonged competition of weeds with rice in paddy field is not presently clear. The answer to this problem may provide useful information for the planning of an effective and economical weed control program. This paper reports the results of the third experiment undertaken to evaluate the effect of time of weed eradication on rice in paddy field.

MATERIALS AND METHODS

The experiment was conducted on the clay pots in the screen house of the Chiayi Agricultural Experiment Station in the first and second crops of 1970. Two levels of fertility, three weed species, and five different times of weed eradication were arranged in a randomized complete block design experiment with three replications. The plots were represented by individual clay pots with surface area of 314 cm^2. Low and high levels of fertility were represented by the application of 80, 40, 40 and 160, 80, 80 kg per ha of N, P_2O_5 and K_2O, respectively. Three weed species, *Echinochloa crusgalli*, *Monochoria vaginalis*, and *Cyperus difformis*, were employed to represent grassy, broadleaf, and sedge weeds, respectively. Weeds were eradicated at 15, 30, 45, and 60 days after the transplanting of rice in the first crop and at 10, 20, 30 and 40 days after transplanting of rice in the second crop respectively. A standard weed free treatment was also included for comparison.

One seedling of the rice variety, Chianung 242 was transplanted in each clay pot. Weeds were planted around rice seedling right after transplanting at the rate of three weeds per pot or about 100 weeds per m^2. The first crop was transplanted on February 25, 1970 and harvested on July 5, 1970. The second crop was transplanted on July 28, 1970 and harvested November 11, 1970. Data for grain yield and components of yield were recorded for the evaluation of weed damage to rice which was expressed in the percentage of weed-free check treatment.

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RESULTS AND DISCUSSION

The Effect of Time of Weed Eradication on Grain Yield of Rice

The grain yield of rice as affected by the time of weed eradication is given in Table 1. The average yield reduction of rice recorded for the first, second, third, and fourth eradications of weeds was 0, 16.7, 29.4, and 51.6%, respectively, showing that the degree of weed damage increased with the delay in the time of weed eradication. Difference in rice yield among times of weed eradication was significant at 1% level (Table 2) . The average percentages of yield reduction for the first, second, and third eradications were greater in high rate of fertilization treatment while that for the fourth eradication appeared slightly larger in low rate fertilization indicating that heavy fertilization favors weeds in their competition with rice during the early growing stage of rice. Thus, early weeding appears more important in paddy field with high rate of fertilization.

Table 1. Yield performance of rice in percent of weed-free treatment, 1970.

Crop Season	Time of weed eradication (DAT)*	*Echinochloa crusgalli*			*Monochoria vaginalis*			*Cyperus difformis*			Average		
		HF* (%)	LF* (%)	Mean (%)	HF (%)	LF* (%)	Mean (%)	HF (%)	LF (%)	Mean (%)	HF (%)	LF (%)	Mean (%)
First	15	109.9	115.4	112.7	96.4	110.3	103.4	112.1	108.8	110.5	106.2	111.5	108.9
	30	103.2	83.1	93.2	89.6	97.1	93.4	109.5	110.3	109.9	100.8	96.8	98.8
	45	84.2	69.9	77.1	85.1	92.7	88.9	102.3	92.7	97.5	90.5	85.1	87.8
	60	50.0	41.9	46.0	75.2	76.5	75.9	63.5	59.6	61.6	62.9	59.3	61.1
Second	10	87.9	90.4	89.2	91.2	92.7	92.0	89.3	99.3	94.3	89.5	94.1	91.8
	20	57.2	62.5	59.9	62.8	69.9	66.4	74.4	79.4	76.9	64.8	70.6	67.7
	30	45.6	52.2	48.9	39.5	58.8	49.2	64.7	58.8	61.8	49.9	56.6	53.3
	40	29.3	28.7	29.0	38.1	39.7	38.9	38.6	39.7	39.2	35.3	36.0	35.7
Average	15(10)	98.9	102.9	100.9	93.3	101.5	97.7	100.8	104.1	102.5	97.9	102.8	100.4
	30(20)	80.2	72.8	76.5	76.2	83.5	79.9	92.0	94.9	93.5	82.3	83.7	83.3
	45(30)	64.9	61.1	63.0	62.3	75.8	69.1	83.5	75.8	79.7	70.2	70.9	70.6
	60(40)	39.7	35.3	37.5	56.7	58.1	57.4	51.1	49.7	50.4	49.1	47.7	48.4

*DAT=Days after transplanting. HF=High rate of fertilization, LF=Low rate of fertilization.

Table 1 also shows that weeds eradicated at 15 days after transplanting did not cause any damage to rice but those removed at 30, 45 and 60 days after transplanting resulted in the reduction of yield by 1.2, 12.2, and 38.9%, respectively in the first crop. However, weeds eradicated at 10, 20, 30, and 40 days after transplanting in the second crop reduced

grain yield of rice by 8.2, 32.3, 46.7, and 64.3%, respectively. The crop season×time of weeds eradication was highly significant (Table 2) , indicating that damage of weeds eradicated at different stages of rice growth varied with crop seasons. In the first crop, weed growth was generally slow during the early growing stage of rice because of low temperature and competition of weeds rice is usually less severe. As a result, grain yield of rice was barely affected even though weeds were eradicated as late as 30 days after transplanting. In the second crop, however, weeds are likely to compete more effectively with rice during the early growing stage of rice since high temperature is available for the rapid growth of weeds. Consequently, weed damage became evident when eradication was made as early as 10 days after transplanting.

Table 2. Combined analysis of variance for grain yield of the first and second rice crops in 1970.

Source of variation	D.F.	S.S.	M.S.	F.	L.S.D.	
					5 %	1 %
Treatment	59	5,632.81	95.47	19.09**	1.21	1.32
Crop seasons (CS)	(1)	803.49	803.49	160.70**	3.92	6.84
Fertility levels (FL)	(1)	1,907.11	1,907.11	381.42**	3.92	6.84
Weed species (WS)	(2)	105.77	52.89	10.58**	3.07	4.78
Time of weed eradication (TWE)	(4)	2,112.97	528.24	105.65**	2.44	3.47
CS×FL	(1)	121.52	121.52	24.30**	3.92	6.84
CS×WS	(2)	0.03	0.02	0	3.07	4.78
CS×TWE	(4)	223.10	55.78	11.16**	2.24	3.47
FL×WS	(2)	32.84	16.42	3.28*	3.07	4.78
FL×TWE	(4)	84.93	21.23	4.25**	2.24	2.47
WS×TWE	(8)	112.80	14.10	2.82**	2.01	2.66
CS×FL×WS	(2)	11.16	5.58	1.12	3.07	4.78
CS×FL×TWE	(4)	34.93	8.73	1.75	2.24	3.47
CS×WS×TWE	(8)	40.47	5.06	1.01	2.01	2.66
FL×WS×TWE	(8)	23.27	2.91	0.58	2.01	2.66
CS×FL×WS×TWE	(8)	18.42	2.30	0.46	2.01	2.66
Error	116	579.76	5.00			

* Significant at 5% level. ** Significant at 1% level.

In Taiwan, farmers usually practice hand weeding 3 to 4 times in the first crop and 2 to 3 times in the second one during the whole growing period of rice. The first weeding usually begins at about 15 days after transplanting in the first crop and 10 days in the second one, then it is carried out once in every 10 and 7 days in the first and second

crops of rice, respectively. It was observed in this experiment that weeds eradicated before 30 days after transplanting affected rice yield very slightly in the first crop where as eradication made at 10 days after transplanting in the second crop resulted in a substantial reduction of rice yield. It was also indicated in the previous experiment that weeds emerged at 60 days after transplanting was still harmful to rice in the first crop, but rice yield was not affected by weeds emerged at 30 days after transplanting in the second crop (Chang, 1970b) . It appears that more effective control of weeds may be obtained for transplanted rice in Taiwan if the first hand weeding is delayed about 10 days in the first crop and advanced about 3 days in the second crop.

The damage of weeds eradicated at different times varied with weed species as reflected by a highly significant weed species× time of weed eradication interaction (Table 2) . *Echinochloa crusgalli* is an "efficient plant" (Black *et al.*,1969) which competes effectively with rice throughout the whole growing period. Thus, it is not surprising that rice suffered the heaviest damage from this weed no matter when eradication was made. Fortunately, the infestation of barnyard grass in most paddy fields of Taiwan is generally not severe (Chang, 1971) . *Monochoria vaginalis* caused more reduction of yield during the early growing stage of rice simply because this weed never grows tall and competes highly with rice only when rice plant is still small. *Cyperus difformis*, a sedge weed capable of growing as tall as rice plants, affected rice lightly when early eradications were made but heavily affected rice if eradications were delayed. The results clearly indicate that early eradication of *Monochoria vaginalis* and late weeding of *Cyperus difformis* are equally important for transplanted rice.

The Effect of Time of Weed Eradication on the Components of Yield

The average performance of yield components of rice expressed in percent of weed-free treatment is presented in Table 3. It was observed that the number of panicles per plant was more severely affected by the time of eradication in the second crop. The damage recorded for *Monochoria vaginalis* was greater in early growing stage of rice while heavier damages were recorded for late eradication *Echinochloa crusgalli* and *Cyperus difformis* in the first crop. In the second crop, however, three weeds differed slightly in their effects on the number of panicles per plant. In general, weed damage increased with the time of weed eradication.

Table 3. Average performance of yield components in percent of weed-free treatment, 1970.

Yield Component	Weed species	Fertility level*	Time of weed eradication first crop				Time of weed eradication second crop			
			15 DAT*	30 DAT	45 DAT	60 DAT	10 DAT	20 DAT	30 DAT	40 DAT
Number of panicles per plant	*Echinochloa crusgalli*	HF	110.8	78. 5	61.3	39.8	91.7	43.7	48.0	43.7
		LF	105.6	87.0	74.1	50.0	90.2	56.1	65.9	56.1

	Monochoria	HF	89.3	96.8	72.0	64.5	91.7	58.2	33.5	39.3
	vaginalis	LF	98.2	87.0	92.6	74.1	90.2	80.5	56.1	56.1
	Cyperus	HF	110.8	110.8	89.3	67.7	77.2	62.6	58.2	43.7
	difformis	LF	105.6	111.1	87.0	61.1	90.2	73.2	56.1	56.1
Number of grains per panicle	*Echinochloa*	HF	94.6	98.3	95.0	68.9	102.5	114.6	85.1	65.8
	crusgalli	LF	105.4	90.8	100.3	90.5	96.4	92.4	82.8	56.4
	Monochoria	HF	97.1	94.8	98.2	94.8	108.7	102.6	86.8	91.9
	vaginalis	LF	115.1	112.3	98.7	103.0	101.4	85.0	72.5	77.5
	Cyperus	HF	96.0	100.6	99.8	81.5	111.7	101.5	106.6	81.7
	difformis	LF	106.4	103.0	104.0	100.3	111.1	107.9	115.1	68.9
Weight of 100-grain	*Echinochloa*	HF	104.5	99.6	101.9	93.3	100.0	103.9	103.9	100.0
	crusgalli	LF	98.5	103.3	87.1	84.9	105.1	109.0	105.1	105.1
	Monochoria	HF	100.8	98.1	99.6	98.1	100.0	103.9	103.9	107.7
	vaginalis	LF	101.9	98.5	88.6	103.3	101.1	109.0	105.1	101.2
	Cyprus	HF	99.6	95.9	100.8	104.6	103.9	100.0	100.0	100.0
	difformis	LF	100.7	99.6	97.1	97.1	101.2	101.2	101.2	109.0
Percentage of fertility	*Echinochloa*	HF	100.1	99.6	99.3	95.2	100.3	102.6	101.2	99.0
	crusgalli	LF	99.7	99.6	98.7	95.9	100.0	100.6	98.3	94.1
	Monochoria	HF	99.4	97.2	100.9	100.7	101.1	99.6	102.6	101.5
	vaginalis	LF	100.2	98.8	100.7	100.5	99.5	102.4	98.2	97.4
	Cyperus	HF	100.8	103.2	99.4	100.6	101.4	101.6	99.5	99.5
	difformis	LF	100.2	100.2	100.1	100.2	100.6	99.4	99.6	98.9

*HF High rate of fertilization. LF=Low rate of fertilization. DAT=Days after transplanting.

The number of grains per panicle was affected mostly by late eradication of weeds. Weed damage was more pronounced in low rate of fertilization in the second crop. The effect of *Monochoria vaginalis* appeared less significant than those of *Echinochloa crusgalli* and *Cyperus difformis*. The weight of 100-grain and the percentage of fertility were not affected by the time of weed eradication, indicating that the reduction of grain yield of rice may be largely attributable to the decrease in the number of panicles per plant and the number of grains per panicle.

SUMMARY

The effect of time of weed eradication on rice was evaluated in both crops in 1970. Average percentages of yield reduction recorded for the first, second, third, and fourth eradications of weeds were 0, 16.7, 29.4, and 51.6%, respectively. Weeds eradicated at 15, 30, 45, 60, and 10. 20, 30, 40 days after transplanting in the first and second crops reduced yield by 0%, 1.2%, 12.2%, 38.9%, and 8.2%, 32.3%, 46.7 %, 64.3%, respectively. *Monochoria vaginalis* caused more damage to rice if early eradication was not made while *Echinochloa crusgalli* and *Cyperus difformis* reduced rice yield more severely when they were eradicated until late growing stage of rice. The damage of weeds eradicated at early growing stage of rice appeared heavier in high fertilizer treatment. The time of weed eradication affected the number of panicles per plant and the number of grains per panicle but not the weight of 100-grain and the percentage of fertility.

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水田雜草對水稻之影響

Ⅲ 雜草之拔除時期

張 萬 來、毛 振 鵬

摘 要

嘉義農業試驗分所繼續於民國59年第１、２期作在網室內調查三種之主要水田雜草不同拔除時期對水稻爲害之情形。初步結果顯示，第１、２、３與４四種不同處理之雜草拔除時期分別減產稻谷、0、16.7、29.4與51.6%。第１期作在插秧後15、30、45與60日拔草，而第２期作則在插秧後10、20、30與40日拔草時，分別減產0、1.2、12.2與38.9及8.2、32.3、46.7與64.3%。鴨舌草若不在早期拔除時爲害較大，而稗草與三角草則延至後期拔除時較易造成嚴重爲害。一般言之，雜草之爲害以重肥區較爲嚴重。雜草拔除時期之早晚只爲害每株穗數與每穗粒數，而百粒重與稔實率則不受影響。

利用γ線誘導染色體轉座減少西瓜種子數之研究

I 小鳳西瓜二對染色體轉座同型結合系統之育成

邱阿昌[2] 陳文郁[3]

一、緒 言

三倍體無子西瓜由 Kihara 等[6]首先研究成功後，現已成爲商品。在臺灣大型三倍體西瓜經郁宗雄等[9,15,16]之研究改進，現已普遍生產，並大量外銷，近年來小型西瓜風行一時，深受生產者及消費者所歡迎，但嫌種子太多，鳳山熱帶園藝試驗分所有鑑於斯，乃一方面從事三倍體小型無子西瓜之育種，一方面從事以染色體轉座方法育成少種子（Semi—seedless）之小型西瓜。

利用人工方法誘導染色體轉座（Interchange or Translocation）而能降低配偶子稔性及減少種子數之報告甚多，Stadler[13]及 Anderson[1]在玉米，Burnham 及 Cartledge[4]，Sisodia 及 Shebeski[12]在大麥，Evans[5]在蠶豆，以及另外幾種植物均曾以放射線處理花粉或種子而誘導染色體轉座。Burnham (1956, 1962)[2][3]曾論及轉座引起之半稔性之利用價值，利用染色體轉座而減少西瓜種子數，曾由 Oka 等[8]以及 Simotsuma[10][11]等先後試驗及討論，雖未育成商業用之西瓜品種，但其誘導轉座而能減少種子數已得到證實。

二、材料及方法

以固定之小鳳西瓜乾燥種子，用γ線處理，其照射量如表1。

表1 西瓜種子 γ 線照射量

Table 1. The dosage of γ—ray irradiation on watermelon seeds

處理編號 Treatment No.	全劑量 Total dose	線量率 Intensity	照射時間 Radiation time	照射種子量 Amount of seeds
	kr	r/min.		g
R—5	5	520	9′37″	10
R—10	10	520	19′14″	10
R—15	15	520	28′51″	10
R—20	20	520	38′28″	10
R—30	30	520	60′12″	10

處理後之種子於1968年春季播種於室外，開花時檢查其花粉之稔性，選出半稔性株行自交採種，採得之種子於同年秋再行播種，檢查花粉稔性，並選出高稔性株同時進行自交及與未處理之正常小鳳行雜交，1969年春季，將雜交種子播種，調查其花粉稔性，同時部份植株進行株間什交。其後因第一作者赴美進修，暫停試驗兩年，至1971年秋，再將1968年秋季收穫之種子及1969年春季採收之雜交種子再行播種，調查其花粉稔性、種子數及染色體配對情形，其育種步驟如下：

γ 線處理種子→選擇半稔性株（假設爲二對染色體相互轉座異型結合體者）行自交→分離出高稔

本試驗承中國農村復興聯合委員會及臺灣農業研究中心補助經費
1 試驗報告農試字第五五六號
2 臺灣省農業試驗所鳳山熱帶園藝試驗分所技士
3 前臺灣省農業試驗所鳳山熱帶園藝試驗分所技佐，現任農友種苗公司董事長

性株，並進行自交及與未經放射線照射者雜交→調查雜交 F_1 個體之稔性及染色體行爲，以判定其親本是否爲轉座同型結合體→轉座同型結合系統之育成。

花粉稔性調查以 Aceto Carmine 染色鏡檢，染色體檢查以 Farmer's 液固定花粉母細胞，用 Aceto Carmine 染色，以壓擠法 (Smear method) 鏡檢。

三、結果及討論

(一) 種子照射處理後當代之表現：

西瓜種子，無論乾燥或濕潤情形下，經過放射線處理後，發芽率降低，放射線照射量愈增加，發芽率愈降低，同時發芽後外觀正常幼苗數及成活數亦依照射量之增加而減低。在成活之植株中，其花粉稔性發生變化，未經放射線處理者 (CK)，其花粉之稔性甚高，而且植株間之差異甚少，經檢查47株中，花粉稔性均達90%以上；經放射線處理者，花粉稔性在植株間呈現不同程度之變化，有些植株有90%以上之稔性，有些植株則降至10%以下之稔性（表2及圖2，3，4），同時，在同一植株中亦發現有不同程度之稔性，西瓜主蔓及側蔓之花粉稔性亦有不同，此可能由放射線造成嵌合體 (Radiation chimera) 所致。

表2 照射後種子發芽率及其花粉稔性

Table 2. Seed germination and pollen fertility after irradiation

處理編號 Treatment No.	照射量 Dose kr	播種粒數 No. of seeds sown	發芽 Germinated		成活株數 No. of plants survived	株數 (No. of plant)		
			粒數 No.	%		花粉稔性低 Low ferility 0—30%	花粉半稔性 Semi sterility 31—70 %	花粉稔性高 High ferility 71—100%
R—5	5	200	116	58	101	2	4	95
R—10	10	200	87	44	76	5	7	64
R—15	15	200	65	33	52	15	12	25
R—20	20	200	73	37	48	8	6	34
R—30	30	200	52	26	46	14	9	23
CK	—	50	48	96	47	0	0	47

(二) 半稔性株自交後代之表現：

由表2所示，放射線處理後花粉稔性之高低相差甚大，放射線造成花粉不稔之原因甚多，如染色體構造上發生變化時，諸如缺失 (Deficiencies)、倒置 (Inversions)、轉座 (Translocations) 等均可使花粉稔性降低[14]。本試驗之目的爲利用染色體轉座減少西瓜種子數，故其他造成花粉不稔之原因，姑置不論。假定放射線處理後形成二對染色體間相互轉座之異型結合體 (Translocation heterozygote)（圖1），其花粉即產生部份不稔；在西瓜上，Oka (1967)[8]及 Shimotsuma (1967, 1968)[10][11]分別以 X—rays 及 γ—rays 照射西瓜種子，得到二對染色體之轉座異型結合個體具有半稔性花粉之報告。二對染色體相互轉座，在減數分裂時，如無交叉換位 (Crossing over) 發生時，此轉座染色體則有扭轉(Alternate)、鄰接Ⅰ型 (Adjacent—Ⅰ) 及鄰接Ⅱ型 (Adjacent—Ⅱ) 之配對分離方法，其出現之比率爲2：1：1，然而在鄰接之情形下爲不稔，僅在扭轉之情形下，可得到可稔之花粉，故花粉之稔性只有50%。事實上，交叉換位之發生在所難免，因此其稔性不可能固定爲50% (Kihara 及 Shimotsuma)[7]，故本試驗將花粉稔性定爲30%至70%者爲半稔性株，並假設其爲二對染色體之相互轉座而進行自交。在自交時，發現自交不易結果，同時種子數減少，在所

有處理中，半稔性植株共有38株，採到自交種子之株數僅有17株共24果（表3）。此17株自交種子再行播種，分離出高稔性株，在此高稔性株當中，便有二對染色體之相互轉座同型結合體（Translocation homozygote）植株之可能。

表3　半稔性自交之結果

Table 3. Result of selfing of semi—sterility individuals

處理編號 Treatment No.	半稔性株數 No. of plants with Semi—pollen fertility	自交花數 No. of flowers selfed	結果數 No. of fruit set	採得自交種子之株數 No. of plants having progeny	平均每果種子數 No. of seeds per fruit
R—5	4	9	3	3	104
R—10	7	11	2	2	168
R—15	12	15	7	4	81
R—20	6	21	7	5	65
R—30	9	17	5	3	85
CK	12*	14	13	12	283

*高稔性植株 High pollen fertility plants

如表3，在17株半稔性株上所採得之自交種子各爲一系，經播種後，其系統間之花粉稔性不同，有7系統之植株具有高稔性，表示此7系統之染色體可能並未發生轉座，故在本試驗中，將此7系統淘汰；另外10系統之植株表現不同程度之稔性（表4）。在理論上，二對染色體轉座異型結合體自交，其後代應半數爲半稔性，另半數爲高稔性，而在高稔性株中，有半數爲正常株（未轉座），另半數爲轉座同型結合體，故轉座同型結合體植株在理論上應佔後代植株之四分之一；但事實上，由於交叉換位之影響，後代之分離常不能依此計算（Kihara 及 Shimotsuma）[7]，況且在本試驗以半稔性株自交，只是假設其爲二對染色體異型轉座而已，但究竟是否確爲此型轉座，在本試驗由於當時材料有限，不足供 PMC 之分析而未得到答案。故本試驗必須將具有分離性10系統所分離之後代，選出高稔性株，一方面進行自交，以保存該系統之後代，同時必需與未經處理株（CK）行雜交，以明瞭染色體是否爲轉座同型結合或未曾轉座；因爲轉座同型結合株與未轉座株（CK）雜交之 F_1，產生轉座異型結合體之半稔性，而未轉座株與 CK 株雜交，仍爲未轉座之高稔性 F_1 株。

表4　半稔性株自交後代之稔性分離情形

Table 4. The segregation of pollen fertility in the progeny from selfing of semi-sterility individuals

親本編號 Parents No. / 後代 Progeny	R—5—13	R—5—44	R—5—48	R—10—6	R—10—40	R—15—2	R—15—9	R—15—21	R—15—30	R—20—7	R—20—14	R—20—18	R—20—24	R—20—28	R—30—5	R—30—11	R—30—16	CK
調查株數 No. of plants investigated	20	20	18	18	20	20	19	20	20	20	20	20	20	20	18	14	20	20
低稔性株數 No. of low fert. plants	0	3	0	0	4	0	0	1	0	0	4	0	0	0	0	2	0	0
中稔性株數 No. of semi—steri. plants	0	9	0	8	4	0	8	9	0	0	6	0	8	0	7	4	5	0
高稔性株數 No. of high fert. plants	20	8	18	10	12	20	11	10	20	20	10	20	12	20	11	8	15	20

（三）從半稔性株自交之後代選出全稔性株與正常小鳳（CK）雜交F_1之稔性：

共有62株具有高稔性者與正常小鳳（CK）雜交得到之 F_1 組合，其中有2個 F_1 組合之植株均爲低稔性花粉，8個 F_1組合之植株屬於半稔性花粉，只有2個 F_1 組合之植株稔性不穩定，即植株間稔性高低不同；此外有46個組合均表現高稔性。各系統鑑定結果如表5。

表5　分離選出之高稔株與正常小鳳（CK）什交之稔性

Table 5. Pollen fertility in F_1 hybrids between the segregation progeny with high pollen fertility and CK

系號 Line	與CK交配株數 No. of plants crossed with CK	F_1 組合數 No. of F_1 Combination with			
		低稔 Low fert.	半稔 Semi—steri.	高稔 High—fert.	分離稔性 Segregation fert.
R—5—44	6	0	1	3	2
R—10—6	6	0	0	6	0
R—10—40	8	0	0	8	0
R—15—9	6	0	2	3	1
R—15—21	6	0	0	6	0
R—20—14	9	0	0	6	3
R—20—24	6	1	2	3	0
R—30—5	5	0	1	4	0
R—30—11	6	1	2	3	0
R—30—16	4	0	0	4	0
CK	1	0	0	1	0

由表5觀之，高稔性之 F_1 組合表示其親本並未發生染色體轉座；而表現分離現象之組合，其親本可能係轉座異型結合體，其親本之花粉稔性雖高達81%及87%，按理轉座異型結合體，不可能有如此高之花粉稔性，故眞正原因尙不能瞭解，而半稔性之 F_1 組合之親本，可視爲二對染色體相互轉座之同型結合體，至於低稔性 F_1 組合之親本可能包括更多對染色體轉座之同型結合體，經過 PMC 之鏡檢，發現8個 F_1 組合中，有6個組合在第一次減數分裂之親交期（Diakinesis）或中期（Metaphase I）呈現一個四價染色體環或鏈（Ring of ④）及9個二價染色體（Bivalents），另兩個F_1組合則未發現四價染色體環；此種情形在農友種苗公司育成之二對染色體轉座同型結合之三系統之 F_1 組合，亦均發現有四價染色體環。至於2個低稔性 F_1 組合中，有一個 F_1 組合僅發現一個四價染色體環，另一組合則發現有二個四價染色體環（表6及圖7—10），其種子數之多少亦與四價染色體環之有無及多少相吻合，即每果平均發育之種子數如具有一個四價染色體環者（二對染色體相互轉座異型結合體），則較未轉座者（CK）大約減少38%，而有二個染色體環者約可減少55%（表6及圖5，6），此與 Oka 等氏及Shimotsuma[10][11]之報告相較，雖所用之品種不同，但其減少發育種子數之趨向則相似。

（四）轉座同型結合系統自交之稔性：

所有能生產具有二對染色體轉座之異型結合親本（即二對染色體相互轉座同型結合體）之自交後代，均具有高稔性之花粉，而且有普通之種子數，此表示將來自交系統之保存及生產 F_1 組合均無問題，但二個二對染色體轉座同型結合體，自交之種子數不多，故其轉座是否安定，尙待進一步觀察（

表6）。

表6　轉座同型系統及其特性

Table 6. Some characteristics of translocation homozygotes and their F_1 hybrids

同型轉座系統 Translocation homozygote line	自交後代 Selfing progeny		與 CK 什交 F_1 (F_1 Combination)		
	花粉稔性 Pollen fert. (%)	每果種子數 No. of seeds per fruit	花粉稔性 Pollen fert. (%)	每果種子數 No. of seeds per fruit	染色體配對情形 Chromosome configurations
R—5—44—4	96	223	92	274	11Ⅱ
R—15—9—3	94	241	62	104	④+9Ⅱ
R—15—9—5	97	294	94	208	11Ⅱ
R—20—24—1	96	206	52	151	④+9Ⅱ
R—20—24—2	93	306	57	144	④+9Ⅱ
R—20—24—5	98	238	64	119	④+9Ⅱ
R—30—5—2	92	284	97	286	11Ⅱ
R—30—11—2	95	212	53	121	④+9Ⅱ
R—30—11—3	86	243	56	94	④+9Ⅱ
R—30—11—4	85	144	32	63	④+④+7Ⅱ
F—73—B—4*	97	265	58	173	④+9Ⅱ
F74—A—2*	96	192	62	158	④+9Ⅱ
F72—A—5*	98	206	59	161	④+9Ⅱ
CK	96	278	97	266	11Ⅱ

*農友公司育成之系統。Lines from Known-You Seed Co.

（五）多對染色體轉座之異型結合體：

據 Shimotsuma[11] 之報告，旭大和西瓜，如轉座之染色體對數增加時（如④+④，④+④+④……等），則種子數依轉座對數之增加而減少，同時如果多對染色體發生相互轉座時（例如⑥，⑧……等），則種子數更減少，此種現象在本試驗中，以兩個具有半稔性之植株雜交之後代中，亦出現④+④+7Ⅱ，④+④+④+5Ⅱ及⑥+④+④+4Ⅱ等多對染色體轉座之個體，其花粉稔性及種子數則減少甚多（表7及圖10—12）；但其親本均爲半稔性株，故不能視爲轉座同型結合，其後代仍會分離，有待以後繼續分離固定。

表7　多對染色體轉座異型之稔性

Table 7. Pollen fertility and seed number of multi-translocation individuals

染色體配對情形 Chromosome configuration	來源* Parents	花粉稔性 Pollen fertility	平均種子數 Seeds No.
		%	
④+④+7Ⅱ	R—15—21×R—30—11	41	79
④+④+④+5Ⅱ	R—15—21×R—30—11	36	64
⑥+④+④+4Ⅱ	R—30—5×R—30—11	14	28

*親本爲半稔性 Parents with semi-sterility.

綜觀上述，鳳山分所育成之6個系統及農友公司育成之3個系統具有二對染色體相互轉座之同型結合，至於更多對染色體轉座之同型結合系統，有待今後之繼續分離固定，對於轉座系統之結果力、品質等問題亦須繼續調查，以明瞭其實用價值。

THE REDUCTION OF SEED NUMBER OF WATERMELON THROUGH CHROMOSOMAL TRANSLOCATION INDUCED BY γ-RAY IRRADIATION

I. Development of Homozygotes of One Translocation in Hsiao-feng Variety

by

A-chang Chiou, Wen-yu Chen

Summary

For the purpose of reducing the seed number of small-size watermelon by chromosomal translocation, dry seeds of Hsiao-feng variety were irradiated with 5, 10, 15, 20, and 30 Kr doses of γ-rays. The results showed that irradiation produced some harmful effects on seed germination and the rate of seedling survival. The higher the dose of irradiation used, the more harmful effects were observed. Pollen abortions were found in some survival plants and selfing was made with plants showing semi-sterility (Table 2). It was rather difficult to obtain these selfing fruits and there were less seeds in the fruits (Table 3).

The progeny from selfs of the semi-sterile individual showed segregation of pollen fertility (Table 4, Fig. 2-4). The high pollen fertility plants selected in the progeny were selfed as well as crossed with untreated plants CK to produce F_1 hybrids. The pollen fertility of these F_1 hybrids was examined. Two F_1 hybrids with low pollen fertility and eight hybrids with semi-sterility may be resulted from chromosomal translocation heterozygote (Table 5). After PMC investigation, ④+9 II Chromosome configurations in six of the ten F_1 hybrids developed by Fengshan Trop. Hort. Exp. Sta. were found. The same results were also obtained with three F_1 hybrids developed by Known-You Seed & Nursery Co. In addition, ④+④+7 II configuration was found in one F_1 hybrids which were translocation heterozygotes (Table 6, Fig. 5-9). Therefore, it is suggested that the parents of these F_1 hybrids are likely translocation homozygote which showed normal pollen fertility as well as normal amount of seeds (Table 6).

Another three F_1 hybrids obtained from the crossed between semi-sterility individuals showed much lower pollen fertility and seed number. Their chromosome configurations were ④+④+7 II, ④+④+④+5 II, and ⑥+④+④+4 II respectively (Table 7, Fig. 10-12).

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圖一、二對染色體轉座模式圖

A. 正常染色體
B. 轉座異型結合體
C. 轉座同型結合體

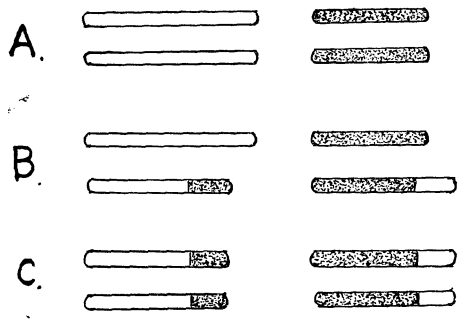


Fig.1 Diagram of translocation involving two pair of choromosomes.
A. Standard chromosomes,
B. Translocation heterozgote,
C. Translocation homozygote.

圖二、正常株之花粉

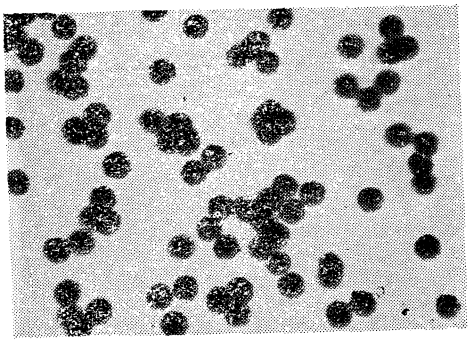


Fig. 2 Normal pollen from untreated plants

圖三、④+9 II之半稔性花粉

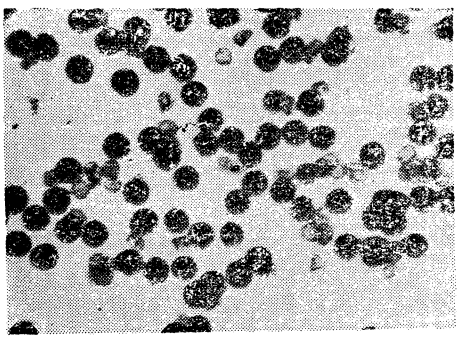


Fig. 3 Pollen from plant of ④+9 II showing semi-sterility

圖四、④+④+7 II之低稔性花粉

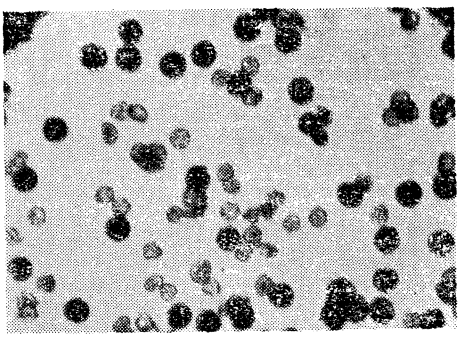


Fig. 4 Pollen from plant of ④+④+7 II showing low fertility.

圖五、染色體轉座種子數減少情形左爲④+④+7 II 轉座者，右爲未轉座者

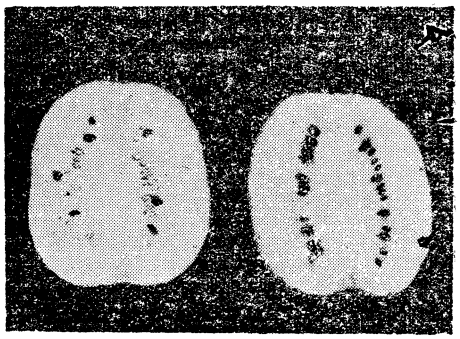


Fig. 5 & 6. Seeds development of watermelon

Left : Fruit from ④+④+7 II plant showing reduced number of normal seeds.

Right : Fruit from untreated plants showing normal seed development.

圖六、同圖五

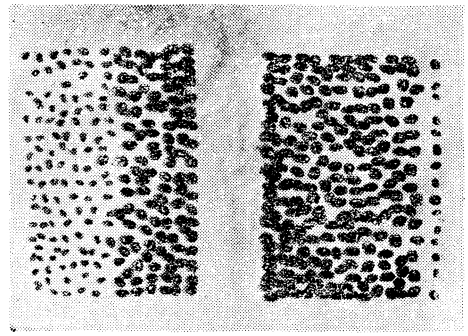


Fig. 6 Ditto

圖七、染色體配對情形 (11 II)



Fig. 7 Chromosome configurations of PMC at metaphase I (11 II)

圖八、染色體配對情形 (④+9 II)



Fig. 8. Ditto (④+9 II)

圖九、染色體配對情形 (④+9 II)



Fig. 9. Ditto (④+9 II)

圖十、染色體配對情形 (④+④+7 II)



Fig. 10 Ditto (④+④+7 II)

圖十一、染色體配對情形 (④+④+④+5II)



Fig. 11 Ditto (④+④+④+5 II)

圖十二、染色體配對情形 (⑥+④+④+4 II)



Fig. 12 Ditto (⑥+④+④+4 II)

黃麻纖維細胞組織與纖維品質之關係研究①

凌 千 里②

一、引 言

黃麻爲田麻科 Corchorus 屬一年生草本植物，生長迅速，栽培容易，其剝練之精洗麻，爲作物中最豐產而價廉之天然纖維，故在本省栽培極廣。

黃麻靱皮部之纖維組織，由無數纖維束彙集而成，纖維細胞 (Ultimate fiber cell) 又結合成纖維束，因之纖維細胞之性狀、組合，對精洗麻之品質，關係極爲密切。

本省目前黃麻纖維品質低劣，而現行推廣品種或即將推廣之新品系，其纖維細胞組織，栽培方法對纖維細胞之影響，與纖維品質間相關性等課題，實有詳加探討必要。冀從黃麻纖維細胞之基本研究，從而提供選育品種，改良栽培方法之依據，俾今後得以生產品質優良之黃麻纖維。

二、前人研究

黃麻纖維細胞束中之細胞數，據印度黃麻農業研究所 (JARI, 1950-52) 報導，以圓果種 (C. capsularis, L) 較長果種 (C. olitorius, L) 爲少，在各種因子相同時，品質比 (Quality ratio) 高者，每束中之纖維細胞數亦多。

三屋壽夫、張拔倫及張亮能 (1948) 於本省研究黃麻淡紅皮等 4 個品種之纖維細胞束發育情形，認一束中之纖維細胞數隨生育日數而增加，至90～110天後多數停止。生育達130天之植株，基部纖維細胞之大小，其縱橫徑爲 13～14μ。

Kundu (1942, 1954) 報導，黃麻纖維細胞之長度爲 500～650μ ，直徑爲 10～30μ ， 長幅比 (Length-breadth ratio) 爲98～118。

陳紹慶、林勝傑 (1970) 記載黃麻纖維細胞之長度最大爲 5000μ，最小爲1500μ；寬度最大爲25μ，最小爲 20μ ；長幅比爲150左右。

Mauersberger (1954) 引述 Ve'tillart 資料，黃麻纖維細胞之直徑爲 20～25μ ，長度爲0.06～0.20 (1524μ～5080μ) 。

Chaudhuri (1963) 謂黃麻加施磷肥，可使纖維細胞長度自 2158μ 增至 2718μ，直徑自 20.3μ 減至 17.3μ ，長幅比自106增至154。

印度黃麻農業研究所 (1954～55) 報導，黃麻纖維拉力佳者，纖維細胞較長較細， 長幅比亦較大，其趨勢在長果種中尤爲明顯。

三、材料及方法

(一) 材料 本研究使用之黃麻品種 (系) 屬圓果種 (Corchorus capsularis) 者，有臺農 1 號、臺農選 1 號、 TN-7-57 等 3 個；長果種 (C. olitorius) 者，有 FS-61-I-2098 1 個。臺農 1 號爲目前栽培面積最廣之品種， 植株高大， 有效莖長在 3 公尺以上， 產量高。 臺農選 1 號 ， 原爲 FS-61-I-2097，自印度引進，經馴化後於民國58年定名之新品種。有腋芽，偶發不定枝，但產量比臺農 1 號高。 TN-7-57 由本省黃麻產區選拔，經純系育成，民國57年區域示範結果，較臺農 1 號增產

本報告係國家科學會補助試驗計劃之一部份，附誌謝忱。

1 試驗報告農試字第五五七號 2 臺灣省農業試驗所臺南棉麻試驗分所技士。

表 1. 黃麻纖維細胞束中細胞數比較表

Table 1. Comparison of the cell number of each fiber bundle among the main jute varieties

品種	細胞數	部位 / 層次	基部 Base 第一層 1st layer	基部 Base 第三層 3rd layer	基部 Base 第五層 5th layer	中部 Middle 第一層 1st layer	中部 Middle 第三層 3rd layer	中部 Middle 第五層 5th layer	梢部 Top 第一層 1st layer	梢部 Top 第三層 3rd layer	平均 Average	總平均 Average
臺農選1號 Tainung selection No. 1	粗莖 Big stem	M±S.D	26±8.47	20±6.82	30±8.05	47±13.47	17±4.69	18±6.82	57±19.47	15±4.99	24.55±9.13	22.50±8.25
		C.V%	32.58	34.10	26.83	29.26	27.59	38.00	34.16	33.27	31.98	
	細莖 Slender stem	M±S.D	31±14.08	15±6.28	14±3.67	39±10.51	11±2.97	12±3.95	40±13.37	11±4.02	20.45±7.36	32.90
		C.V%	45.40	41.89	26.24	26.95	27.15	32.89	33.42	36.55	33.81	
TN-7-57	粗莖 Big stem	M±S.D	27±8.13	28±12.66	32±12.26	51±13.10	22±8.59	20±7.86	51±17.50	19±7.92	26.00±11.01	23.89±9.12
		C.V%	30.11	45.25	38.38	25.68	39.05	39.30	34.33	41.68	36.72	
	細莖 Slender stem	M±S.D	30±11.92	18±6.16	16±4.44	37±8.25	13±3.02	13±2.61	43±18.31	13±3.05	21.78±7.22	32.95
		C.V%	39.73	34.24	27.76	22.31	23.24	20.04	42.58	23.48	29.17	
臺農1號 Tainung No. 1	粗莖 Big stem	M±S.D	30±5.76	30±8.54	31±9.83	57±19.83	21±7.15	20±7.12	49.±17.35	20±6.58	30.89±10.27	25.78±8.45
		C.V%	19.20	28.47	31.71	34.79	34.05	35.60	35.41	32.90	31.52	
	細莖 Slender stem	M±S.D	30±7.84	19±5.70	17±6.24	41±9.99	10±3.22	8±4.66	37±11.04	12±4.30	20.67±6.62	32.84
		C.V%	26.13	30.01	36.72	24.36	32.15	58.19	29.85	35.87	34.16	
FS-61-I-2098	粗莖 Big stem	M±S.D	32±11.14	29±9.79	28±10.33	48±16.52	19±5.66	23±7.26	43.±26.30	22±9.96	29.56±12.18	26.62±10.22
		C.V%	34.81	33.76	36.89	34.42	29.79	31.57	61.16	45.27	38.46	
	細莖 Slender stem	M±S.D	28±6.47	18±8.44	19±7.63	39±11.94	18±5.42	—	43±13.44	15±4.38	23.67±8.25	35.76
		C.V%	23.10	46.89	40.16	30.61	30.13	—	31.24	29.22	33.05	
平均 Average	粗莖 Big stem	M±S.D	28.75±8.38	26.75±9.45	30.25±10.12	50.71±15.80	19.75±6.25	20.25±7.27	50±20.16	19±7.36	27.75±10.65	24.70±9.01
		C.V%	29.18	35.40	33.45	31.04	32.62	36.12	41.27	38.28	34.67	
	細莖 Slender stem	M±S.D	29.75±10.08	17.50±6.65	16.50±5.50	39±10.17	13±3.66	11±3.70	40.75±14.04	12.75±3.94	21.64±7.36	33.61
		C.V%	33.59	38.26	32.72	26.06	28.17	37.04	34.27	31.29	32.55	
L. S. D		5%	8.145	5.864		8.231	5.722		10.455	4.451		
		1%	11.086	7.981		11.202	7.788		14.229	6.058		

9.6%，故此2品種（系）極具推廣栽培價值。FS-61-I-2098 爲本分所引進長果種中，表現較佳之新品系。通常長果種纖維品質及國際市價均高於圓果種，今列入此一品系，藉資比較。各品種（系）分植於行、株距 50cm×12cm 及 30cm×6cm 2 區，至生長130天後同日收穫鮮株，經測得前者莖徑2.25～1.61cm，稱粗莖，後者莖徑 1.46～1.28cm，稱細莖。

（二）方法

1. 取樣及切片：供試品種中分粗莖、細莖2類，每莖徑任選剛收穫之鮮株五株，分基、中、梢3部位取樣，即每部位製10鏡檢片，每莖徑15片，每品種30片，黃麻莖徑粗大，切片時以植株橫斷面之$\frac{1}{8}$～$\frac{1}{12}$爲宜，染色則以 Hematoxylin crystals 與 Aluminum ammonium sulphate 之溶液較爲理想。

2. 鏡檢：觀測均以測微計（Micrometer）度量後換算爲 μ 單位統計，測定細胞之縱、橫徑及細胞膜厚度，以第1層細胞束之細胞爲準，每一切片以系統取樣法抽20個細胞觀測之。觀測細胞束之長度與濶度，及一束中之細胞數，以第1，3、5層細胞束羣爲準，每片測15束。計算纖維細胞之長度，則須先將精洗纖維，以中性亞硫酸鈉法處理，加溫 170°C，經5小時，分離成單纖維（Ultimate fiber cell）後再觀測之，每部位計量100次，每莖徑300次，每品種600次。

3. 纖維品質之測定：將洗得之精洗麻，分別剪取基、中、梢3部，先經梳整成粗細均等之纖維束條，裁成15吋，放置於溫度 20°C±2°C，相對濕度65±2%之檢查室內 24 小時，然後作圈，秤重325mg，扭撚15次，成纖維樣束，黏貼於固定板，以待測定，每部位測定拉力20次，耐屈力4次，累加基、中、梢3部結果平均，得每1品種之測定值。

四、結果與討論

（一）纖維細胞束　本試驗所觀測者計有細胞束長度、濶度，每束細胞數，及細胞束層數多項，此等項目之平均數（m）、標準機差（S.D），變異係數（C.V%），及 L. S. D. 等結果，分述如次；

1. 每束細胞數　由表1統計分析，可顯示下列各點。

（1）品種間之比較　供試品種（系）中，每束中細胞之平均數以 FS-61-I-2098 之 26.62±10.22 個爲最多，順次爲臺農1號 TN-7-57，臺農選1號之 22.50±8.25 個則爲最少。FS-61-I-2098 爲供試品種中唯一之長果種，其每束細胞數均多於其他 3 個圓果種。與前述印度黃麻農業研究所報告一束中纖維細胞數圓果種較長果種爲少之結果相埒。

（2）莖徑間之比較　不論何部位，或何層次，粗莖每束細胞數均顯著多於細莖，尤以每部位之第三、五層細胞束羣更爲明顯。

（3）植株部位及細胞束層次間之比較　不論基部、中部、或梢部第一層細胞束中之細胞數，一般均多於第三及第五層。中、梢兩部，第一層比第三或第五層高達2倍至3倍，粗莖臺農1號中部及臺農選1號梢部，第一層每束平均細胞數皆高達57個，爲供試各組中最多者。第三及第五層之細胞數，基部較多於中部或梢部，故基部各層之細胞較爲平均，尤以粗莖者更顯明。每束細胞數之變異情形，第一層小於其他各層，臺農1號粗莖基部第一層每束細胞數之變異係數（C.V%）19.2%，爲本項目中最小者，因此本試驗觀測單纖維細胞時，均以第一層之細胞爲準。

2 纖維細胞束之長與濶　從表2. 統計分析之結果，可知下列各項：

表2. 黃麻纖維細胞束長濶比較表

Table 2. Comparison of the length and width of fiber bundle among the main jute varieties

Unit: μ

品種 \ 部位			基部 Base				中部 Middle		
			第一層 1st layer		第三層 3rd layer		第一層 1st layer		第三層 3rd layer
			細胞束長 The length of fiber bundle.	細胞束濶 The width of fiber bundle.	細胞束長 The length of fiber bundle.	細胞束濶 The width of fiber bundle.	細胞束長 The length of fiber bundle.	細胞束濶 The width of fiber bundle.	細胞束長 The length of fiber bundle.
臺農選1號 Tainung selection No. 1	粗莖 Big stem	M±S.D	87±11.34	57±14.68	96±26.14	52±10.55	150±20.35	88±29.92	79±17.34
		C.V%	13.03	25.75	27.23	20.29	13.57	34.00	21.95
	細莖 Slender stem	M±S.D	91±21.53	66±19.75	71±21.23	46±11.88	115±14.26	66±16.70	59±9.67
		C.V%	23.66	29.92	29.90	25.82	12.40	25.30	16.39
TN-7-57	粗莖 Big stem	M±S.D	101±12.38	57±17.71	103±33.45	64±17.47	187±16.14	80±21.62	84±20.31
		C.V%	12.26	31.09	32.47	27.30	8.60	27.03	24.18
	細莖 Slender stem	M±S.D	92±25.18	62±17.44	82±17.20	54±11.65	117±12.11	68±16.14	57±11.52
		C.V%	27.36	28.13	20.97	21.57	10.35	23.74	20.20
臺農1號 Tainung No. 1	粗莖 Big stem	M±S.D	99±9.24	62±14.30	113±19.38	66±15.63	196±42.86	92±33.15	86±18.81
		C.V%	9.33	23.06	17.15	23.70	21.87	36.03	21.87
	細莖 Slender stem	M±S.D	97±21.28	61±18.20	83±20.71	53±10.44	119±12.91	69±15.22	51±11.61
		C.V%	21.93	29.83	24.96	19.71	10.85	22.06	22.76
FS-61-I-2098	粗莖 Big stem	M±S.D	114±20.31	75±21.43	116±38.31	63.±14.51	152±21.65	95±26.96	78±16.48
		C,V%	17.82	28.57	33.25	23.03	14.24	28.38	21.13
	細莖 Slender stem	M±S.D	101±19.00	67±11.87	79±33.56	46±10.67	132±18.45	67±20.56	62±11.88
		C.V%	18.81	17.72	42.48	23.20	13.98	30.68	19.16
平均 Average	粗莖 Big stem	M±S.D	100±13.32	62±17.00	107±29.32	61±14.54	171±25.25	88±27.91	81±18.34
		C.V%	13.11	27.12	27.53	23.58	14.59	31.36	22.28
	細莖 Slender stem	M±S.D	95±21.75	64±16.82	79±23.18	50±11.16	121±14.43	67±17.16	57±11.17
		C.V%	22.94	26.40	29.58	22.58	11.90	25.45	19.63
L. S. D		5%	11.055	14.402	21.218	8.245	22.437	13.368	8.817
		1%	15.047	19.602	28.879	11.222	30.538	18.195	12.000

表2. 黃麻纖維細胞束長濶比較表（續）

Table 2. Comparison of the length and width of fiber bundle among the main jute varieties

Unit: μ

品種	項目		部位 中部 Middle 第三層 3rd layer 細胞束濶 The width of fiber bundle.	梢部 Top 第一層 1st layer 細胞束長 The length of fiber bundle.	梢部 Top 第一層 1st layer 細胞束濶 The width of fiber bundle.	梢部 Top 第三層 3rd layer 細胞束長 The length of fiber bundle.	梢部 Top 第三層 3rd layer 細胞束濶 The width of fiber bundle.	平均 Average 細胞束長 The length of fiber bundle.	平均 Average 細胞束濶 The width of fiber bundle.
臺農選1號 Tainung selection No. 1	粗莖 Big stem	M±S.D	49±8.54	163±28.35	84±24.39	80±18.24	41±9.97	89.28±18.19	55.17±14.43
		C.V%	17.43	17.39	29.04	22.80	24.34		
	細莖 Slender stem	M±S.D	41±6.57	120±22.03	67±24.44	60±17.52	35±10.09		
		C.V%	16.01	18.36	36.48	29.19	28.83	20.98	24.41
TN-7-57	粗莖 Big stem	M±S.D	54±12.63	162±39.39	82±23.52	98±25.57	49±18.77	98.06±20.30	59.17±18.43
		C.V%	23.39	24.32	28.68	26.09	38.31		
	細莖 Slender steam	M±S.D	41±6.77	118±17.17	72±70.12	67±11.02	40±8.91		
		C.V%	16.52	14.55	97.38	16.45	22.27	20.81	29.43
臺農1號 Tainung No. 1	粗莖 Big stem	M±S.D	54±12.53	160±24.95	82±27.42	78±14.08	53±10.22	93.89±18.72	57.17±15.57
		C.V%	23.20	15.60	33.44	18.05	19.28		
	細莖 Slender steam	M±S.D	37±7.69	111±20.85	60±21.69	56±14.64	33±10.28		
		C.V%	20.79	18.79	36.15	26.14	31.14	20.55	25.84
FS-61-I-2098	粗莖 Big stem	M±S.D	49±9.99	148±33.56	97±26.87	84±32.68	42±9.93	95.17±22.61	59.95±16.25
		C.V%	20.39	22.67	27.70	38.90	23.64		
	細莖 Slender steam	M±S.D	45±11.03	127±20.66	86±28.48	59±14.63	41±6.61		
		C.V%	24.50	16.27	33.11	24.85	16.11	23.64	24.94
平均 Average	粗莖 Big stem	M±S.D	51±10.92	158±31.56	86±25.55	85±22.64	46±12.22	107±22.56	64±17.23
		C.V%	21.10	20.00	29.72	26.46	26.39	21.02	25.62
	細莖 Slender steam	M±S.D	41±8.02	119±20.18	71±36.18	60±14.46	37±8.97	80±17.35	52 ±15.13
		C.V%	19.46	16.99	50.78	24.16	24.59	21.97	26.69
L. S. D		5%	6.947	19.658	15.646	12.268	14.874	—	—
		1%	9.456	26.756	21.295	16.697	20.244	—	—

（1）品種間之比較　以 TN-7-57 之細胞束長 98.06±20.30μ 爲最大，而該品系之細胞束濶亦較大；臺農選 1 號之細胞束長及束濶則爲 4 個供試品種中最小者。細胞束增長，濶度亦隨之增大，此等關係，似極爲密切。

（2）莖徑間之比較　粗莖者之細胞束長與束濶，一般皆較細莖者爲大，尤其各部位之第三及第五層，更爲顯著。

（3）植株部位與細胞束層次間之比較　纖維細胞束之長濶與每束細胞數，發生密切關連，每束中細胞多者，束必大，細胞少者，束必小，此等情形在上表中極爲普遍，即不論何部位，第一層細胞束之長、濶，一般皆大於第三及第五層；中部及梢部第一層細胞束之長、濶，尤倍於第三及第五層。中部粗莖第一層之平均細胞束長 171.25±25.25μ ，濶 88.75±27.91μ ，爲本項目中最大者，中部細莖第五層之 54±14.76μ 及 40±10.18μ ，則爲平均數之最小者。基部各層差異則較小。

表 3.　黃麻纖維細胞束羣之層數

Table 3. The number of layers in fiber bundle group among the main jute varieties

品種 Variety / 莖徑 Diameter of stem / 植株部位 Section of stem	臺農選 1 號 Tainung selection No. 1		TN-7-57		臺農 1 號 Tainung No. 1		FS-61-I-2098		平均 Average	
	粗莖 Big stem	細莖 Slender stem	粗莖 Big stem	細莖 Slender stem	粗莖 Big stem	細莖 Slender stem	粗莖 Big stem	細莖 Slender stem	粗莖 Big stem	細莖 Slender stem
基部 Base	11—13	6—7	10—12	5—6	9—12	6—7	10—11	5—7	10—12	5.5—6.8
中部 Middle	7—8	6	6—8	4—5	6—8	4—5	6—7	4	6.3—7.8	4.5—5
梢部 Top	3—5	2—4	2—4	2—3	4—6	3—4	4—5	3—4	3.3—5	2.5—3.8
平均 Average	5.8—7.2		4.8—6.3		5.3—7		5.3—6.3		5.4—6.7	

3 細胞束羣之層數　由表3. 知，各品種間以臺農選 1 號之層數爲最多。莖徑間，粗莖者均顯多於細莖者。植株部位間，基部之層數爲最多，臺農選 1 號粗莖基部高達11～13層，爲本項目中最多者。各品種中部之平均層數約爲 5 ～ 7 層，梢部則少至 3 ～ 4 層，致本試驗梢部觀測僅及第三層。基部因層數多，本試驗觀測之一、三、五層，其纖維細胞均發育充實，故差異甚小，此與上述基部各層每一纖維細胞束之細胞數及細胞束長、濶等差異皆小於中、梢部同層次者之情形相若。

（二）單纖維細胞　觀測單細胞之縱徑、橫徑，細胞膜厚度、單細胞長度等項目，並將縱徑、橫徑化作直徑，直徑除長度得細胞長幅比（Length-breadth ratio）；其結果如表 4 ～ 6 。

表4. 黃麻纖維細胞比較表

Table 4. Comparison of the ultimate fiber cell among the main jute varieties

單位 Unit: μ

品種	項目		基部 Base		中部 Middle		梢部 Top		平均 Average	
			細胞直徑 The diameter of fiber cell	細胞膜厚 The wall thickness of fiber cell	細胞直徑 The diameter of fiber cell	細胞膜厚 The wall thickness of fiber cell	細胞直徑 The diameter of fiber cell	細胞膜厚 The wall thickness of fiber cell	細胞直徑 The diameter of fiber cell	細胞膜厚 The wall thickness of fiber cell
臺農選1號 Tainung selection No. 1	粗莖 Big stem	M±S.D	16.44±2.55	5.83±1.24	16.73±3.13	6.17±1.23	16.75±2.42	5.98±0.91	16.55±2.71	5.86±1.13
		C.V%	15.5	20.72	18.75	20.72	14.44	15.08		
	細莖 Slender stem	M±S.D	16.06±2.7	5.50±1.10	17.04±2.75	6.03±1.26	16.87±2.68	5.62±1.00	16.31	18.75
		C.V%	16.81	18.33	16.10	20.95	16.26	16.67		
TN-7-57	粗莖 Big stem	M±S.D	16.2±2.14	5.98±1.04	19.17±3.80	7.17±1.59	17±2.47	5.23±1.35	16.89±2.70	585.±1.25
		C.V%	13.14	17.4	19.73	22.79	14.08	26.96		
	細莖 Slender stem	M±S.D	15.78±2.44	5.52±1.21	17.06±2.76	6.09±1.29	16.13±2.60	5.06±1.00	15.79	21.48
		C.V%	15.75	20.23	15.69	21.52	16.35	20.00		
臺農1號 Tainung No. 1	粗莖 Big stem	M±S.D	16.74±2.91	5.85±1.35	17.98±3.20	6.44±1.73	15.70±2.95	4.79±1.09	16.25±2.89	5.44±1.38
		C.V%	17.53	22.47	17.80	28.87	18.82	21.74		
	細莖 Slender stem	M±S.D	15.34±3.11	5.45±1.19	16.32±2.83	5.42±1.36	15.38±2.31	4.68±1.55	17.78	24.53
		C.V%	19.83	23.84	17.71	27.14	14.97	23.10		
FS-61-I-2098	粗莖 Big stem	M±S.D	17.91±2.77	6.02±1.28	18.15±3.25	6.15±1.17	17.44±2.91	5.56±1.13	17.62±2.86	5.88±1.23
		C.V%	15.32	21.32	17.62	19.47	17.29	18.80		
	細莖 Slender stem	M±S.D	17.57±2.83	6.02±1.36	17.10±2.47	6.02±1.08	17.56±2.90	5.52±1.38	16.28	20.52
		C.V%	16.23	22.65	14.38	17.93	16.81	22.93		
平均 Average	粗莖 Big stem	M±S.D	16.82±2.59	5.92±1.23	18.01±3.35	6.48±1.43	16.72±2.69	5.39±1.12	17.18±2.88	5.93±1.26
		C.V%	15.37	20.48	18.48	22.96	16.16	20.65	16.67	21.36
	細莖 Slender stem	M±S.D	16.19±2.77	5.62±1.22	16.88±2.70	5.89±1.25	16.49±2.62	5.22±1.23	16.52±2.70	5.58±1.23
		C.V%	17.16	21.26	15.97	21.89	16.10	20.68	16.41	21.28
L. S. D		5%	1.177	0.695	1.799	0.759	1.023	0.738	0.803	0.4198
		1%	1.602	0.946	2.449	1.033	1.393	1.005	1.111	0.5806

表 5. 黃麻單纖維長度比較表

Table 5. Comparison of the length of ultimate fiber among the main jute varieties

單　位
Unit: μ

品種	長度 \ 部位		基部 Base	中部 Middle	梢部 Top	平均 Average
臺農選 1 號 Tainung selection No. 1	粗莖 Big stem	M±S.D	1891±337.19	2710±764.46	2430±693.97	2605±744.93
		C.V%	17.75	28.31	28.92	
	細莖 Slender stem	M±S.D	2853±980.61	2968±1006.83	2781±686.53	27.84
		C.V%	33.81	33.56	24.68	
TN-7-57	粗莖 Big stem	M±S.D	2019±351.00	2622±738.04	1959±477.91	2618±639.31
		C.V%	17.55	28.39	23.90	
	細莖 Slender stem	M±S.D	2758±725.47	3601±909.29	2750±634.13	24.01
		C.V%	25.91	25.26	23.06	
臺農 1 號 Tainung No. 1	粗莖 Big stem	M±S.D	1739±403.24	2649±658.18	2506±666.11	2466±612.09
		C.V%	23.72	24.38	26.64	
	細莖 Slender stem	M±S.D	2004±422.37	3149±809.81	2748±712.83	24.52
		C.V%	21.12	25.31	25.94	
FS-61-I-2098	粗莖 Big stem	M±S.D	2047±364.14	2572±772.92	1850±389.36	2196±549.33
		C.V%	17.34	29.73	20.49	
	細莖 Slender stem	M±S.D	2318±613.43	2310±592.96	2081±563.14	24.51
		C.V%	26.67	25.78	27.06	
平均 Average	粗莖 Big stem	M±S.D	1924±363.89	2638±733.4	2186±556.84	2249±551.38
		C.V%	19.14	27.70	24.99	23.94
	細莖 Slender stem	M±S.D	2483.25±685.47	3007±829.72	2590±649.16	2593±721.45
		C.V%	26.88	27.48	25.19	26.52
L. S. D		5%	119.151	217.439	191.246	
		1%	162.171	295.947	260.296	

表 6. 黃麻單纖維細胞長幅比

Table 6. The length breadth ratio of ultimate fiber cell of jute

品種 Variety	部位 Section of stem	基部 Base	中部 Middle	梢部 Top	平均 Average	
臺農選 1 號 Tainung selection No. 1	粗莖 Big stem	115.02	161.98	145.07	140.69	156.46
	細莖 Slender stem	177.65	174.18	164.85	172.23	
TN-7-57	粗莖 Big stem	124.63	136.78	115.24	125.55	155.50
	細莖 Slender stem	174.78	211.08	170.49	185.45	
臺農 1 號 Tainung No. 1	粗莖 Big stem	103.88	147.33	159.62	136.94	152.18
	細莖 Slender stem	130.64	192.95	178.67	167.42	
FS-61-I-2098	粗莖 Big stem	114.29	141.71	106.08	120.69	124.60
	細莖 Slender stem	131.93	135.09	118.51	128.51	
平均 Average	粗莖 Big stem	114.46	146.95	131.50	130.97	
	細莖 Slender stem	153.75	178.33	158.13	163.40	
總平均 Total Average		134.11	162.64	144.82	147.18	

由表 4～6 統計分析，可獲知下列各點：

1. 品種間之比較　纖維細胞直徑及膜厚，長果種 FS-61-I-2098 達 17.62±2.86μ 及 5.88±1.23μ，顯大於其他供試品種；細胞長度則以 TN-7-57 之 2618±639.31μ 爲最長， FS-61-I-2098 之 2196±549.33μ 爲最短，故該品系之長幅比126.60亦爲供試品種中最小者。

2. 、莖徑間之比較　粗莖之細胞直徑及細胞膜厚，不論基、中、梢部，均大於細莖；細胞長度則細莖長於粗莖， TN-7-57 細莖細胞長達 3036±756.30μ ，而該品系粗莖僅爲 2200±522.32μ ，因此粗莖之細胞長幅比均顯然小於細莖。

3. 植株部位間之比較　不論細胞直徑、長度、膜厚及長幅比，均以中部者大於基、梢部；基部之細胞膜較梢部厚；細胞長度及長幅比，則梢部者較大於基部。

本試驗黃麻各品種（系）纖維細胞直徑平均爲 16.25～17.62μ，細胞長度爲 2916～2618μ，細胞膜厚爲 5.44～5.88μ ，細胞長幅比爲 124～156 ，與 Kundu （1954）報導黃麻細胞直徑 10～30 μ ，長度 500～6500μ ，長幅比 98～118, Mauersberger (1954) 引述 Ve'tillart 資料，黃麻細胞直徑爲 20～25μ ，細胞長度爲 0.06～0.20in. （1524μ～5080μ）；及三屋壽夫，張拔倫等 (1948) 報導之直徑 12～14μ ，細胞膜厚 2～5μ 比之，稍有出入，此或因所用研究材料不同所致。

（三）纖維品質　本研究所測定之纖維品質、有拉力、耐屈力、長度及色澤等多項，其結果如表 7：

表 7. 黃麻纖維品質比較表

Table 7. Comparison of the average qualities of retted jute

品質 Qualities / 基徑 Diameter of stem / 品種 Varieties		拉力負荷（磅） Breaking load (lb)		耐屈力（轉） Flex (Cycle)		長度（公分） Length (cm)		色澤 Luster
臺農選 1 號 Tainung selection No. 1	粗莖 Big stem	39.60	41.19	942.50	982.50	319	284	乳黃，有光澤
	細莖 Slender stem	42.78		1022.50		250		淡乳白，富光澤
TN-7-57	粗莖 Big stem	40.25	41.38	1096.75	994.00	325	281	淡乳黃，富光澤
	細莖 Slender stem	42.53		891.25		238		淡乳黃，富光澤
臺農 1 號 Tainung No. 1	粗莖 Big stem	41.70	41.65	1117.25	1002.38	320	291	淡乳白，富光澤
	細莖 Slender stem	41.60		887.50		262		淡乳黃，有光澤
FS-61-I-2098	粗莖 Big stem	37.63	38.28	900.50	890.63	292	263	淺褐色，光澤較差
	細莖 Slender stem	38.93		880.75		235		淡褐色，光澤差
平均 Average	粗莖 Big stem	39.79	—	1014.25	—	—	—	
	細莖 Slender stem	41.46		920.50		—		
L. S. D	5%	2.640	3.732	114.535	161.980	—	—	
	1%	3.577	5.057	155.211	219.506	—		

由上表知：各品種或莖徑間各項纖維品質之差異，均未達顯著平準。惟一般言，品種間以臺農 1 號爲最優，順次爲 TN-7-57，臺農選 1 號，而以 FS-61-I-2098 爲最劣；莖徑間拉力，各品種之細莖優於粗莖，耐屈力粗莖較優於細莖。

（四）纖維細胞組織與纖維品質之相關　黃麻纖維細胞束之長、濶及每束中之細胞數，單纖維細胞直徑、長度、膜厚、長幅比等與纖維拉力負荷、耐屈力等品質間之相關，經統計後之相關 r 值及查 Fisher 氏「不同顯著水準 r 表」知 r 之顯著情形如表 8：

由上表知：

1 每一纖維細胞束中之細胞數、細胞束長、束濶與拉力負荷、耐屈力等纖維品質均呈負相關，其中尤以細胞束濶與拉力負荷更爲顯著，即每一細胞束愈大，含細胞數愈多者，其拉力負荷等品質有較低之趨勢。黃麻 FS-61-I-2098 品系每束細胞數、細胞束長、束濶均爲最大，纖維拉力、耐屈力亦爲最低，即一顯例。

2 黃麻單纖維細胞之長度與纖維拉力負荷呈極顯著正相關。細胞長幅比與拉力負荷，細胞膜厚與耐屈力均呈顯著正相關。細胞直徑與纖維拉力負荷、耐屈力；細胞長度、長幅比，與耐屈力，雖均未達顯著標準，但從其 γ 值之大小與正向觀之，亦可知其趨勢。換言之，纖維細胞長度、長幅比愈大，纖維拉力負荷亦愈强。印度黃麻農業研究所（1954～55）謂纖維拉力佳者，纖維細胞較長較細，長幅比亦較高，此與本試驗之結果，甚相符合。張拔倫（1962）引用 Burkill 資料，認普通紡織之條件，單一纖維細胞應有正常良好之長度，其長幅比應有1000～2000。陳紹慶、林勝傑（1970）記載亞

表 8. 黃麻纖維細胞組織與纖維品質間之相關

Table 8. The correlation between the anatomy of jute fiber cells and retted fiber qualities

細胞組織 The anatomy of fiber cell / 纖維品質 Retted fiber qualities	纖維細胞束 Bundle of fiber cells			單纖維細胞 Ultimate fiber cells			
	每束細胞數 The cell number of each fiber bundle	細胞束長 The length of fiber bundle	細胞束濶 The width of fiber bundle	細胞直徑 The diameter of fiber cell	細胞膜厚 The wall thickness of fiber cell	細胞長度 The length of fiber cell	細胞長幅比 The length breadth ratio of fiber cell
拉力荷（磅） Breaking load (lb)	− 0.197	− 0.161	− 0.413*	0.250	0.177	0.563**	0.416*
耐屈力（轉） Flex (cycle)	− 0.402	− 0.075	− 0.170	0.290	0.587*	0.473	0.386

**Significant at 1 %　　*Significant at 5 %

麻之長幅比爲1486；大麻爲710。孫逢吉（1943）記上等海島棉之長度爲 2 吋以上，濶爲0.000647 吋，化得長幅比爲3091以上。本試驗黃麻之長幅比爲124～156，因此黃麻纖維僅限用於織製麻布、麻袋。故如何從選育品種或改良栽培技術，以取得纖維細胞較長及長幅比較高之黃麻纖維，以提高黃麻纖維品質，仍爲吾人努力之方向。

五、摘　要

本研究以黃麻各品種（系）之植株莖徑，纖維細胞之組織，與其對纖維品質間之相關，舉行試驗，期能從基本研究中，提供選育品種，栽培方法之依據，俾本省能以生產品質優良之黃麻纖維。

（一）纖維細胞束　1 黃麻每一纖維細胞束之細胞數，以 FS-61-I-2098 之26.62 ±10.22 個爲最多，臺農選 1 號之22.50±8.25 個爲最少，粗莖者顯著多於細莖者。2 第一層細胞束中之細胞數均多於第三及第五層，尤其中、梢部，第一層比第三及第五層多 2～3 倍。 3 纖維細胞束長、 濶以 TN-7-57 爲最大，臺農選 1 號爲最小，粗莖者大於細莖者。4 細胞束羣之層數，粗莖者多於細莖者，基部多於中部，梢部最少，臺農選 1 號粗莖基部達11～13層爲最多。

（二）單纖維細胞　1. 單纖維細胞直徑及膜厚， 以長果種 FS-61-I-2098 之 17.62±2.86 μ 及 5.88±1.23μ 最大；細胞長度則以 TN-7-57 之 2618±639.31μ 爲最長， FS-61-I-2098 之 2196±549.33μ 爲最短，該品系之長幅比 126.60爲最小。2. 粗莖之細胞直徑及膜厚平均大於細莖，細胞長度則短於細莖，故粗莖之長幅比較小。3. 植株中部之細胞直徑、膜厚及長度均大於基、梢部，尤其細胞長度差異最爲明顯，致中部之細胞長幅比162.64爲最大。

（三）纖維品質　黃麻臺農選 1 號、 TN-7-57, 臺農 1 號等 3 品種（系）之拉力負荷、耐屈力、長度及色澤等纖維品質差異不大， FS-61-I-2098 則較遜。

（四）纖維細胞組織與纖維品質間之相關　1. 纖維細胞束之濶度與纖維拉力負 荷呈顯著負相關 $r=-0.413$. 2. 纖維細胞膜厚與纖維耐屈力呈顯著正相關 $r=0.587$ 。3. 纖維細胞長度與纖維拉力負荷呈極顯著正相關$r=0.563$. 4. 細胞長幅比與纖維拉力負荷呈顯著正相關$r=0.416$.

本試驗進行期間蒙本分所季前分所長景元之鼓勵， 單纖維分離工作承臺灣糖業試驗所謝工程師文景之幫忙，本分所同仁蕭松雄、邱炳輝兩先生，朱惠芳、林鳳菊、蘇麗貞等小姐之協助取樣，纖維品質檢查，鏡檢觀測， 或統計整理資料，文成後復蒙賴分所長銘立之細心校閱，一併致謝。

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THE CORRELATION BETWEEN THE ANATOMY OF JUTE FIBER CELL AND RETTED FIBER QUALITIES

by

C. L. Ling

It is expected that the basic investigation of the relation between the some anatomical characteristics of fiber cells and the qualities of jute retted fiber may offer the method of variety selection, cultivation. Thus, the better qualities of jute fiber may be obtained in Taiwan.

1. Bundle of fiber cells :

(1) The cell number of each fiber bundle of jute is the most numerous for the vareity FS-61-I-2098, which is 26.62±10.22, and that for the variety Tainung No. 1. is the least one, 22.50±8.25. The cell number of fiber bundle for the bigger stem is significantly more numerous than the slender stem.

(2) The cell number of each fiber bundle in first layer is more numerous than those in third, fifth layer; especially in the top and middle part of stem, the cell number of fiber bundle in first layer is 2-3 times that in third, fifth layer.

(3) The length and width of fiber bundle is the largest for variety TN-7-57, and the least for variety Tainung No. 1. In general, the length and width of fiber bundle of bigger stem is larger than of slender stem.

(4) The number of layer in fiber bundle group is more numerous for bigger stem than slender stem. The number of layer is larger for butt part, and the least of top part. The number of layer for the butt part of variety Tainung No. 1. which has big stem is 11-13. It is the most numerous.

2. Ultimate fiber cells :

(1) The diameter and wall thickness of ultimate fiber cells is the largest for the variety FS-61-I-2098, $17.63 \pm 2.68\mu$ for diameter, and $5.88 \pm 1.23\mu$ for wall thickness. The length of cell is the most long for variety TN-7-57, $2168 \pm 639.31\mu$. The variety FS-61-I-2098 has the least length of cell, $2196 \pm 549.33\mu$. The length breadth ratio for the latter, 126.60, is therefore the least one.

(2) The cell diameter and cell-wall thickness for big stem are greater than slender stem, moreover, the length of cell is shorter for the former. Hence the length-breadth ratio for big stem is also smaller.

(3) The cell diameter, cell-wall thickness, and cell length for middle part of stem is larger than those of butt part and top part. Especially, the cell length is the most conspicuous. Hence the length breadth ratio of fiber cells in middle part, 162.64, is the most large one.

3. The breaking load, flex, retted fiber length and luster of Tainung selection No. 1., TN-7-57, and Tainung No. 1. are insignificantly different from each other. Those for FS-61-I-2098 is relatively weak.

4. The correlation between the anatomy of fiber cells and retted fiber qualities :

(1) There is significantly negative correlation between width of fiber cells bundle and breaking load of retted jute, $r = -0.413$.

(2) There is significantly positive correlation between cell-wall thickness and flex strength of retted jute, $r = 0.587$.

(3) There is very significantly positive correlation between the length of fiber cell and breaking load of retted jute $r = 0.563$.

(4) There is significantly positive correlation between the length breadth ratio of fiber cells and breaking load of retted jute, $r = 0.416$.

圖 1. 黃麻植株部位與纖維細胞束層數之關係

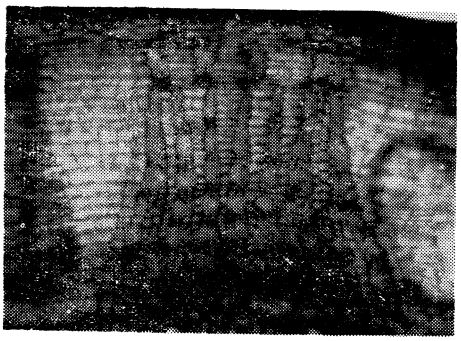
（臺農選 1 號細莖爲例）

Fig. 1. The relation between the number of layers in fiber bundle group and the part of jute stem

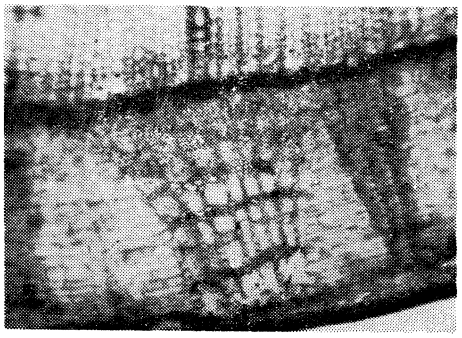
(Ex. : The slender stem of variety Tainung selection No. 1)

(X100)

（1）基　部 Butt part



（2）中　部 Middle part



（3）梢　部 Top part

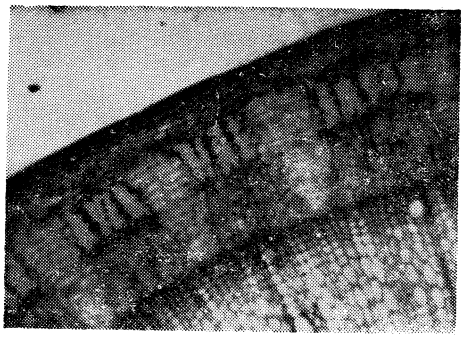


圖 2. 黃麻不同品種與纖維細胞束之關係

(各品種均以細莖中部爲例)

Fig. 2. The relation between the bundle of fiber cells and various jute varieties (strain)

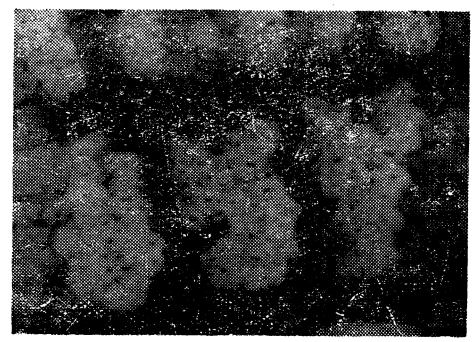
(Ex. : Middle part of the slender stem)

(X400)

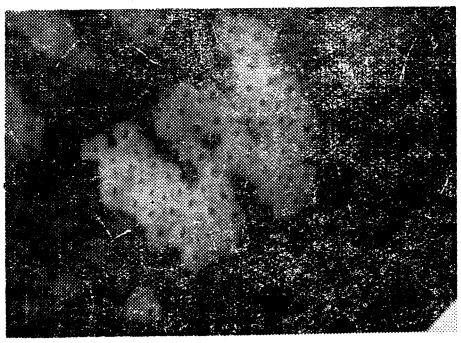
(1) 臺農選1號 Tainung selection No. 1



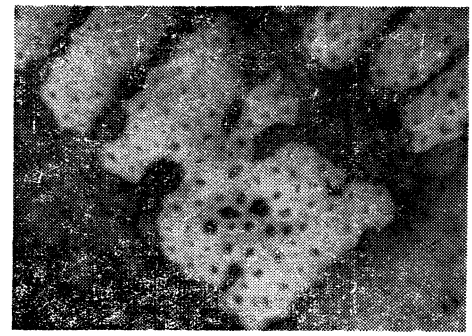
(2) TN-7-57



(3) 臺農1號 Tainung No. 1



(4) FS-61-I-2098



栽培密度與施肥量對大豆產量及農藝性狀之影響[1]

詹 國 連　曹 文 隆[2]

一、前　　言

本省大豆栽培，以高、屏地區之裡作爲主。裡作大豆的栽培，是在第二期稻作收穫後，不予整地，隨即播種。其所用行、株距完全與水稻相同。該地區水稻栽植密度，大別之有寬行密植及正條密植兩種。因之必須探知以此等密度栽培大豆時，在產量上及農藝性狀上之差異；同時，施肥量與作物之密度、產量及農藝性狀等直接有關，故宜合併研究之。

目前高、屏地區裡作大豆栽培之密度，以就水稻正條密植（7.5×7.5寸）相同之行、株距栽培者爲最多，其產量亦最高。李（1965）謂可增產6％～17％，惟洪（1965）報導以30×5公分（即8×5寸二株水稻之株距爲大豆之行距）種植大豆時，其產量最高。詹（1972）亦謂正條密植（7.5×7.5寸）之大豆產量最低。湯（1965）稱臺大高雄五號之行株距以20×10，十石以20×5或40×5公分之產量較佳。Lehman 及 Lambert（1960）報導 18～24 吋的行距，較36～40吋者，可增產15％。但 Hartwig（1957）則謂每呎栽種粒數（株距）爲6、9、16、18或21粒時，大豆產量上的差異不大，故關於大豆之栽培密度，尚無定論。

至於大豆之施肥量，林及李（1960）認爲本省之豆類，對肥料之反應很小，可能係稻田肥料之殘效足够豆類之需。林及溫（1962）認氮肥對大豆之效應不甚明顯，磷與鉀對大豆產量之影響亦未達顯著水準。馮（1964）稱苗栗之砂土區施用鉀肥60公斤，紅壤區90公斤（兩區之氮及磷均固定，同爲20及80公斤）時，可分別增產11％及14％。兪等（1962）報告大豆之增產，以磷、鉀配合使用較單用爲有效，每公頃磷、鉀各施用60公斤（要素）時，大豆之產量最高。

總上所述，本省大豆之行、株距及施肥量，均有再加研討之必要。本試驗之目的即在探討不同裡作大豆之栽培密度及施肥量，對於大豆之產量及農藝性狀之影響，供作裡作大豆栽培上之參考。

二、材料及方法

（一）供試品種　臺農三號

（二）試驗設計　採用逢機完全區集4×3（密度×施肥量）之複因子試驗設計，小區行長2.925～3.00公尺，寬2.7～2.8公尺，重複四次。各小區之產量，在統計分析時，均換算爲公頃產量。各處理之代號及說明如下：

1.栽培密度（d）

d_1 40.5×10公分（水稻寬行密植9寸×4.5寸三行水稻之株距爲大豆之行距），小區面積爲8.505m²（3m×2.835m），每小區種7行，共種210株（每公頃種247,000株），密度較小。

d_2 30×10公分（水稻寬行密植8寸×5寸二株水稻之株距爲大豆之行距），小區面積爲8.1m²（3m×2.7m），每小區種9行，共種270株（每公頃種333,330株），密度最大。

d_3 27×13.5 公分（水稻寬行密植9寸×4.5 寸之行、株距爲大豆之行、株距），小區面積爲8.02m²（2.97m×2.7m），每小區種10行，共種220株（每公頃種274,310株），密度較大。

d_4（ck）22.5×22.5公分（水稻正條密植7.5寸×7.5寸之行、株距爲大豆之行、株距），小區面積爲7.898m²（2.925m×2.7m），每小區種12行，共種156株（每公頃種197,510株），密度最小。

1.試驗報告農試字第五五八號。2.臺灣省農業試驗所技士、技術員。

2.施肥量　全量於第一次中耕培土時施下：

表 1.　大豆施肥量 (公斤／公頃)

Table 1.　The rate of fertilizer application (kg/ha)

肥料組合 (f) Combination of fertilizer	施肥量 (Rate) *			N:P_2O_5:K_2O
	N	P_2O_5	K_2O	
f_1 (低氮，高磷、鉀) (Lower—N, Higher—P_2O_5, K_2O)	20	80	60	1 : 4 : 3
f_2 (中氮，磷、鉀) (Medium—N, P_2O_5, K_2O)	40	120	80	1 : 3 : 2
f_3 (高氮、低磷、鉀) (Higher—N, Lower—P_2O_5, K_2O)	80	160	100	1 : 2 : 1.25

*氮、磷、鉀三種肥料分別、酸硷、過磷酸石灰及氯化鉀。

*N, P_2O_5 and K_2O are supplied by ammonium sulfate, calcium supperphosphate and potassium chloride, respectively.

（三）調查項目及方法　本試驗共調查六項目，各項調查方法如下：

1.株高　由地面至植株頂端之高度，以公分記之。

2.分枝數　係每株之分枝數目。

3.主莖節數　係持每株主莖上之節數。

4.莢果數目　爲每株之莢果總數（包括一、二、三粒莢及空莢）。

5.單株種子重　爲每株種子之乾重量，以公克記之。

6.百粒種子重　爲100粒乾燥種子之重量，以公克記之。

三　試驗結果與討論

本試驗於57年夏、58、59兩年春、夏作，共計進行五次（二次春作，三次夏作），試驗地點爲苗栗農工職校農場，試驗地爲砂壤土（PH 爲6.5～6.8），肥力中等，五期作之前作物均係水稻，茲誌試驗結果如下：

（一）不同處理之大豆產量　根據產量變方分析表（表1.）知，在三年五期作的試驗中，僅59年夏作之大豆產量受栽培密度之影響，有 5 %之顯著差異；其餘四期作，則概不受栽培密度之影響。此一結果與 Hartwig (1957) 氏所稱每呎栽種粒數（株距）爲 6 、 9 、16、18或 21 粒時，大豆產量所差不大。又 R.L. Smith (1959) 謂每英畝播種30～150磅種子時，大豆之產量是：播種量在30～120磅時，其產量無差異；而135～150磅時，則產量遞減之結論相符合。但與詹 (1972) 、湯 (1965) 等報導，大豆之產量受栽培密度之影響頗大；Lehman 及 Lambert (1960) 謂18～24 吋較36～40吋之行距，可增產15%；Probst (1945) 謂 2 ～ 3 吋之株距較 1 ～ 4 吋者，大豆之產量較高等結論不符。至於施肥量處理，在本試驗中則概未達顯著水準，此可能由於稻田施肥量高，其殊效已够大豆生長所需，加施肥料，並不能使大豆增產。

表2. 大豆產量變方分析表

Table 2. Analysis of variance for seed yield of soybeans

變因 (Source of variation)	自由度 (D. F.)	均方 (Mean square) 57年夏 2nd Crop 1968	58年春 1st Crop 1969	58年夏 2nd Crop 1969	59年春 1st Crop 1970	59年夏 2nd Crop 1970	F 值 (F value) 57年夏 2nd Crop 1968	58年春 1st Crop 1969	58年夏 2nd Crop 1969	59年春 1st Crop 1970	59年夏 2nd Crop 1970
區組 Block	3	13361972.3	120735.4	226808.3	21457.7	47000.7	23.03**	1.52	0.22	0.25	1.53
處理 Treatments	(11)	92772.7	82047.5	20482.8	112623.3	46367.9	1.57	1.04	0.02	1.29	1.50
栽培密度 (d) Spacing (d)	3	143888.9	159229.9	38313.9	217424.3	115535.4	2.43	2.01	0.04	2.49	3.75*
施肥量 (f) Amount of fertilizer (f)	2	63131.3	15939.6	3858.4	18085.0	49994.3	1.07	0.20	0.004	0.21	1.62
d×f	6	77095.1	65492.4	17072.2	7155155.5	10575.5	1.30	0.83	0.02	1.05	0.34
機差(Error)	33	59138.9	79105.1	1037590.4	7228.8	30792.4					

*顯著在5%平準。 *Significance at 5% level.

**顯著在1%平準。 **Significance at 1% level.

(二) 栽培密度與大豆產量之關係 四種栽培密度中，d_4（密度最小）在五期作試驗中，其產量均爲最低。d_4 密度在水稻栽培試驗中，爲正條密植之正方型式栽培，行、株距同爲7.5寸，其行距在本試驗中爲最窄者，而其他三種密度（d_1、d_2、d_3）之行距均較 d_4 寬，爲寬行密植，作長方型式栽培。此項行距寬窄之差別，在陽光利用之效能上頗有區別，前者（正條密植）不利於陽光的射入，特別是植株的中、下部，陽光被葉羣遮住，常受不到陽光；而後者（寬行密植）因行間較寬，陽光較易射入。光線是光合作用之能源，能源受到限制時，光合作用之量必然降低，因而低產。因之大豆之產量，顯受栽培形式之限制，長方形栽培時較正方形栽培者爲優。

就產量順序而言，不論春作或夏作，d_1（密度較小）及 d_3（密度較大）二密度之大豆產量，均較 d_2（密度最大）高，是以大豆之產量除受栽培型式之影響外，還並受栽培株數之限制，株數太多（如 d_2，每公頃種333,330株）或太少（如 d_4，每公頃種197,510株）時，均使大豆之產量降低，唯有在適當之栽培密度（如 d_1、d_3，分別爲每公頃247,000株及274,310株）時，可得理想產量。

表 3. 栽培密度與大豆產量之關係

Table 3. The effect of spacing on grain yield of soybeans

年份 Year	期作 Cropping	產量順序 Orders of grain yield				指數 % Index	備註 Remark
1968	2nd Crop	d_1	d_3	d_2	d_4	d_1/d_4	d_1=40.5×10cm
		3035.0	2926.7	2910.0	2768.3	101.09	=247,000 Plants/ha
1969	2nd Crop	d_3	d_1	d_2	d_4	d_3/d_4	d_2=30×10cm
		911.7	865.8	805.0	789.2	101.15	=333,330Plants/ha
1970	2nd Crop	d_1	d_2	d_3	d_4	d_1/d_4	d_3=27×13.5cm
		1777.1	1756.3	1658.8	1563.8	101.14	=274,310Plants/ha
							d_4=22.5×22.5 cm
							=197,510 Plants/ha
1968	1st Crop	d_1	d_3	d_2	d_4	d_1/d_4	
		2164.2	2035.0	2019.2	1882.5	101.14	
1969	1st Crop	d_3	d_1	d_2	d_4	d_3/d_4	
		2307.5	2257.5	2171.6	2000.8	101.15	

（三）施肥量與大豆產量之關係　本試驗中三種施肥量組合對大豆產量之影響，其差異均未達顯著水準，故大豆之產量對肥料全無反應。不同季節對不同肥料之需求稍異，夏作有需要高量氮肥、低量磷、鉀肥料（f_3）之趨勢；春作則有相反之趨勢，即春作需求中量至低量氮肥，中量至高量磷、鉀肥料（（f_1 及 f_2）（表4.）。

有關三要素肥料對大豆產量之反應小或不明顯，林及李（1960），林及溫（1962）諸氏均有報導。G.H.Abel, Jr. 謂在無根瘤菌之土壤中，於播種大豆時施用100磅（每英畝）氮肥之結果，使大豆的根瘤形成極爲不良，大豆產量僅有 6～16英斗；種子所含蛋白質亦降低爲27～34%；若播種時不施氮肥，則大豆之根瘤形成極爲良好，產量高達35～40英斗，蛋白質含量亦正常。Hardy（1959）的三要素肥料試驗，於大豆不同生長時期施用氮肥之處理中，大豆的產量却無差異。此等試驗足以說明大豆之根瘤生長良好時，則氮肥將無效果可言。

磷素在大豆種子中，其含量（40英斗種子中含磷素16磅）雖不如鉀素的高（40英斗大豆種子中含鉀素50磅），但磷素對大豆產量之反應，報導者衆；C.D. Welch 謂在土壤中有效性磷低於40磅（每英畝）時，加施磷肥即有效用。Nelson（1946）在北卡洛琳那沿海平原含有效性磷素低之土壤中，不加磷肥時大豆之產量爲6.4英斗，但若加施磷肥，則產量可高至33.8英斗。Bary（1961）更明確地畫出磷素與大豆產量關係之曲線圖，指出在其他元素適量，土壤中含有效性磷素每英畝爲10磅時，大豆之產量最高只可達到75%，但有效性磷素爲30磅時，則可達最高產量之98%。兪（1962）及 Miller 等（1961）報告，磷與鉀之比率，也許比單一之磷素用量更爲重要。在有效性磷低，有效性鉀極低之土壤中（PH爲6.6），產量最高者係出自磷、鉀二肥料同時均高之區，而產量最低者，却爲磷肥最高而缺鉀之區。Howell（1954）在營養液之試驗中，磷素由2PPM 增到 10PPM 時，有促進大豆生育之趨勢；但大豆品種間對磷素的需求標準有顯著差異。Chief 大豆品種，在磷素高至 12PPM 時，

生育極爲良好，但 Liconln 品種則出現明顯的磷素過量毒害。總之，磷素對大豆產量之反應，受土壤中有效性磷素、土壤反應（（PH 6.5—6.8 最適）、磷、鉀比率等諸因素之影響，合於諸因素則有效。

鉀素對大豆產量效應之報告頗多：馮（1964）謂於苗栗之砂土區施用鉀肥60公斤，紅壤區90公斤（兩區之氮及磷固定爲 20及80 公斤），可分別增產11%及14%。C.D. Welch 則謂在土壤中含鉀素低於75磅（每英畝）時，則宜施鉀肥。Rouse（1961）在阿拉巴馬州含磷素高，鉀素低的土壤中，施用50磅鉀素，大豆產量增加到50%。類似的情況，如 Nelson 等（1945）在含鉀非常低的土壤中，施鉀肥後增產四倍，同時使豆莢不裂開，增加莢果的充實度，並改良種子品質，因爲在此種極差的土壤中，施用120磅鉀素時，種子的油分增加 2 %，惟蛋白質則降低 5 %。Reid 及 York（1955）報告大豆種子在發芽時，對可溶性鹽類非常敏感，因之鉀素不應與種子施在一起。最好的施法是條施在離開種子 2 吋的一側，並在種子的下方 2 吋。Bray （1961）的鉀素曲線更明確指出：土壤中素有效性鉀素爲50磅時，大豆產量大概可達到最高產量的50%；而有效性鉀素在 200 磅時，則可達到最高產量的97%。故鉀肥之施用與土壤中鉀素之含量，施用之方法及磷、鉀之比率均有關係。肥料效應反應之複雜性，於茲可見。

表 4. 施肥量與大豆產量之關係

Table 4. The effect of rate of fertilizer application on grain yield of soybeans

年份 Year	期作 Cropping	產量順序 Order of grain yield			指數 % Index	備註 Remark
1968	2nd Crop	f_3	f_1	f_2	f_3/f_2	$f_1=N—P_2O_5—K_2O$
		2968.3	2922.5	2841.9	101.0	=20—80—60 kg/ha
						=1 : 4 : 2
1969	2nd Crop	f_3	f_2	f_1	f_3/f_1	$f_2=N—P_2O_5—K_2O$
		852.5	851.3	825.0	101.0	=40—120—80 kg/ha
1970	2nd Crop	f_2	f_3	f_1	f_2/f_1	=1 : 3 : 2
		1726.5	1715.9	1624.7	101.0	$f_3=N—P_2O_5—K_2O$
						=80—160—100 kg/ha
1969	1st Crop	f_1	f_2	f_3	f_1/f_3	=1 : 2 : 1.25
		2069.3	2011.8	2002.5	101.0	
1970	1st Crop	f_2	f_1	f_3	f_2/f_3	
		2214.8	2190.6	2148.1	101.0	

（四）不同處理對大豆主要農藝性狀影響之分析本試驗研究之六項性狀，大多受栽培密度之影響，其中分枝數及莢果數二性狀，在三期作中均受密度之影響，達於極顯著之差異水準；主莖節數之多寡與密度無關；種子百粒重及株高與密度之關係，在三期作中無一致之傾向。施肥量之於農藝性狀，與施肥量之於大豆產量之關係完全吻合，全無反應。

表 5. 大豆主要農藝性狀變方分析表（夏作）

Table 5. Analysis of variance of various agronomic characters of soybean plants(2nd crop)

變因 Source of variation	自由度 D.F.	年份 Year	均方 (mean sgure) 株高(1) Plant height	分枝數(2) No. of branches	主莖節數(3) No. of main stem nodes	莢果數(4) No. of Pods	單株種子重(5) Seed wt. Per plant	種子百粒重(6) Wt. per 100 seeds	F 值 (F—value) (1)	(2)	(3)	(4)	(5)	(6)	F顯著值 Significance 5%	level 1%
密度 (d)	3	1968	107.94	3.0	0.13	389.44	60.31	1.62	9.03**	0.18	0.37	15.9 **	17.04**	0.76	2.89	4.44
Spacing (d)		1969	16.56	1.508	1.733	158.73	10.64	0.83	1.11	5.69**	2.19	10.83**	7.55**	0.72	2.89	4.44
		1970	14.00	1.210	0.26	199.56	14.45	3.68	1.81	4.48**	0.23	11.76**	14.62**	1.47	2.89	4.44
肥料組合 (f)	2	1968	4.180	0.47	0.665	48.82	8.66	0.58	0.35	0.03	1.90	1.99	2.45	0.27	3.28	5.32
Combinations of fertilizer(f)		1969	3.49	0.069	0.942	12.63	0.03	2.39	0.24	0.26	1.20	0.86	0.02	2.08	3.28	5.32
		1970	1.65	0.38	0.10	8.27	4.53	1.02	0.21	1.41	0.09	0.49	4.58*	0.41	3.28	5.32
d×f	6	1968	24.81	0.14	0.52	23.89	3.215	2.53	2.08	0.008	1.50	0.98	0.91	1.18	2.39	3.41
		1969	18.71	0.722	0.605	30.84	2.39	2.13	1.24	2.72*	0.77	2.11	1.70	1.85	2.39	3.41
		1970	2.29	0.37	0.51	13.02	1.39	10.74	0.30	1.37	0.46	0.77	1.41	4.31**	2.39	3.41
機差 (Error)	33	1968	11.95	15.71	0.35	24.48	3.54	2.14								
		1969	14.84	0.265	0.789	14.65	1.41	1.15								
		1970	7.73	0.27	1.12	16.97	0.98	2.49								

* 顯著在5%平準，** 顯著在1%平準。

* Significance at 5%level, **Significance at 1% level.

（五）不同栽培密度與大豆主要農藝性狀之關係，由表6. 知六項性狀中，種子百粒重及主莖節數與栽培密度無關；莢果數，分枝數及單株種子重等三性狀，則極受其影響，三性狀所受密度影響之順序完全一致，即d_4（密度最小）給予之影響最大，d_1（密度較小）次之，d_3（密度較大）再次之，d_2（密度最大）最次。換言之，密度愈小，莢果數與分枝數愈多，單株種子愈重；密度愈大時則反是。因之疏植可使此三性狀之數目增加。至於株高則與密度成正比，密度愈大，株高愈高，此蓋植株呈徒長現象也。

表 6. 栽培密度與大豆主要農藝性狀之關係（夏作）

Table 6. The effect of spacing on agronomic characters of soybean plants(Summers crop)

項目 Item	年份 Year	順序 Order				項目 Item	年份 Year	順序 Order			
密度與株高 Spacing—Plant height	1968	d_2	d_3	d_1	d_4	密度與莢果數 Spacing—No. of pods	1968	d_4	d_1	d_3	d_2
		56.1	52.7	51.3	48.9			48.6	43.7	38.1	36.0
	1969	d_3	d_1	d_4	d_2		1969	d_4	d_3	d_1	d_2
		44.51	42.62	42.38	41.79			28.23	24.04	23.66	19.33
	1970	d_2	d_3	d_1	d_4		1970	d_4	d_1	d_3	d_2
		47.61	46.46	45.45	45.27			51.42	46.20	43.48	42.23
密度與分枝數 Spacing—No. of branches	1968	d_4	d_1	d_3	d_2	密度與單株種子數 Spacing—seed wt. per plant	1968	d_4	d_1	d_3	d_2
		3.82	3.53	3.04	2.69			17.34	15.62	13.25	12.43
	1969	d_4	d_1	d_3	d_2		1969	d_4	d_1	d_3	d_2
		3.73	3.28	3.26	2.87			6.70	5.63	5.61	4.40
	1970	d_3	d_1	d_4	d_2		1970	d_4	d_1	d_3	d_2
		3.41	3.37	2.90	2.80			17.45	17.35	14.97	14.50
密度與主莖節數 Spacing—No. of main stem nodes	1968	d_3	d_4	d_2	d_1	密度與種子百粒重 Spacing—wt. per 100 seeds	1968	d_4	d_1	d_2	d_3
		11.8	11.7	11.71	1.6			19.40	19.35	18.78	18.69
	1969	d_3	d_4	d_2	d_1		1969	d_4	d_3	d_1	d_2
		11.31	11.18	10.63	10.56			13.67	13.32	13.17	13.07
	1970	d_4	d_3	d_1	d_2		1970	d_3	d_2	d_4	d_1
		12.19	12.16	11.94	11.90			20.48	19.70	18.93	18.78

註（Remark）：d_1=40.5×10cm=247,000Plants/ha　d_3=27×13.5cm=274,310Plants/ha,
d_2=30×10cm=333,330Plants/ha　d_4=22.5×22.5cm=197,510Plants/ha.

（六）不同施肥量對大豆農藝性狀之關係　六項調查的農藝性狀中，除單株種子重在57年夏作時，受不同施肥量之影響有 5 %之差異顯著外，其餘的五項性狀，則全無反應，此與本試驗大豆產量概不受施肥量之影響，完全一致，再次說明大豆對肥料反應效果，在施肥量高之稻作輪作地區施行時，甚難見效。

表 7. 施肥量與大豆農藝性狀之關係（夏作）

Table 7. The effect of rate of fertilizer application on agronomic characters of soybean plants (2nd crop)

項目 Item	年份 Year	順序 Order			項目 Item	年份 Year	順序 Order		
肥料與株高 Fertilizer–Plant height	1968	f_2	f_1	f_3	肥料與莢果數 Fertilizer–No. of pods	1968	f_3	f_2	f_1
		52.7	52.3	51.7			43.26	41.77	39.78
	1969	f_3	f_1	f_2		1969	f_1	f_3	f_2
		43.27	42.87	42.34			24.44	24.21	22.80
	1970	f_2	f_3	f_1		1970	f_2	f_1	f_3
		46.48	46.29	45.85			46.51	45.91	45.08
肥料與分枝數 Fertilizer–No. of branches	1968	f_3	f_2	f_1	肥料與單株種子重 Fertilizer–seed wt. per plant	1968	f_3	f_2	f_1
		3.46	3.21	3.14			15.40	14.65	13.93
	1969	f_1	f_3	f_2		1969	f_2	f_3	f_1
		3.38	3.29	3.26			5.62	5.59	5.53
	1970	f_1	f_3	f_2		1970	f_2	f_3	f_1
		3.26	3.13	2.96			16.9	15.86	15.ｶ4
肥料與主莖節數 Fertilizer–No. of main stem nodes	1968	f_3	f_1	f_2	肥料與種子百粒重 Fertilizer–wt. per 100 seeds	1968	f_3	f_2	$_1f$
		11.9	11.7	11.5			19.27	19.00	18.90
	1969	f_3	f_1	f_2		1969	f_2	f_1	f_3
		11.14	10.96	10.66			13.77	13.16	13.01
	1970	f_2	f_3	f_1		1970	f_3	f_2	f_1
		12.09	12.09	11.96			19.76	199.59	19.08

註 (Remark) f_1 : $N—P_2O_5—K_2O = 20—80—60 = 1:4:3$

f_2 : $N—P_2O_5—K_2O = 40—120—80 = 1:3:2$

f_3 : $N—P_2O_5—K_2O = 80160—100 = 1:2:1.25$

四、摘　　要

（一）本試驗之目的，在探求大豆最適當之栽培密度與施肥量。試驗始於民國57年夏作，終於59年夏作，共計進行五次，試驗地點在苗栗農工職校農場，試地爲砂壤土（PH爲 6.5—6.8），肥力中等，其前作物皆爲水稻。

（二）產量變方分析結果，除59年夏作，不同密度處理間之大豆產量，達於 5 %差異顯著外，其餘四期作，不同密度間之大豆產量，概無差異。三種施肥量組合之大豆產量，五期作均不顯著（表 2

）。

（三）四種栽培密度個別比較時，d_4（密度最小，每公頃種197,510株）之大豆產量最低；其他三種密度之大豆產量較高，依次爲d_1（密度較小，每公頃種247,000株）次之，d_3（密度較大，每公頃種274,310株）再次之，d_2（密度最大，每公頃種 333,330株）之產量較低。因之密度對於大豆產量之影響，可得結論爲：①採用正條密植方式栽植而株數太少時（如d_4），大豆之產量最低。②採用寬行密植方式栽植而株數太多時（如d_2），其產量不會理想。③惟有採用寬行密植方式栽植而植株數目適當時（d_1、d_3），則其產量最佳（表３）。

（四）三種施肥量組合，對大豆產量之影響，雖不顯著，但期作間對肥料之需求似異，夏作有需要高量氮肥，低量磷、鉀肥料（f_3）之趨勢；春作則相反，需求中量至低量氮肥，中量至高量磷、鉀肥料（f_1、f_2）之趨勢（表４）。

（五）六種農藝性狀中，不受栽培密度影響者爲種子百粒重，主莖節數。極受栽培密度影響者爲莢果數，分枝數，單株種子重等三性狀；寔植時對此三性狀有利。株高則相反，愈密植時株高愈高，此蓋徒長故也（表５、表６）。

（六）六項農藝性狀與大豆產量相似，概不受施肥量之影響，（表４、表７）。

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註本文所引用之國外報告文獻全係載於 The Soybean 一書第四節及第八節者，不及一一列出。

Effects of Spacing and Rate of Fertiliztion on Yield and Agronomic Characters of Soybean[1]

Kuo—Lein Chan　　Wen-Long Tsai[2]

The objectives of this experiment are to investigate the effect of spacing and rate of fertilization on grain yield and agronomic charaters of soybeans. A 4×3 factorial experiment

design, with four spacings, i.e : d_1 (40.5×10cm, 247,000 phants/ha) , d_2 (30×10cm, 333,330 phants/ha) , d_3 (27×13.5cm, 247,310 phants/ha) , and d_4 (22.5×22.5cm, 197,510 phants/ha) , and with three rates of fertilization, i. e : f_1 (20—80—60 kg/ha) , f_2 (40—120—80 kg/ha) , and f_3 (80—160—100 kg/ha) , are used. Agronomic charaters studied were : grain yield per plot, plant height, no. of main stem nodes, no. of pods, seed weight per plant, and weight per 100 seeds. The experiment repeated five times was begun in Summer (2nd crop) 1968 at the experimental farm of Miao-Li Agriculture & Vocational School, and ended in Summer 1970. The field is of sandy—loam soil with medium fertility, and with rice plant was the previous crop. The results are summarized as follows :

1. Analysis of varince of grain yield showed that there was no significant difference among spacings for all crops studied expect the Summerly crop of 1970, in which it was significant at 5% level. The effect of different rate of fertilization on yield was also not significant for all crops (Table 2) .

2. When four different spacings were compard individually, treatment d_4 (the lowest plant density) had the lowest yield ; and the other three had higher yield with d_1(247,000 phants/ha) greater than d_3 (247,310 phants/ha) and d_2 (the largest plant density, 333,330 phants/ha) , respectively. Thus it is conciuded that 1) either low plant density (such as d_4) or very high plant density (suchas d_2) will result unsatisfactory low yield. 2) Wide—row—close planting with medium plant density, such as d_1 or d_3, will produce the highest yield (Table 3) .

3. The effect of three rates of fertilization varied with crop seasons. However, it seemed that higher nitrogen and lower phosphorous and potassium (f_3) is required for Summer (2nd crop) crop, and low to medium nitrogen with higher P and K for Spring (1st crop) crop. (Table 4)

4. Of six agronomic characters investigated, weight per 100 seeds and node number on the main stem were not affected by spacings ; number of pods, number of branches and seed yield per plant, were the most influenced characters by spacings. Spacious planting will invariably favour these characters, On the contrary, plant height will be taller with higher plant density because of the elongate growth of internode.(Table 5 and 6)

5. The effect of rates of fertilization on agronomic characters were not significant. (Table 4 and 7)

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Seed and Root Exudations in Relation to *Rhizoctonia* Damping-off of Various Crops[1]

Chin-chyu Tu[2]

Introduction

The relation between plant exudates and soil-borne diseases is a challenging problem in the field of plant pathology. Barton (1) and other workers (2,3,4,5,67,8,9,10,13,) indicated that exudates from roots or other plant parts are attractive to parasitic organisms, or inductive to a growth response of pathogens that aids the infection process. Schroth and Snyder (11) proved that amino acids and sugars of bean exudates favorably influenced germination and growth of chlamydospores of *Fusarium solani* f. *phaseoli* in soil. Schroth and Cook (14) reported that plant exudate was not specific to *Fusarium* spp. since spores of may other fungi germinated contiguously to seed germination of bean, and they evidently proved that incidence of pre—emergence damping—off of bean caused by *Rhizoctonia* sp. (isolates of the *Praticola* type) and *Pythium* spp. was greatly influenced by the amount of seed and young root exudation. Schroth and Hendrix (12) also found that chlamydospores of *F. solani* f. *phaseoli* germinated in the presence of exudates from many nonsusceptible plants as well as the host plant. On the other hand, the specificity of root exudates in stimulating plant pathogen was demonstrated by Kerr (8). He grew sterile seedlings in cellophane bags and buried in the soil inoculated with *Pellicularia filamentosa* (=*Rhizoctonia solani*). An intense development of the pathogen occurred on the cellophane opposite to the roots of the two susceptible hosts of lettus and radish, but such effect was not observed with tomato roots, which are not susceptible to the pathogen. Buxton (2) also reported a specific relationship between the germination of spores of *F. oxysporum* f. *pisi* and the exudates of three pea varieties differing in susceptibility to this pathogen. Although further understanding of the dynamic situation operating in the rhizosphere is needed, it is almost certain that root exudates of plants play an important role in the establishment and maintaince of the rhizosphere microorganism populations.

The experiments reported herein were made to determine whether the amount of seed exudations would vary among different susceptible host plants and whether the exudates would influence growth of *R. solani* mycelium and incidence of pre—and post—

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emergence damping- off. Consideration was also given to the sites of seed and young root exudations.

Materials and Methods

Nineteen crops varying in susceptibility to *Rhizoctonia solani* were used in this study. The isolate of *R. solani* was obtained in 1968 from kenaf seedlings. The fungus was maintained through serial transfers on potato—sucrose agar (PSA) . Each hyphal cell of the isolate was found to be multinucleate.

The susceptibility of different plants to *R. solani* was studied by planting seeds in autoclaved soil infested with mycelial suspension. The soil was contained in greenhouse flats. Four hundred seeds of each crop were planted in 20 rows (20 seeds/row) in a completely randomized design. The number of seeds germinated was recorded 10 days after planting.

The filter paper technique (11) was applied for chemical detection of substances exuded from seeds and seedlings. A piece of 7×10—in. Whatman No. 3MM filter paper was inserted between two pieces of same size of aluminum foil and autoclaved for 15 minutes at 250°C. Seeds of different crops were first treated in a solution of 10% Clorox (sodium hypochlorite) and 2% ethanol for 4 minutes, then placed on the filter paper 1½ in. apart the edge. The paper was moistened with sterile distilled water and placed in a sterilized 1×10×8—in. plastic container. Sterilized nonabsorbant cotton was used to press the foil snugly against the seeds and the young seedlings, to encourage roots to grow flush with the paper. The container was placed in a polythylene bag, kept in the dark, and canted at 60° angle to induce the roots to grow downward and against the paper. Materials exuded from plant parts were absorbed by the filter paper. After 5 days, the germinated seeds were removed and tested for contamination by placing them in Petri dishes containing PSA. The filter paper was dipped in ninhydrin color reagent to detect the exudation of amino acids, amides, and amines. Silver nitrate was used to detect the exudation of reducing sugars. Fifty replications were made for each crop.

Root exudates from the seedlings of various crops were collected to determine their effects on the mycelial growth of *R. solani*. Colorox-treated seeds were planted in sterile 500—ml flasks (5 per flask) containing purified sand that had been acid washed and ignited. After 10 days on the laboratory bench, seedlings were carefully removed and each flask was tested for contamination by placing segments of seedlings and a small amount of sand in Petri dishes containing PSA. The contents of 10 flasks were washed several times with sterile water. The washings were filtered to eliminate root retritus and evaporated to 10 ml. The eluate was then centrifuged in a Spinco refrigerated ultracentrifuge at 35,000 rpm for 30 minutes. This procedure gave a clear supernatant liquid virtually free of bacteria and fungi. Twenty ml of the concentrate were poured into a sterile 50 —ml flask and inoculated with 1 ml mycelial suspension of *R. solani*. After 5 days of incubation at 28°C, the colony was filtered for measurement of mycelial dry weight. Solid media were prepared by adding 2% of agar powder into the concentrate. Each Petri dish containing 20 ml of the medium was inoculated with a 3 mm—diam. of mycelial

disc. The colony diameters were measured after 2 days of incubation at 28°C.

For determining the effect of exudates on the hyphal growth of *R. solani* in soil after planting various crops, autoclaved sandy loam contained in plastic pots was either infested with 5 ml mycelial suspension per pot or remained uninfested to serve as control. After planting of seeds, 4 pieces of slides coated with water agar were inserted into a pot at different directions. All pots were kept in the laboratory where the temperature fluctuated around 28±2°C and provided with 10 hr. illumination. Five replicates were made for each crop and the test was repeated three times.

The water—agar—coated slides were carefully removed from pots 7 days after inoculation and passed through heat fixing, running water washing, and finally stained with Rose bengal—phenol solution. Percentage of hyphal appearance on each slide was counted by examining 350 microscopic fields under a low power (×100) microscope.

Results

Susceptibility of 19 different crops to *Rhizoctonia solani* :

Of the 19 different kinds of crop (Table 1) tested, no pre—emergence damping—off (including seed rot) was observed with cabbage, sorghum, corn, radish, broccoli, rice, and cotton. Comparatively severe incidence of the disease was found on peanut, carrot, soybean, mungbean, jute, and pea, and the percentages of diseased plants were 78.9%, 50.0%, 33.3%, 25.7%, and 22.0%, respectively. The other crops, including tomato, onion, broadbean, garlic, wheat, and kenaf, showed less than 13.0% infection.

Seedlings of peanut, garlic, broadbean, rice, and wheat were free from the attack of *R. solani*. However, seedlings of mungbean, soybean, and cotton were completely destroyed within 24 days following seed germination. The percentages of seedlings of the other crops killed by the fungus ranged from 2.5% to 75.0%. Detailed results are shown in Table 1.

Comparison of regions of exudation in seedlings of 19 different plants :

Development of the filter paper with ninhydrin showed that exudation was primarily from germinating seeds and/or root tips of primary, lateral and adventious roots depending upon the kinds of plants. The exudation of ninhydrin—reacting materials in the plants tested appeared to be particularly heavy from seeds (Fig. 3) . The source of the exudates was found to be in the vicinity of the apical meristem, region of the elongation, and region of developing root hairs of the seedlings of broadbean, radish, sorghum, corn, kenaf, soybean, tomato, broccoli, and especially mungbean. Amounts of ninhydrin—reacting materials varied from crop to crop. According to the reacted areas on the filter paper, the greatest amount of ninhydrin—reacting materials was exudated from seeds and seedlings of peanut and broadbean, while only trace amount of the exudates was obtained with rice, cabbage, mungbean, radish, carrot, and tomato (Fig. 1) .

Table 1. Percentages of pre—and post—emergence damping—off of various crops grown on the soil infested with *Rhizoctonia solani*@

Crop	No. of seeds planted	Corrected germination percentage (%)	Pre—emergence damping—off (%)	Post—emergence damping—off (%)
Cabbage	400	100.0	0	10.0
Sorghum	400	100.0	0	73.7
Pea	400	78.0	22.0	17.4
Jute	400	74.3	25.7	60.0
Mungbean	400	74.3	25.7	100.0
Corn	400	100.0	0	2.5
Radish	400	100.0	0	40.0
Onion	400	93.6	6.5	75.9
Carrot	400	50.0	50.0	14.3
Peanut	400	21.1	79.0	0
Garlic	400	95.0	5.0	0
Broadbean	400	94.1	5.9	0
Broccoil	400	100.0	0	14.3
Rice	400	100.0	0	0
Wheat	400	97.1	2.9	0
Tomato	400	87.5	12.5	14.3
Soybean	400	66.7	33.3	100.0
Kenaf	400	97.1	2.9	11.8
Cotton	400	100.0	0	100.0
LSD 5%			0.04	0.08
1%			0.07	0.14

@Including seed rot. Total percentage of damping-off seedlings in 24 days following germination.

A similar pattern of exudation was obtained by developing the filter paper with color reagents specific for sugars. Exudation of silver nitrate—reacting materials was also highly variable among crops (Fig. 1 and 4) . The major sites of exudation were from germinating seeds and young roots. However, sugar exudation of mungbean was different from the other crops, and was mainly from roots. It was obvious that broadbean, garlic, and wheat exudated greater amounts of sugars than the other crops. No sugar exudation was detected from rice, onion, and carrot.

Influence of root exudates on mycelial growth of *Rhizoctonia solani*

The mycelial density of *Rhizoctonia solani* in the soil changed considerably after planting of plants (Fig. 2) . The initial percentage of hyphal appearance of *R. solani* in the soil was 2.4%, then increased to 12.1%, 11.3%, and 8.0%, respectively, 10 days after

planting pea, mungbean, and soybean. Seedling of cotton, rice, sorghum, broadbean, peanut, tomato, and onion also increased the mycelial density to some extents. However, some crops such as garlic, jute, cabbage, radish, broccoli, corn, and especially wheat reduced the mycelial density of the organism in the soil.

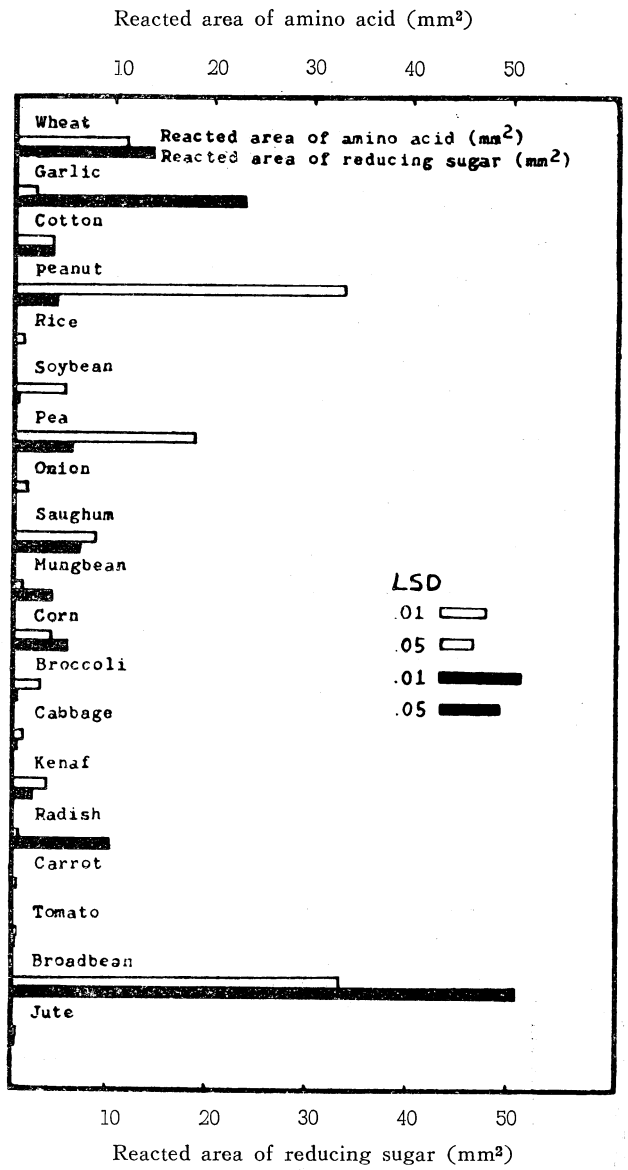
Table 2. Growth of *Rhizoctonia solani* on various root—exudates at 28°C.

Crop Root—exudate	Avg. colony diameter (mm) after 2 days of growth	Avg. mycelial dry weight (mg) after 5 days of growth
Cabbage	64.15	0.07
Pea	61.25	0.27
Jute	63.75	0.42
Corn	62.25	0.37
Radish	68.62	0.22
Onion	57.12	0.22
Carrot	60.25	0.12
Broccoli	58.83	0.42
Wheat	58.25	0.72
Tomato	64.00	0.12
Soybean	64.25	0.09
Kenaf	65.25	0.39
Cotton	68.00	0.37
CK	60.37@	0.37@@
LSD 5%	6.32	0.04
1%	8.47	0.06

@2% distilled water agar.
@@Distilled water.

Similar results were obtained from the cultivation of *R. solani* with root exudates of various crops (Table 2) . *R. solani* grew well on the medium containing radish and cotton root exudates. The colony diameter of *R. solani* on these two root—exudate media measured 68.62 and 68.00 mm, and that on water—agar medium only reached 60.37 mm. The radial growth of *R. solani* seemed to be inhibited on the media containing broccoli—, wheat—, or onion—root exudate. Although the radial growth of the organism on wheat—root exudate was poor, it was rather compact and the dry weight of the colony was higher than those on other root—exudate media.

Figure 1. Chemical detection of substances exudated from seeds and seedlings of various crops at 5 days after germination



Discussion

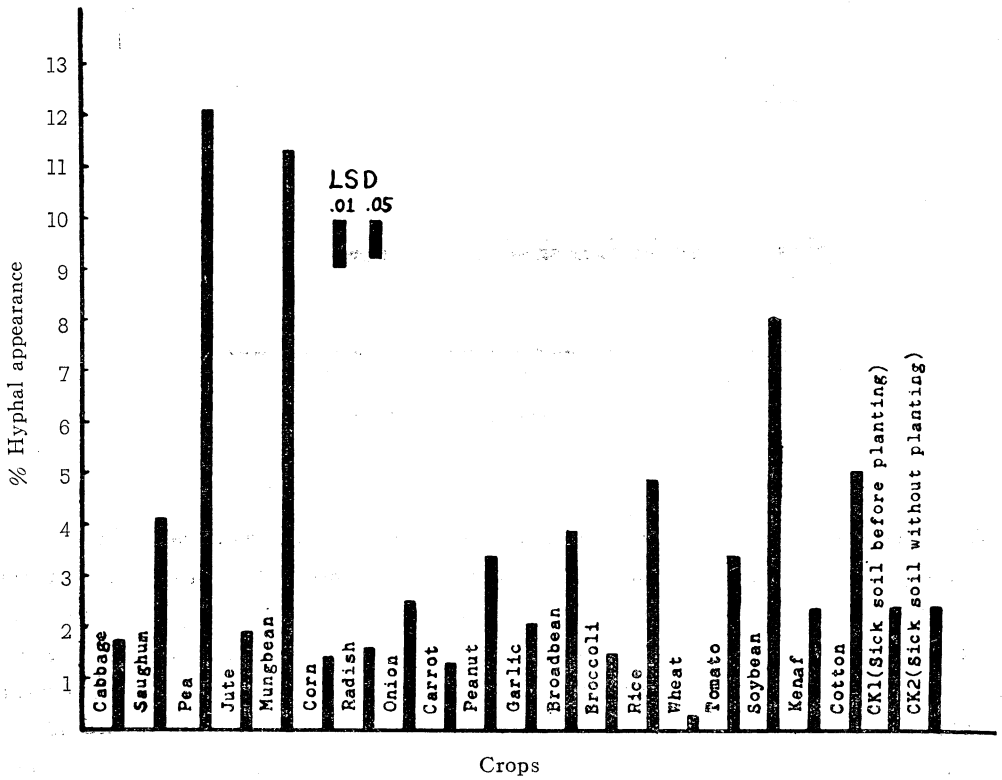
This study indicates that the susceptibility of plant to *Rhizoctonia solani* can be classified into four groups : a) both seeds and seedlings are susceptible, this group includes soybean, jute, mungbean,onion, carrot, tomato, pea, and kenaf ; b) seeds are susceptible, they are garlic, broadbean, and wheat ; c) seedling are susceptible, they are cabbage, sorghum, corn, radish, broccoli, and cotton ; and d) both seeds and seedlings are resistant, this group includes rice only. It was also found that the susceptibility of seeds of different crops was in the order of peanut, carrot, soybean, mungbean, jute, pea, tomato, onion,

broadbean, garlic, wheat, kenaf. The degree of seedling susceptibility to the disease was in the order of mungbean,soybean, cotton, onion, sorghum, jute, pea, tomato, carrot, broccoli, kenaf, cabbage.

Incidence of both pre—and post—emergence damping—off was affected by the hyphal density of *R. solani* in the soil (Table 1 and Figure 1) . There was a significant difference in increase of hyhphal density among the crops planted (Fig. 2) , and those plants stimulating hyphal density in the soil also induced hyphal growth *in vitro* with their root exudates. However, the disease incidence tended to become higher when the radial growth of colony was stimulated by the root exudates of the plants. Increase in mycelial weight appeared to have no important role on severity of the disease. The results reported herein agree with Kerr's observation (8) that radish is one of mycelial growth stimulators of *R. solani in vitro* (Table2) , but this is not always found to be true *in vivo* (Table 1 and Figure 2) . It is presumed that the ability of stimulation is influenced by soil structure, soil physical and chemical conditions, and soil microflora rather than plant root exudates alone.

Schroth and Cook (14) reported that the quantity of seed exudation was an important factor affecting the incidence of bean damping—off among varieties. In this study, however, the amount of root exudates seemed to be not so important as seed exudations.

Figure 2. Changes of hyphal density of *Rhizoctonia solani* in soil at 10 days after planting of various crops



Young roots of broadbean secreted a greater amount of both amino acids and reducing sugars among 18 different crops (Fig. 2) , but only 5.9% of the seeds were infected with the pre—emergence damping—off and no diseased seedlings were observed (Table 1) . This result indicates that the incidence of *R. solani*—damping—off is mainly affected by the nature of substances exuded. Therefore, further studies on the relationship between susceptibility of plants to *R. solani* and the nature of root exudates are necessitated.

Figure 3. Exudation patterns of ninhydrin-positive substance of various crops on filter papers

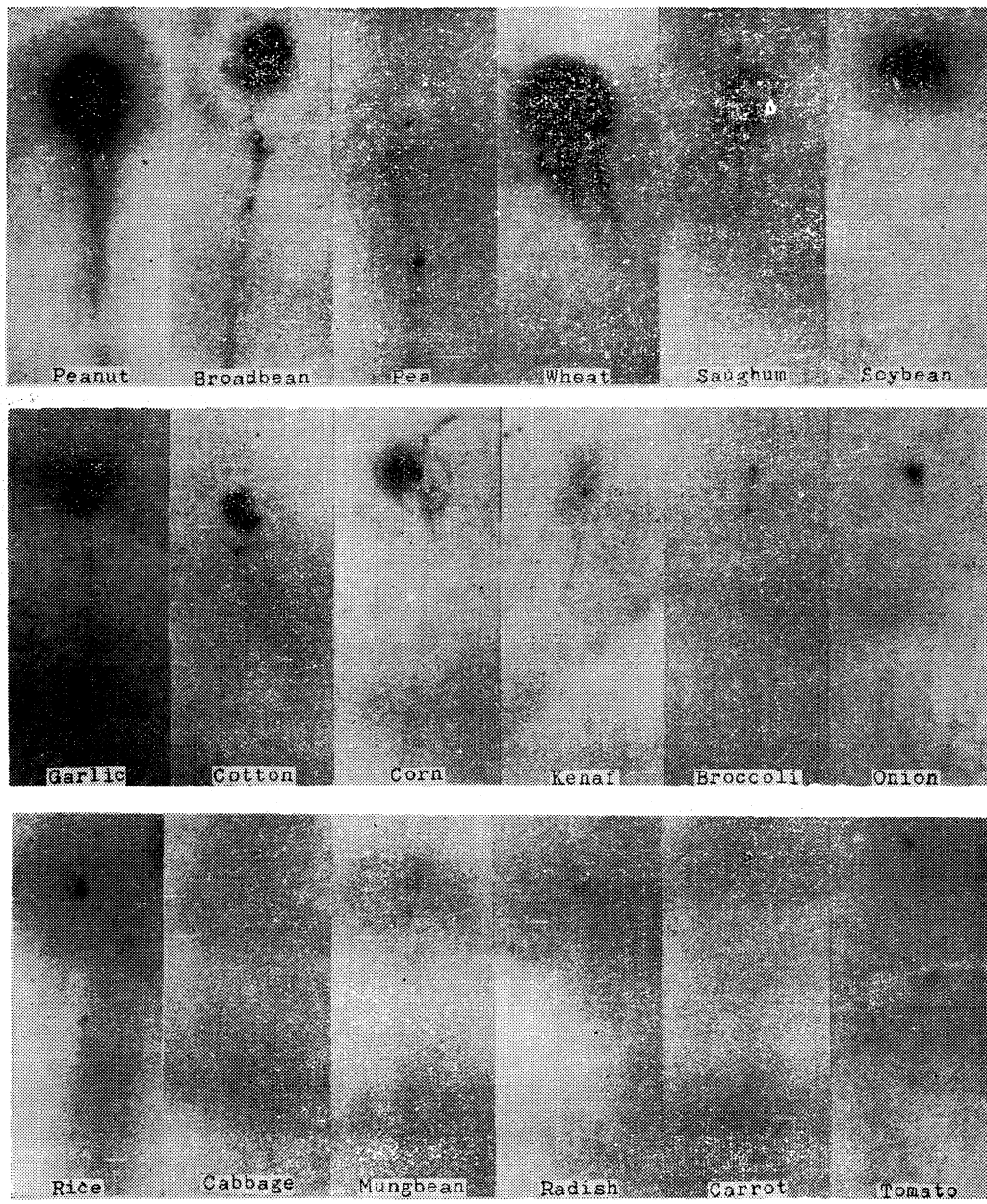
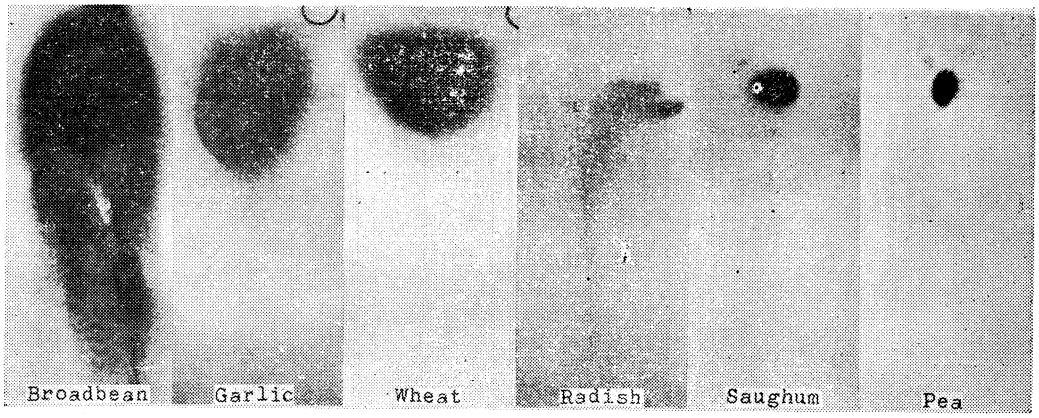
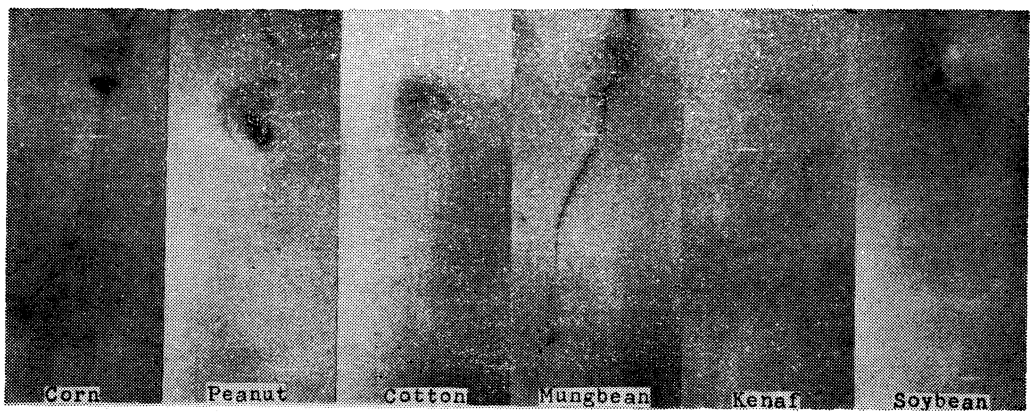
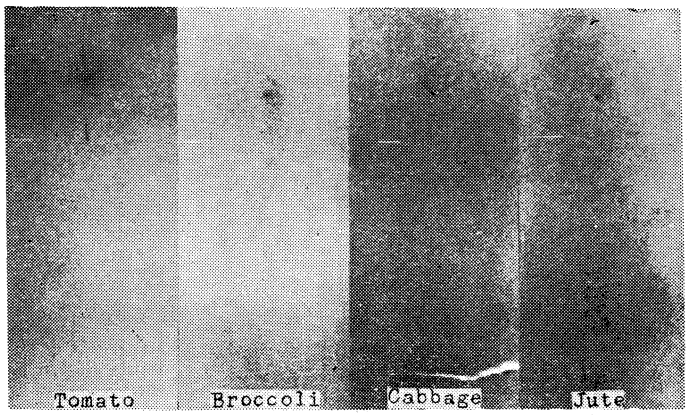


Figure 4. Exudation patterns of silver nitrate-positive substances of vrious crops on filter papers







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種子和根分泌物與某些作物發生 *Rhizoctonia* 腰折病之關係[1]

杜　金　池[2]

中文摘要

植物根或其他部位之分泌物已被確認可引誘寄生性生物之發生，促進植物病原菌之生長，並有助於侵染之完成。本研究以19種對 *Rhizoctonia solani* 不同感病程度之作物，以濾紙法測定其種子和根分泌物中含有氨基酸類及低醣類之多寡和分泌部位，比較各種作物種子和根分泌物培養病原菌後對菌絲生長之影響，並與栽植各種作物後土壤內菌絲密度之實際增減情形對照觀察，以資進一步瞭解種子和根分泌物對各種作物發生 *Rhizoctonia* 腰折病之關係。

供試19種作物對 *R. solani* 菌株 K-1之 感病情形可分成四類：① 種子和幼苗均可被侵染者有大豆、黃麻、綠豆、洋葱、胡蘿蔔、番茄、豌豆、和蘇麻；②僅種子可被侵染者有大蒜、蠶豆、和小麥；③僅幼苗可被侵染者有白菜、高粱、玉米、蘿蔔、花椰菜和棉花；④種子和幼苗均有抗性者僅水稻。

各種作物氨基酸類之分泌大都源自發芽種子，主根和支根根尖、根毛、或生育中鬚支根等，因作物不同，分泌部位亦異。依據濾紙法測量各種作物在濾紙上分泌氨基酸類面積大小結果，以花生及蠶豆分泌量最多，而水稻、白菜、綠豆、蘿蔔、胡蘿蔔、和番茄則僅微量。低醣類之分泌大都源自發芽種子和幼根，惟綠豆分泌部位集中在幼根。在供試作物中低醣類分泌量以蠶豆、大蒜和小麥等 3 種作物顯著地比其他作物爲多。

作物之萌前腰折病和萌後腰折病之發生與土壤內病原菌菌絲密度有密切關係。種植後可增進 *R. solani* 在土壤內菌絲密度之作物，在室內研究中證明其根分泌物確可刺激菌絲體之生長。根分泌物分兩種情形刺激菌絲體生長，促進菌絲平面生長速度或增進菌絲體乾重量。菌絲體乾重量之增加對罹病程度之加劇和土壤內菌絲密度之增大，並無直接而明顯之關連。

本研究之完成得國家長期科學發展委員會之補助。

1 試驗報告農試字第五五九號

2 臺灣省農業試驗所臺南棉麻試驗分所技正兼植物保護系主任

北蕉及中華矮蕉品種性狀比較試驗[1]

戴　邦　本[2]

一、緒　言

按本省60年來統計，每年5～11月爲颱風發生期，其中以7～9月發生率最高，佔全年之80%。就蕉作而論，夏秋蕉易遭受颱風爲害。矮蕉因植株較矮，具抗風力，受害較輕，但對抗風性及多種經濟性狀，以往黃啓章氏已有研究報導，特就其中尚未涉及部份，繼續作進一步探討。近數年來雖獎勵秋冬蕉外銷，但增產效果不大，矮蕉是否能取代北蕉供增產夏秋蕉之用，殊有再檢討價值。矮蕉品種在世界主要生產地區，包括在貿易上以矮蕉爲主者，有加那里羣島（Canary Island）、巴西、東非、夏威夷及飛枝島（Fiji Island）曾用爲外銷品種。在馬的尼奎（Martinigue）、幾內亞（Guinea）、喀麥隆（Cameroons）均佔有重要地位，或供外銷用。澳洲新南威爾斯（N. S. W.）已被 Giant Cavendish所取代。本試驗之目的，在比較北蕉及矮蕉在經濟栽培上性狀，及其在栽培上可能性，供夏秋蕉品種更新之參考。試驗於民國57年2月開始，因遭受水災而停頓。民國58年重新種植，再遭受風災，曾完成災害率調查部份。另於58年風災後利用球莖留芽以生產秋蕉爲目的，於59年12月底完成。

二、材料與方法

北蕉及矮蕉均屬於 Musa 屬，Eumusa亞屬，M. Acuminata 種，AAA 羣，Cavendish 亞群。本試驗供試北蕉及矮蕉，因來源均已不可考，極可能來自我國大陸。矮蕉具有多數同物異名及同名異物之無性繁殖系，香蕉無性繁殖系中，偶有發生體細胞突變（Somatic mutation），因其栽培分佈極廣，本省近年亦已引入新品系，尚未鑑別確定其親緣關係，爲避免混淆起見，本試驗供試品種之學名，係按照 Simmonds 推薦之定名法暫定，北蕉爲 Musa Acuminata Var. Pei—Chiao 及矮蕉爲 Musa Acuminata Var. Dwarf Chinese，試區均採用隨機區組設計，行株距爲2.4×2.1 m，小區面積50.4m²，2品種，每小區栽10株，重複5次，共計100株。試區吸芽高度標準，北蕉爲100cm，矮蕉爲50cm，生產秋蕉爲目標，田間栽培管理按現行推廣方法實施。

三、結果及討論

（一）品種生長比較

1.試驗報告農試字第五六〇號。

2.臺灣省農業試驗所鳳山熱帶園藝試驗分所技正。

表1. 香蕉品種生長比較

Table 1. Comparison of vegetative growth of two banana varieties

項目 Items / 品種 Varieties	假莖色 Colour of pseudo-stem	株高 Plant height (cm.)	假莖下部粗 Diameter of pseudo stem of lower part (cm.)	假莖中部粗 Diameter of pseudo-stem of middle part (cm.)	葉長 Length of leaf (cm.)	葉寬 Width of leaf (cm.)	種植收穫 Days from planting to harvest (Days)	植株寬度 Plant width 東—西 West—East (m.)	植株寬度 Plant width 南—北 North—South (m.)	萌芽數 No. of peepers (Plant /per)
北蕉 Pei—Chiao	深黑褐	212.92	17.23	12.77	213.66	72.79	358.40	3.52	3.55	10.06
矮蕉 Dwarf Chinese	深黑褐	137.54	16.45	13.22	154.83	69.67	371.11	2.90	2.93	12.58
差數 Differance	0	75.38	0.78	− 0.45	58.83	3.12	− 12.71	0.62	0.62	-2.52
指數 Index 北蕉 Pei—Chiao	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
指數 Index 矮蕉 Dwarf Chinese	100.00	64.59	95.47	103.52	72.47	95.71	103.55	82.93	82.54	125.05

按最後一次生育調查結果，矮蕉較北蕉矮35%，爲矮蕉抗風優越之主要原因。本試驗北、矮蕉採用苗高比爲2：1，故今後北、矮蕉種植與產期調節，可按100：65 種植及留芽高度加以應用。矮蕉假莖中部直徑粗超過北蕉3.25%，如就二品種株高與假莖粗比率加以比較，矮蕉中、下部粗度均有增加，此爲矮蕉抗風强另一原因。矮蕉生育所需日數較北蕉爲長，此點可能與矮蕉採用較小吸芽有關。株寬與種植行株距有關，二者株寬比約爲100：82，產量比爲100：85，因此如能按照株寬比將矮蕉密植，其單位面積產量上將不致較北蕉爲低。

(二) 果房性狀比較

表 2. 香蕉品種果房性狀比較

Table 2. Comparison of fruit bunches of two banana varieties

項目 Items / 品種 Varieties	果房長 Length of bunch (cm.)	果房距畦面距離 Distance from bunch to plot level (cm.)	苞葉痕至最上部果手距離 Distance from bract scar to first hand (cm.)	果軸基部至最上部果手距離 Distance from first hand to the base part of peduncle (cm.)	果手間距離 Distance among fruit hands (cm.)	果手排列整齊率 % of normal arrangement of fruit finger (%) 第一果手 First hand	果手排列整齊率 % of normal arrangement of fruit finger (%) 第二果手 Second hand
北蕉 Pei—Chiao	59.57	136.60	27.48	59.56	9.84	100.00	100.00
矮蕉 Dwarf Chinese	48.97	91.38	29.05	48.79	7.76	0	40.00
差數 Differance	10.60	45.22	− 1.57	10.77	2.08	100.00	60.00
指數 Index 北蕉 Pei—Chiao	100.00	100.00	100.00	100.00	100.00	100.00	100.00
指數 Index 矮蕉 Dwarf Chinese	82.21	66.95	105.71	81.53	77.16	0.00	40.00

矮蕉果房較短，果手密集，果房距地面較低，果房重心可減低33.05%，亦爲抗風原因之一。惟矮蕉在商品價值上最大缺點，即第1～2果手之果指排列不整齊，其原因一爲果梗基部至第一果手距離過短，果手無法着生於垂直果軸上，而係着生於果軸彎曲部份，致果指所受重力不均。另一原因係按照 Simmonds 氏報告，三倍體香蕉幼果期能自發產生 Auxin，正常者均分佈於果實避陽面第1～2果手，可能因上部葉片蔽蔭後，在幼果期受側射陽光照射影響，轉移 Auxin 正常分佈之部位，誘致果實向兩側彎曲，依據近期完成之冬夏蕉疏果試驗，可將矮蕉果房上部第1～2段不整形果手，在開花後或在果實發育初期疏除，代之以增加下部保留果手數，如此可以避免不整形果手發生，對產量並不致有顯著影響。

（三）果手重及果指數比較

表 3. 香蕉品種平均果手重比較

Table 3. Comparison of hand weight of two banana varieties

果手重 Wt. of fruit hands / 品種 Varieties	No. 1 First hand	No. 2 Second hand	No. 3 Third hand	No. 4 Fourth hand	No. 5 Fifth hand	No. 6 Sixth hand	共計 Total	平均 Average
北蕉 Pei—Chiao (kg)	2.95	2.40	2.02	1.80	1.72	1.54	12.43	2.07
*矮蕉 Dwarf Chinese (kg)	2.20	2.18	1.79	1.64	1.48	1.37	10.66	1.78
差數 Differance (kg)	0.75	0.22	0.23	0.16	0.26	0.17	1.77	—
指數 Index 北蕉 Pei-Chiao	100.00	100.00	100.00	100.00	100.00	100.00	—	—
指數 Index 矮蕉 Dwarf Chinese	74.52	90.67	88.71	85.89	85.89	88.64	—	—

表 4. 香蕉品種果指數比較

Table 4. Comparison of fruit fingers of two banana varieties

果指數 No. of fruit fingers / 品種 Varieties	No. 1 First hand	No. 2 Second hand	No. 3 Third hand	No. 4 Fourth hand	No. 5 Fifth hand	No. 6 Sixth hand	共計 Total	平均 Average
北蕉 Pei—Chiao	21.77	17.89	15.44	15.26	15.07	14.98	100.41	16.73
矮蕉 Dwarf Chinese	22.86	17.53	15.66	15.07	14.99	14.71	100.82	16.80
差數 Differance	− 1.09	0.36	− 0.22	0.19	0.08	0.27	− 0.41	—
指數 Index 北蕉 Pei-Chiao	100.00	100.00	100.00	100.00	100.00	100.00	100.00	—
指數 Index 矮蕉 Dwarf Chinese	105.01	97.99	101.43	92.20	99.47	98.20	100.04	—

本試驗中北蕉及矮蕉每株果房均留6果手。北蕉1～6果手重在 2.95～1.54kg 之間，均超過1.50kg 外銷標準，第1與第6果手之差爲 1.41kg。矮蕉果手重在2.20～1.37kg之間，其中 5～6果手在規定標準以下，第1與第6果手之差爲 0.83kg，矮蕉上下果重較爲接近，此點對商品價值上頗爲有利。因試區栽培環境不如產地理想，如在香蕉產區生產，預料均可超過檢驗標準。關於果指數兩品種間極爲接近，均在12指以上，可符合外銷標準。

（四）產量比較

表 5. 香蕉品種產量比較

Table 5. Comparison of the yield of two banana varieties

品種 Varieties	I	II	III	IV	V	共計 Total	平均 Average	指數 Index
北蕉 Pei—Chiao (kg)	13.04	12.09	11.87	11.65	13.52	62.17	12.43	100.00
矮蕉 Dwarf Chinese (kg)	11.36	10.31	10.31	10.93	10.55	53.28	10.66	85.16
差數 Differance (kg)	1.68	1.78	1.74	0.72	2.97	8.89	1.77	14.84

就以上北、矮蕉產量差異比較結果爲 $t=4.955>\binom{N=4}{P=0.01}=4.604$，可知北蕉與矮蕉間有極顯著差別，即北蕉產量較矮蕉爲高。矮蕉株高、株寬、葉長實測值均較北蕉爲小。因本試驗係採用2.4m×2.1m 相同行株距，但矮蕉行株距寬度較北蕉爲小，故如將矮蕉成比例密植，對增產頗具潛力。

（五）抗風效果比較

本試驗進行期間，於民國58年9月27日，遭衛歐拉颱風吹襲，最大風速爲 27.5m/sec.，測定風害情形如下表。

表 6. 香蕉品種颱風災害率比較

Table 6. Comparison of typhoon damage to Pei—Chiao and Dwarf Chinese

項目 Items / 品種 Varieties / 區集 Blocks	假莖折斷率 Breakage of pseudostem (%)		倒伏率 Uprooting (%)		未倒伏及未折斷率 No breakage and no uprooting (%)		葉柄折斷率 Breakage of petiole (%)	
	北蕉 Pei-Chiao	矮蕉 Dwarf Chinese	北蕉 Pei-Chiao	矮蕉 Dwarf Chinese	北蕉 Pei-Chiao	矮蕉 Dwarf Chinese	北蕉 Pei-Chino	矮蕉 Dwarf Chinese
I	62.50	0	25.00	22.22	12.50	77.78	83.33	17.50
II	44.45	0	22.22	0	33.33	100.00	100.00	15.00
III	55.56	0	11.11	40.00	33.33	60.00	75.00	26.67
IV	62.50	0	25.00	20.00	12.50	80.00	100.00	43.75
V	66.67	0	11.11	10.00	22.22	90.00	100.00	18.89
共計 Total	291.67	0	94.44	92.22	113.88	407.78	458.33	121.81
平均 Average	58.33	0	18.89	18.44	22.78	81.56	91.67	24.36
指數 Index	100	0	100	97.62	27.93	100	100	26.57

矮蕉在27.5m/sec.風速下無倒折現象，北蕉爲58.33%，倒伏率矮蕉爲18.44%，北蕉爲18.89%，二者極少差異，未折斷及未倒伏株中，矮蕉佔81.56%，北蕉僅佔22.78%。曾將未折斷及未倒伏株，就其折葉率加以調查，矮蕉爲24.36%，北蕉爲91.67%，矮蕉抗折葉率超過北蕉73.43%。在上述風速下，北蕉因損害嚴重必需廢耕，而矮蕉因損害較輕，經加强管理後尙可獲得部份生產。

（六）果手形態品質抗病及儲藏比較

本試驗有關果手形態、果肉率、水分、品質、炭疽病感染、貯藏期等之觀察，係以果指爲單位，觀察所得結果如下。

表 7. 香蕉品種果手形態、品質、炭疽病感染率及貯藏力比較

Table 7. Comparison of hand morphology, quality, susceptibility to anthracnose and storage life of two banana varieties

項目 Items / 品種 Varieties		果手寬 Width of hand (%)	果座寬 Width of crown (%)	果柄長 Length of pedicel (%)	果柄寬 Width of pedicel (%)	果指長 Length of finger (%)	果指寬 Width of finger (%)	果指厚 Thick-ness of finger (%)	果指重 Weight of finger (%)
指數 Index	北蕉 Pei—Chiao	100	100	100	100	100	100	100	100
	矮蕉 Dwarf Chinese	103.55	91.04	100.98	103.23	95.13	98.41	98.15	85.25

項目 Items / 品種 Varieties		果皮厚 Thickness of skin (%)	果肉率 Per. of pulp (%)	果肉水分含量 Water content of pulp (%)	果肉組織 Texture of pulp (%)	炭疽病感染率 Susceptibility to anthracnose (%)	貯藏日數 Storage life (%)
指數 Index	北蕉 Pei-chiao	100	100	100	細密黏性大	100	100
	矮蕉 Dwarf Chines	81.82	98.80	96.67	細軟黏性較小	138.03	82.08

上表每品種供試果手數爲6個，重複3次，分割爲單獨果指，用 S. P. F. No.2 處理切口以防腐。果柄寬及果肉利用率均甚接近。因北蕉及矮蕉果柄長度及果指寬度相同，但果座寬度矮蕉較北蕉小9%，由於果肩相互壓迫，致使果指呈扇形開張，爲形成矮蕉果手反較北蕉爲寬之主要原因，亦爲矮蕉果手特有形態與品種特徵。有關品質方面，矮蕉果指較輕，如以二者果重比較，矮蕉果皮並非較北蕉爲薄；果肉利用率亦近似，肉質稍細軟，黏性略低。於民國59年曾就11月上旬生產之秋蕉，就品質、貯藏期及炭疽病加以比較，採用8分熟度未經催熟果實，盛於供外銷用紙箱，置於常溫試驗室內。按照香蕉熟度標準色指數 (Standard Colour index number for banana ripening) 標準色分級進行，品質及貯藏調查爲採用 6 級，炭疽病感染率採用 7～8級。所得結果爲至黃熟期北蕉可貯藏21.2日，矮蕉爲17.4日，北蕉較矮蕉耐貯3.8日，可知品種間貯藏力不相同。至於是否因種間果皮氣孔數、澱粉醣化、果皮組織及厚度與硬度不同影響貯藏力，則有待進一步探討。關於炭疽病發生，在果實着色達7級熟度時即開始發病，待至8級時發病已較嚴重，病斑已擴大相接合，故本試驗調查期

採用7級，其發病率北蕉爲60%，矮蕉爲83%，矮蕉超過北蕉23%。關於果實成分黃啓章氏，曾就北、矮蕉水分、灰分、粗纖維、脂肪、蛋白質、醣等加以分析，果肉經20人品評其風味，並曾經參加檢驗試銷日本市場，以上各項中彼亦認爲極少差異。

四、摘　要

（一）矮蕉植株形態由於株高較矮，假莖基部莖粗並未減少，而中部莖粗反而增加，爲矮蕉抗風主要原因。矮蕉在27.5m/sec. 風速下，風災損害小於北蕉，矮蕉無折斷，北蕉爲58%，倒伏率則均爲18%，折葉率北蕉超過矮蕉73.43%。由於矮蕉有抗風效果，故適於供生產夏秋蕉用。

（二）矮蕉及北蕉以相同行株距種植，產量差異比較結果，北蕉產量高於矮蕉。矮蕉因株寬較小，如按北蕉及矮蕉株寬比，縮短矮蕉種植行株距，單位面積產量將可能提高。因試區栽培環境不如理想，如在蕉產區進行，預料其產量尙可大幅度提高。

（三）矮蕉果指排列不如北蕉整齊，原因有二：一爲第1～2果手多着生於果軸較高彎曲部位，每個果指所受重力不等；另一原因可能爲上部果手受不同方位陽光照射，使其幼果期 Auxin 分佈轉位，使矮蕉果指排列不整齊。

（四）北蕉及矮蕉品質比較：果指數均在12個以上。果手較北蕉爲寬，原因由於矮蕉果座較北蕉短9%，果肩相互壓迫而使果手增寬，爲矮蕉果手特有形態。北、矮蕉果實所含水分接近，矮蕉果肉黏度較小。利用未催熟青果貯藏結果，矮蕉貯藏期較北蕉少3.8日。炭疽病感染率矮蕉超過北蕉23%。矮蕉如用爲夏秋蕉增產時，在果品處理上需要加强。

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Comparison of Some Economic Characters of the Cavendish Bananas Pei－Chiao and Dwarf Chinese

by

B. B. Dai

Summary

In the summer and fall months, typhoon often causes serious loss in the production of Taiwan banana, Pei—Chiao, a member of the Cavendish group. In these months, Pei—

Chiao planted for fall harvesting is taller than the ones planted to be harvested in any other seasons. In order to minimize typhoon damage, Dwarf Chinese, a shorter Cavendish clone, may be considered as a substitution. The present study was designed to compare Dwarf Chinese with Pei—Chiao with respect to plant and bunch characters, yields, fruit quality, typhoon damage, storage life, and susceptibility to Anthracnose. The suckers of each clone were planted in a plot in a randomized block design with four replications to produce fruits for fall harvesting. Pei—Chiao was twice as tall as Dwarf Chinese when they were planted, and in both clones six hands were saved for each bunch. The trial was carried out in Fengshan from 1968 to 1970 with the following results :

1. At the time of shooting, the pseudostem height of Dwarf Chinese was about 65% the height of Pei—Chiao.

2. Dwarf Chinese withstood typhoon better than Pei—Chiao. When the velocity of the typhoon reached 27.5m/sec., no breakage of pseudostem was found in Dwarf Chinese while the percentage of pseudostem breakage was as high as 58% in Pei—Chiao. Breakage of petiole was also 73.43% much lower in Dwarf Chinese.

3. When the spacing was 2.4m×2.1m for both clones, the yield of Dwarf Chinese was significantly lower than the yield of Pei—Chiao. The yield of Dwarf Chinese may be improved if adjustment is made in proportion to its smaller plant size by using closer spacing.

4. The fingers of the first and second hands of Dwarf Chinese tended to be irregularly arranged.

5. In comparison with Pei—Chiao, the finger of Dwarf Chinese weighed less and its skin was thinner. Dwarf Chinese also had a shorter storage life and was more susceptibility to Anthracnose.

檬果果斑病之研究

Ⅰ. 病徵及病原菌[1]

廖 嘉 信[2]

一、前 言

臺灣檬果果斑病 (Mango fruit spot) 民國五十八年 (1969) 在臺南縣玉井鄉局部發生，初期僅見於 Irwin 及 Keitt 二主要栽培種。至翌年，南部地區普遍發生此病，且逐漸向中部地區蔓延。民國60年 9 月中旬，經二次颱風侵襲之後，各檬果產區罹病嚴重。筆者於是年開始依 Koch 氏法則，進行病組織分離病原及接種結果，證實其爲一種細菌性病害，與 Patel 氏等1948年在印度發見之 *Pseu-domonas mangiferae-indicae* (4) 近似，而非*Elsinoe mangiferae* 所引起之瘡痂病 (Mango Scab) (6)。病原爲單極單鞭毛之桿狀菌，不僅侵害果實，小枝及葉片、葉柄亦同受害，爲目前檬果之一嚴重病害。

二、病 徵

檬果果斑病病原細菌之侵入果實，受環境影響甚大。據筆者觀察，氣溫在 30°C 及相對濕度70%之情況下，持續數天即易發生本病。病原可由皮目 (lenticel) 侵入果皮，一週後在皮目呈三角形裂縫，並分泌透明膠液，逐漸擴展爲星形、黑褐色、中央突起、大小約 0.5cm 之病斑（（圖一），以光照面發生較嚴重。枝葉之病斑，主要在傷口邊緣產生墨綠色擴散狀斑塊，寬約 2—3mm ，上下表面均有發生，末期呈黑色稍隆起之病斑，邊緣明顯，中央偶有不規則裂痕（圖二），枝條上病斑伴有流膠，並無系統性病徵發見。

三、材料與方法

病原分離係就檬果產區採取之病果、病葉，以 Dowson 氏 (1949) 之劃線平板法分離病原。

病原接種試驗所用之接種原濃度爲 10^8cell/1ml.，菌齡48小時，以果實針刺接種、塗抹接種和葉部擦傷接種，計有七菌株產生與原來相同之病斑，其菌株來源如表一。

本試驗計劃承中國農村復興委員會補助，並承蒙國立中興大學植病系主任孫守恭教授暨徐世典博士之鼓勵與指導，謹誌謝忱。

1.試驗報告農試字第五六一號

2. 臺灣省農業試驗所嘉義農業試驗分所技士。

表一、七供試菌株來源

菌株代號	寄主	採集地	分離日期
FS25	Keitt 果實	臺南縣玉井	60. 6. 3
FS30	Keitt 果實	臺南縣玉井	60. 6. 3
FS32	Irwin 果實	臺南縣玉井	60. 6. 9
FS33	Irwin 果實	臺南縣玉井	60. 6. 9
LS 7	Irwin 葉片	臺中縣沙鹿	60.10.21
LS 8	Irwin 葉片	臺南市惠光	60.10.21
LS12	棠棣子 葉片	嘉義縣大林	60.10.27

病原形態及生理性質之初步試驗及檢定，其步驟及方法係參照 Thomas H. Lord 所著 Determinative Bacteriology; W. F. Harrigan等所著 Laboratory Methods in Microbiology; Breed, R. S. 等所著 Bergey's Manual of Determinative Bacteriology 及陳大武所編植物病理研究法，分別於下列各試驗結果中詳述之。

四、結果與討論

（一）病原菌之形態及染色性質：

Gram 染色反應，抗酸性染色，內生胞子染色，鞭毛排列觀察，莢膜觀察等之供試菌株爲在 Potato dextrose agar斜面，30°C 下，培養24—48小時之新鮮菌落，以 Hucker 氏變法，Ziehl-Neelsen氏法，Wirtz 氏法，Bailey 氏法及 Anthony 氏法進行染色觀察。菌體大小度量則以 Nutrient agar 斜面培養24小時之菌落，以 Benian 氏剛果紅陰染、再測量其大小。觀察結果，供試菌株爲 Gram 陰性，非抗酸性，無內生胞子，單極單鞭毛，無莢膜之桿狀菌，單胞或短鏈狀，具活動性，大小爲0.4—0.6×0.8—1.7μ.。

（二）病原之培養性質：

Potato dextrose agar平板，培養於 30°C，48小時之菌落爲圓形，白色或乳白色，全緣，表面平滑，中高，半透明，均質，具光澤，直徑約 2—3mm，生長良好。在 Nutrient broth 中，生長中等，混濁均勻，有微量粘稠性沉澱，表面具輪環，Potato slant 爲乳白色或淡褐色，有消化現象。

（三）病原菌之生理性質：

1.病原生長之溫度效應，Nutrient broth中，各試管加入一耳量供試菌株，分別在 5, 8, 12, 16, 20, 24, 28, 30, 32, 36, 40, 44°C 下培養48小時後，以 Spectrophotometer 測知其生長溫度範圍爲 8—36°C 最適溫度爲 28—30°C.。

2.氫離子效應，將 Nutrient broth 分別調整爲 pH 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0 接種後，培養在 30°C，經48小時，以Spectrophotometer 測定，其生長範圍爲 pH 4.0～10.0，最適之 pH 爲7.0。

3.碳水化合物之醱酵，以Ayers, Rupp及Johnson氏合成培養基爲基礎，分別添加L-Arabinose, Glucose, Saccharose, Lactose, Maltose, Starch, Inulin, L-Rhamnose, Trehalose, Dextrin, D-mannose, D-Galactose, D-Xylose, Raffinose, Grycerin, Salicin, D-Mannitol, Sorbitol, 及0.1%之 1.6% Bromcresol purple 酒精液爲指示劑，以 Arnold sterilizer 在 100°C 消毒20分鐘，連續三天。再以穿刺培養法接種供試菌，置於 30°C，觀察三週，結果如下：七個供試菌株在

Glucose, D-Xylose, Saccharose, Starch, Trehalose, Dextrin, D-Galactose, Raffinose Grycerin D-Mannitol 及 Sorbitol 均能產生酸，但不生氣體；在 L-Arabinose, Lactose, Maltose, Inulin, L-Rhamnose, D-Mannose, Salicin均不產生酸及氣體。

4.澱粉水解，以 Starch nutrient agar 平板，分別接種供試菌，並置於 30°C ，經48小時，以 Lugol's iodine Solution 注入平板上，菌落周圍呈現透明環，顯示有澱粉水解酵素之形成。

5.硝酸鹽之還原，以 Nitrate Broth 培養在 30°C 經 3 天後，以 α-naphthylamine-Sulfanilic acid 檢定，顯示FS33 培養液呈紅色反應，即有還原作用，其餘各供試菌則否，但加入微量鋅粉後，硝酸鹽亦被還原而呈紅色，此則示無硝酸鹽被還原。

6.吲哚之生成，以Peptone Water 培養供試菌，並在試管壁與棉栓間懸夾一長5cm×0.5cm寬之 Gnezda 草酸試紙，在 30°C 下，經48小時以上，觀察得草酸試紙無變色反應，即無吲哚之生成。

7.硫化氫之生成，將供試菌移植於 Nutrient broth 中，試管內懸垂長方形（5×0.5cm）醋酸鉛濾紙，在 30°C 下培養 3 天，觀察得濾紙呈黑褐色，顯示有硫化氫之產生。

8.酪素水解，將 Milk agar平板接種供試菌，置於 30°C ，經48小時 ， 菌落周圍呈現顯明的透明環，示知有酪素水解酵素產生。

9.石蕊還原，將 Litmus milk 接種後，置於 30°C ，經 2～14天，觀察培養基之變化 ，培養液由紫色變爲紅色，即爲還原作用。

10.氧氣之關係， 以Potato dextrose agar 作振盪培養後，置於 30°C ，經48小時，僅表面有菌落生長，可知本病原爲好氣性細菌。

11.觸酶之生成，將 PDA 培養之菌落置於含10% H_2O_2 之試管中，觀察得有連續氣泡發生，並持續 5 分鐘以上，即有觸酶之生成。

12.明膠液化，以 Plain gelatin做穿刺培養，在 20°C ， 經14天後， 培養基上層液化而呈噴火口狀。

13.致死溫度，將盛 Nutrient broth 之試管插於恆溫水漕內，調節水溫使管內外相等 ，再取一耳量菌培養試管中，經10分鐘立即取出冷却，於 30°C 培養48小時，觀察得其致死溫度爲攝氏55度。

就上述各試驗結果所示，檬果果斑病病原之形態及生理性質，與 Patel 氏等1948年在印度所發現之 *Pseudomonas Mangiferae-indicae* 近似，其主要的差異爲後者能在 Lactose 產生酸，在 Uschisky氏液微能生長，而果斑病病原則否。據 Dowson氏 (1949) 之分類法，*Pseudomonas*屬爲不能利用 Lactose 之菌類。其次是後者能感染 Cashew nut, 但筆者經數次接種病原於 Cashew nut 葉片上，均不能獲得病斑。惟據本病原所顯示之生理現象 ，則當屬 *Pseudomonas* sp., 必須更進一步研究，以確認其分類地位。

五、摘　要

檬果果斑病爲臺灣檬果之新病害，民國五十八年發見以來，爲害日趨嚴重，一般認爲抗病力甚强之菜檨子（本地種），枝葉亦嚴重受害。果實之病斑發生在皮目上，初期有流膠及三角形裂縫，漸擴展呈黑褐色之星形，同時病斑突起，細菌分泌物沿果皮流下。葉部病斑與1948年 Patel 氏等在印度發現者近似。本病亦在葉柄及幼枝發生。

病原經試驗結果證實爲一細菌性病害。病原體爲桿狀，大小約 0.4～0.6×0.8～1.7μ ，單胞或呈短鏈狀，Gram 陰性，非抗酸性，無內生胞子及莢膜，具活動性之單極單鞭毛，在馬鈴薯葡萄糖培養基平板上爲圓形，白色或乳白色，中高、全緣之菌落，生長良好。肉汁培養液中，生長中等，混濁均勻，有微量粘性沈澱，表面有輪環。在 Uschisky 氏及 Cohn 氏液均不生長 。 本病原菌之生長適溫爲攝氏28～30度，氫離子在 pH7.0 時生長最好。在 Glucose, Saccharose, Starch, Trehalose,

Dextrin, D-Galactose, D-Xylose, Raffinose, Grycerin, D-Mannitol 及 Sorbitol 培養基中產生酸，但不產生氣體，能水解澱粉和酪素。除 *Fs 33* 外，不能使硝酸鹽還原。能使白明膠液化，石蕊還原，不產生吲哚，產生硫化氫和觸酶之好氣性桿狀菌。據試驗結果證實，本病原之生理及形態與 Patel 氏等 (1948) 發現之 *Pseudomonas mangiterae-indicae* 近似，惟不能爲害 Cashew nut 。

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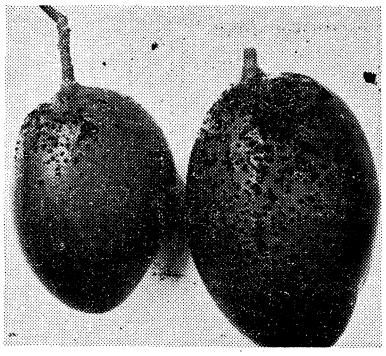


圖 1. 檬果果斑病果實上病徵 (Keitt品種)

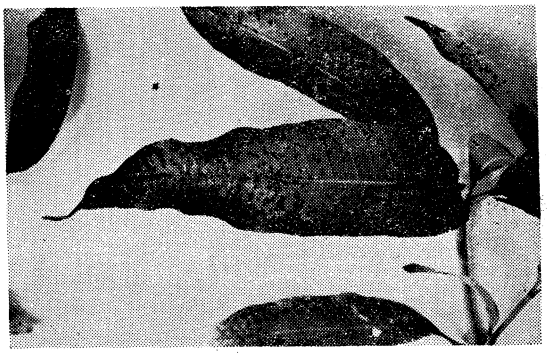


圖 2. 檬果果斑病葉片上病徵 (Irwin品種)

STUDIES ON MANGO FRUIT SPOT

I. Symptoms and Causal Organism

by

Chia-Hsin Liao

Summary

The fruit spot of Mango, a new disease in Taiwan was found at Yu-Ching in 1969, the same disease had reported by Patel in India in 1948. The disease is characterized by appearing crack with clearing exudate at lenticels on fruits about at the 10th day after infection, then turning to deep brown stellate spots with raised and heavy bacterial exudate flows downward. The lesions are 1-5mm in diameter, 2-3 mm in depth. The leaf lesions are angular, dark brown, water-soaked areas from 1-4 mm in diameter with clearing margin, rough and raised later. In severely affected ones, the most of fruits and leaves are falled down, sometimes the tender branch may infected.

The causal bacterium was isolated, it is a aerobic bacterium, rod-shaped 0.4-0.6×0.8-1.7μ in size, Single or short chain, not acid-fast, without endospore, motile by monotrichous flagellum. Potato-Dextrose Agar colony is circular, white to creamy white with entire margin, smooth, glistening, translucent. No growth in both Uschisky's solution and Cohn's.

The temperature range for growth of the bacterium is 8-36°C, the optimum temperature being 28-30°C. The pH range for growth is 4.0-10.0, the optimum being 7.0. Starch and casein are hydrolyzed, nitrates are not reduced except Fs 33, gelatin is liquefied, Litmus is reduced, no indole is produced, hydrogen sulfide is produced. Acid but no gas is produced from glucose, saccharose, starch, Trehalose, Dextrin, D-Galactose, D-Xylose, Raffinose, Grycerin, D-Mannitol and Sorbitol, no acid and gas are produced from L-Arabinose, Lactose,Maltose, Inulin, L-Rhamnose, D-Mannose and Salicin.

The causal bacterium affects *Mangifera indica* L. but does not infects *Anacardium occidentale* L. (Cashew nut) .

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