1978 ANNUAL REPORT

ON

MECHANIZATION OF CLOSE-GROWN TOBACCO

by

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TABLE OF CONTENTS

1978 ANNUAL REPORT -- MECHANIZATION OF CLOSE-GROWN TOBACCO

I. INTRODUCTION

This report describes the fifth year of research and development on Mechanization of Close-Grown Tobacco at N. C. State University. The project, initiated in January 1974 under support by Carreras Rothmans, Ltd., emphasizes research dealing with mechanization of transplant production and direct seeding, cultural operations, entire plant harvest and processing of close-grown (high plant population) tobaccos.

II. MECHANIZED TRANSPLANT PRODUCTION

A. Background. Since 1974, research has been conducted on the development of a mechanized system for producing tobacco transplants. Major goals are to improve efficiency of transplant production and to increase transplant quality and uniformity. In addition to developing or adopting mechanized operations of fumigation, bed-forming and seeding, covering, etc., field tests have been conducted to evaluate the effect of various parameters such as weed control method, seed size and pre-treatment, coating method, seeding density, mulch type and density, and seedbed cover on uniformity of seedling development. While improvements in transplant uniformity have been achieved in comparison with conventional methods, further research is needed to obtain plants sufficiently uniform to permit mechanized lifting. Uniformity improvements appear to be associated principally with mechanized bed forming and seeding operations, which establish a more uniform microenvironment for seed germination; however, further effects due to seed sizing, treatment, cover, management, etc. are also recognized. Non-uniformity appears, in fact, to be largely the result of gradual development of a non-uniform microenvironment beneath the covers, perhaps due to non-uniform water entry, irregular drying, variations in cover height, and other factors.

Field studies were continued in 1978 at the Lower Coastal Plains Tobacco Research Station on development of a mechanized system for producing transplants. Objectives were (1) to study the effect of type of cover, mulch type, and seed spacing on uniformity of seedling development and (2) to obtain further knowledge regarding microenvironmental factors which influence seed germination and early growth of seedlings.

B. Materials and Methods. The experimental plan consisted of a split-split-split-split plot design with complete randomization with each split. Factors included two covers (perforated plastic and solid plastic), three mulches (none, Turfiber, and Jacklin), two between-row spacings (2" and 3", and two within-row spacings (1.5" and 2.25"). Two replications were made for each of two seedings.

The field location and layout were the same as in 1977, with three main plots each having twelve beds of 200 ft. length. The bed layout system had the following characteristics:

Center-to-center tractor wheel spacing.................86"

Effective width fumigated..............................60"

Width of tilrovated bed................................56"

Width of formed bed prior to seeding...................48"

Width of seeded zone...................................36"

Irrigation lanes were located between the 2nd and 3rd, 7th and 8th, and 11th and 12th beds.

Land preparation, fertilization and fumigation were completed during the Fall of 1977. Following turning, discing and some shaping of the field, the beds were marked off and fertilizer applied to a 5' width at the rate of 2000 lb/acre of 12-6-6. After tilrovating to 3-5" depth, methyl bromide was injected into the soil at the rate of 378 lb/acre and the beds covered simultaneously with 2.0 mil solid plastic. These operations were completed between 11-22-77 and 11-28-77.

The beds remained covered until seeding during February and March of 1978. Three seeding trials were introduced (Feb. 16, Feb. 27 and March 16); however, only the latter two trials were evaluated due to a problem associated with fumigation and lack of weed control in the seeding trial of Feb. 16. Also adverse weather prevented completion of covering for this trial until Feb. 25.

Procedures for each seeding trial were as follows. After removal of the solid polyethylene cover (which was destroyed during removal), beds were tilrovated and seeded (G-28, Asgro coated) with the same equipment described in the 1976 report. Alternate seed bands provided either 3 or 4 rows to establish the 3" and 2" between-row spacings, respectively. Within-row spacings of 1.5" and 2.25" were obtained by changing the drive sprocket to the seeder. Hydromulch materials (Turfiber or Jacklin) were applied at a rate of between 1800-2000 lb/acre, then water was sprayed onto the bed surfaces with a portable water wagon with presure boom to obtain approximately 0.5-inch H_2O on the seeded bed. The beds were covered with 1.5 mil perforated polyethylene (3/8" holes on 3" centers) and solid polyethylene.

During the latter part of March, unusually high outside temperatures and clear weather occurred, and there was an obvious effect on plant growth due to high temperatures beneath the covers. Temperature measurements showed 105^{o}F under perforated plastic and 112-115^{o}F under solid plastic. Irrigation did not appear very effective since the droplets quickly ran off the covers. Covers were removed between April 7 and 12 and replaced by nylon covers which were held in place with wire spikes. Nylon covers were removed May 11.

Seedling samples were collected at the time most plants were of transplant size (5/22-5/25). For example collection, three sampling sites were located for each bed. At each site, two samples of plants were collected from the two central bands which represented two plant densities. The collection area was 8" long x 6" wide for each sample.

Collection and measurement of plants were as follows: plants were carefully cut at ground level, immediately placed into plastic bags, then stored temporarily in ice chests to minimize weight changes prior to taking measurements. Collected plants were taken to the laboratory and individual plant weight, stem length, stem diameter and extended length were measured, and the number of plants recorded for each sample.

C. Results and Discussion. The effects of the various factors on percent plant stand are shown in Table 1. On the average, plant stand appeared to be reduced slightly under solid plastic in comparison with perforated, possibly due to higher temperatures which developed under solid plastic. Turfiber showed higher plant stands than no mulch or Jacklin mulch. It was also observed that plants grew more slowly for the Jacklin mulch. Seed spacing, as expected, had no affect on plant stand. It is to be noted that the overall 47% is considerably lower than the 76% achieved during 1977. High temperatures experienced during April are considered to be the major reason for the reduced stand.

The effects of the various factors on transplant parameters are summarized in Table 2. Transplants were generally larger for perforated plastic, no mulch, and wider plant spacings. Because of an interaction of mulch x cover, further study of the data showed that under solid plastic, the no-mulch treatment gave larger values of plant parameters, followed by Jacklin, than Turfiber. However, under perforated plastic, plant parameters were larger for Turfiber, followed by no-mulch, then Jacklin. The situation is complicated by the fact that plants are generally larger for reduced populations. However, under perforated plastic, plant stand was highest for Turfiber and plant parameters were also highest.

Evaluation of the effect of various factors on the coefficients of variability for various transplant parameters showed generally (Table 3) that plants were more uniform when grown under perforated plastic. Also, plants appeared to be slightly less uniform for higher populations (closer within-row spacings) and for treatments which have higher plant stands, such as the Turfiber treatments. Comparison of the CV for 1978 data with that of 1977 showed that transplant uniformity was better for the 1977 season. Higher CV's for 1978 are likely associated with higher ambient temperatures and test of solid plastic (which gave increased variability).

Correlation coefficients between various transplant parameters are shown in Table 4. All parameters were significantly correlated; and, as in 1977, the highest correlation was between extended length and stem length. Some variation occurred between other correlations for the two years; however, the indications are still strong that two least correlated parameters such as extended length and stem diameter or stem length and stem diameter would be useful to express the size and style of transplants.

Observations made during the course of the experiment support previous observations relative to problems associated with perforated plastic covers and heavy rainfall. Excess rainfall caused sagging of covers and non-uniform water entry. It, further, appeared that as water receded beneath the cover, the cover was pulled into the channels by adhesive forces between the water and the plastic. This was evident by the cover sagging to the ground only at low lying areas of the beds. This problem demands further research to assure uniform clearance between the cover and germinating seed. Suggested approaches include supporting the cover by supplementary means, increasing the depth of the channels, and/or reducing the channel width. Other observations related to ponding (accumulation) of water between the channels for solid plastic covers. This problem was particularly evident for the first seeding following heavy rains. As above for perforated plastic, some means must be considered for assuring runoff from the beds.

Certain problems associated with various types of plantbed covers have been observed during the last four years, and these are summarized in Table 5. Solid plastic has the advantage of excellent moisture retention under the cover, but the high temperatures which can occur beneath the cover during sunny weather can severely damage the plants. Perforated plastic largely overcomes the high temperature problem; however, other problems arise associated with non-uniform water entry, progressive drying, and cover adhering to soil after heavy rain. Nylon covers provide for uniform water entry and avoid high temperature problems; however, the beds dry rapidly during fair weather and irrigation is essential, beds can become very wet during rainy weather, leaching of fertilizer may occur, and plant growth is generally slower under nylon than under perforated plastic.

A sub-study was conducted to examine the performance of G-28 seed coated by the Royal Sluis Co. of Holland, in comparison with Asgro coated seed. While plant stand was slightly higher for the Royal Sluis seed, plant parameters were smaller and coefficients of variability were generally higher. These results, however, are consistent with normal responses due to increased plant population.

Another sub-study was conducted to obtain preliminary information on comparative performance of plants established by mechanical seeding of coated seed vs. hydroseeding. Four seeding treatments in the test were (1) hydroseeding, chitted seed, (2) hydroseeding, normal seed, (3) mechanical seeding of coated seed, firmed after seeding and (4) mechanical seeding of coated seed, unfirmed. Two replications were made for each of 3 covers, perforated plastic, solid plastic and polycoat (nylon with bonded polyethylene). Hydroseeding was performed by mixing the seed with hydromulch which was applied at about 2000 lb/acre. Plants appeared to have been uniformly seeded with hydroseeding, and plant stand was calculated to be at least 10% higher than for mechanical seeding. This could be non-significant since plant stand for hydroseeding was based on estimated number of seed/area which involves several measurements such as number of seed/wt., mulch application rate, tractor speed, etc. Plant stand was higher under perforated plastic than under the other covers. No apparent differences in uniformity of seedlings were noted among the seeding treatments, except that results were somewhat erratic for unfirmed coated seed for the various covers. Interestingly, the hydroseeding treatments showed more rapid growth under perforated plastic than the coated seed, but the reverse under solid plastic. High temperatures could have seriously affected early growth under solid plastic. Because of the promising results with hydroseeding this approach should be investigated further in future studies.

III. EFFECTS OF TRANSPLANT VARIABILITY

A. Background. Studies were initiated in 1976 to examine the effect of transplant variability on yield. Three lots of sized plants and two lots of variable plants were grown under replicated trials. The results showed that variability of final stem height and final yield were not affected by initial transplant variability, measured in terms of extended length of transplant. The studies were expanded in 1977 to include selection on the basis of two plant parameters, extended length and stem diameter. Nine lots, representing three ranges of extended length and three ranges of stem diameter and one lot representing a mixture of plant sizes, were selected for study. In general, the longer transplants were more uniform in height at all subsequent stages of growth and remained taller until flowering. No definite trend was observed between initial length of plant and final yield; however, within the same length group, plants with larger stem diameter gave higher yields (stockier plants). Because of inconclusive results, perhaps associated with weather conditions, methods of tagging transplants, etc., the study was continued during 1978.

B. Materials and Methods. Ten groups of seedlings of different sizes were selected according to the same plan used in 1977, except for slight changes in the range of plant parameters. Seedlings in groups 1 to 9 were selected on the basis of extended length and stem diameter, each group having a relatively narrow range of each parameter. Group 10 was obtained by mixing an equal number of plants from each of the nine selected groups. Ranges for the two parameters for each group are shown in Table 6.

The ten groups of plants were transplanted in a randomized block layout with 22 plants per group (row). The main block was replicated three times. All groups were transplanted on 48-in. rows with a conventional 2-row transplanter. Transplanting and all cultural practices (fertilization, cultivation, topping, etc.) were the same for all size groups. Plants were hand topped and sucker control chemicals used, according to recommended practices. Tobacco was harvested at approximately 3-week intervals to obtain the bottom one-half and top one-half of the leaves. Tobacco leaves from each plant were tagged and cured conventionally on sticks. Cured leaf weights and government grades were established for each plant following curing.

C. Results and Discussion. Table 6 shows the initial plant sizes and average values of cured weight/plant, price index, and price coefficients of variability. The data shows that plant size had essentially no effect on yield and price. Yield varied over a small range of 173 to 189 g/plant with no consistent trends observed as in 1977. Indications are that plant size does not affect yield, except under adverse weather such as experienced following transplanting during 1977. In those cases, the larger plants appear to survive better and produce higher yields. Also, the price index showed only a small range from $2.30 to $2.45/kg for bottom leaves and $2.85 to $2.95 for top leaves with no apparent trends. Note that group 10, which included all sizes of plants, gave yields, price indexes and CV's which appear completely in line with the other groups. As expected, bottom leaves received a lower price index and showed more price and grade variability than the top leaves.

IV. DIRECT FIELD SEEDING STUDIES.

A. Background. As a follow-up to the observations during 1977 that late season direct seeding with early growth under nylon appeared promising, studies were continued during 1978. A major objective was to direct field seed Oriental tobacco to a range of plant populations and to observe the overall effects, including management and curing, on the final characteristics of the cured product. Implicit to the work were the assumptions that (1) the crop must be direct seeded to achieve the normally high plant population and (2) the crop must be harvested with a once-over operation. It is contemplated that the cured product might be utilized as a blend component of reconstituted sheet (using perhaps leaf and stalk) or leaf might be used in the traditional manner.

B. Materials and Methods. Procedures for land preparation and seeding were similar to those described for the mechanized transplant production studies. Land preparation, fertilization and fumigation were completed in March, 1978. Fertilizer (8-8-24) was applied at 600 lb/acre to 40 beds of 86 ft. length, then the beds were fumigated with methyl bromide injected at 400 lb/acre and covered with 2.0 mil solid plastic.

Two seedings of 16 beds each were made on March 31 and May 3, 1978. The Oriental tobacco (Smyrna) seed, coated by Asgro Seed Co., were direct seeded into 4 rows/bed at 12" between-row spacing. Beds were covered with nylon and irrigation applied twice daily for about two weeks until germination was complete. Within-row spacings were estimated at 1.5", 2.25", 3.0", and 6.0" to provide effective plant populations of 348,000, 232,000, 174,000, and 87,000 plants/acre. Since the beds occupied 4/7th of the total area, actual populations were about 60% of these values. The experimental plan consisted of two replications of 8 beds/rep with four populations of two beds each.

Tobacco was hand topped to 44-48 inches height and sprayed with 4% Royaltac. Since the contact chemical did not control suckers completely, remaining suckers were removed by hand prior to harvest.

At harvest, tobacco plants were cut with machetes and packed into bulk racks in a whole-plant form. Two harvests were made for seeding 1 (July 20 and August 9); however, only one harvest was made for seeding 2 (August 17) due to rapid leaf senescence and disease. Only enough tobacco was harvested from a given treatment to fill one rack. Tobacco was bulk cured following a typical flue-curing schedule with stem drying temperatures reaching 170°F.

C. Results and Discussion. Evaluations of leaf chemistry, smoke analyses, and physical properties are currently being made by a cooperating tobacco company.

Observations made during the course of the experiment indicate that excellent stands can be achieved by direct seeding with appropriate consideration given to cover and water availability during germination. The cover may, in fact, not be essential if irrigation can be applied without severe impact damage. Furthermore, it was evident that time from seeding until topping is considerably shorter with direct seeding than transplanting. Plants which were seeded around the first of April were larger by mid-June than most of the Station's transplanted tobacco, which was seeded during February. Elimination of transplant shock by direct seeding could reduce overall time required from transplant size to harvest by about two weeks.

Weed control was very satisfactory for the seeded beds, with only minor weeding involved. Spaces between beds however required cultivation. Future work should include weed control (Enide, Paarlan, etc.) for these areas.

When the plants were about 12-15" tall, a wind and hail storm caused significant leaf damage and lodging of plants. In fact, the tops of many plants were broken by the hail. These plants produced a rattoon crop with two or three shoots per plant. Because of the slender plant style of Oriental tobacco, there may be an advantage to using a 2-row layout, with cultivation and movement of soil around the plants to provide additional support.

A further problem of weather fleck and black shank was noted which likely reduced yield and quality. The weather fleck incidence may have been aggravated by too frequent irrigation when the plants were small. Varieties of Oriental should be tested which have greater disease resistance than Smyrna.

An attempt was made to harvest the tobacco when the upper leaves had reached maturity and had developed some "body". This necessitated sacrificing some leaves at the bottom of the plant. The suggestion is made that lower topping might be beneficial in reducing leaf loss and further increasing body and aroma. Earlier topping (perhaps chemically) would provide improved sucker control for the Oriental, which tends to sucker profusely even before the apical flower bud is removed.

Overall, the cured leaf quality appeared fair to good; however, it is recognized that various production and curing conditions will need to be optimized to obtain the best cured leaf quality, compatible with whole plant harvest and bulk curing procedures.

V. STUDY OF SYSTEM LAYOUT AND CERTAIN FIELD VARIABLES ON PRODUCTION OF CLOSE-GROWN TOBACCO.

A. Background. During 1977, a study was initiated to examine the effect of various bed layouts, in combination with a range of topping heights and plant spacing, on yield, lower leaf loss, and leaf quality. This work is of particular importance to the selection of the most suitable layout for future work, since methods and equipment for transplanting, cultivating, topping, and harvest must be developed for the specific layout. In order to fully evaluate the above factors, a 3-year study was planned.

B. Materials and Methods. A field experiment described in detail in the 1977 report was continued for the second year to study four bed layouts, two within-row spacings (9" and 18") and four topping heights (18", 24", 30" and 36"). The four layouts were as follows:

1. 4-row on bed: raised bed four to six inches high, 86" bed spacing, 4 rows at 16" between rows.
2. 3 -row on bed: same as 1 but 3 rows at 24" between rows.
3. 3-row flat: same as 2 but planted flat.
4. 2-row flat: center-to-center spacing of 48" between 2-row pairs, 12" between rows.

Plant populations for the different treatments were as follows:

Layout	Spacing	Actual Plants/Acre
4-row	9-inch	32,400
	18-inch	16,200
3-row	9-inch	21,708
	18-inch	10,854
2-row	9-inch	29,040
	18-inch	14,520

Field plots of each treatment combination were approximately 30 ft. in length to provide from 60-160 plants/plot. Four replications were made to provide 128 field plots.

Cultural practices were established following the plan of 1977. Following land preparation, pre-plant chemicals (Mocap, Di-Syston, and a pre-emergence herbicide) and fertilizer (800 lb/acre, 8-8-24) were incorporated. Beds were transplanted June 1 and 2, 1978.

Two cultivations were made at approximately two and four weeks after transplanting with total N of 150 lb/acre established by topdressing during the first cultivation. Orthene was used for insect control.

Plots were hand topped and Off-Shoot T and Royal MH used for sucker control.

Harvest of plots was made when tobacco maturity and ripeness were adjudged most suitable for the entire plant. Tobacco was bulk cured in a whole plant form in racks under typical flue-curing management.

C. Results and Discussion. Evaluations to be made include yield and quality; % yield of stalk, lamina and midrib for bottom, middle, and top stalk positions; chemical analyses and tar and PMI determinations. Table 8 shows the effect of various layouts on yield/acre. As in the previous study, yield increased with increased topping height from 18" to 36", with up to 1000 lb/acre increase. Closer spacing (9-inch) gave up to 400 lb/acre increase over the wider spacing. Yield differences due to planting layouts were less than those for 1977. Increasing yields were obtained for 3-row on bed (3640), 3-row flat (3726), 2-row (3783) and 4-row (4062) layouts, respectively. Due to adverse weather conditions during June of 1978, yield values were reduced from about 1000 to 2000 lb/acre in comparison with the 1977 study. This study will continue during 1979.

VII. RESEARCH PLANNED FOR 1979.

A. Mechanized Transplant Production and Direct Field Seeding. This work will be continued with the objectives (1) to conduct more extensive tests on hydroseeding with emphasis on uniformity of seed distribution, (2) to study the effects of various seed treatments on synchrony of seed germination and subsequent transplant uniformity, (3) to determine the effect of Turfiber mulch in comparison with no mulch on hydroseeding operation and plant growth under perforated plastic, nylon and polycoat covers, and (4) to study the effect of various bed surfacing techniques prior to seeding and raised vs. unraised covers on plant growth and uniformity. The above research will be conducted at the Lower Coastal Plain Tobacco Research Station on the same field site as used previously. Sampling of experimental plots will be performed when plants reach transplant size, and two parameters, extended length and stem diameter, measured and compared for the various treatments.

Studies to determine the effect of transplant variability on growth, yield and quality will be continued along the same lines as in 1978. This work requires several years of testing to demonstrate the effects due to transplant size, because of apparent performance differences arising from year to year due to weather conditions immediately following transplanting.

Late season trials of direct field seeding will be continued with the objectives of (1) hydroseeding to various plant populations and determining the effect of nylon vs. polycoat on plant stand, (2) growing the tobacco (both Oriental and flue-cured types) to a harvestable stage, and (3) bulk curing representative samples in a whole-plant form. Various evaluations will be conducted on the cured material to determine suitability for use in cigarettes or in reconstituted sheet.

B. Study of System Layout and Field Variables. This study, indicated in 1977, will be continued in 1979 to provide a third year's data. Procedures will be the same as in previous years, with replicated tests on four planting layouts, two within-row spacings and four topping heights.

C. Rapid Drying of Close-Grown Tobacco. Tests will be initiated to compare the chemical, physical and other characteristics of normally cured vs. rapidly dried close-grown tobacco. There are some indications that rapidly dried tobaccos might be suitable for use in sheet manufacture, and if so, significant economic gains could be realized in on-the-farm processing. In addition to increasing the curing capacity of bulk barns, expected dry weight yields would be larger. Objectives of the 1979 tests will be (1) to produce 3 varieties of close-grown tobacco, (2) cure each variety by normal vs. accelerated curing schedules, and (3) conduct pertinent evaluations related to acceptability of the cured product.

Table 1. Effect of type of cover, type of mulch, between-row spacing, and within-row spacing on percent plant stand (1978).

Factor	Seeding No. 1	Seeding No. 2	Average
Type of cover			
solid plastic	34	57	45
perforated plastic	33	65	49
Type of mulch			
no mulch	30	64	46
Turfiber	39	63	51
Jacklin	31	56	43
Between-row spacing			
3"	37	61	49
2"	31	61	46
Within-row spacing			
1.5"	36	60	48
2.25"	30	63	46
Average	33	61	47

Table 2. The effect of cover, mulch, and seed spacing on transplant parameters (1978).

Factor	Parameter: Plant Weight (g)	Extended Length (cm)	Stem Length (cm)	Stem Diameter (mm)
Cover				
solid plastic	12.06	18.57	5.81	5.84
perforated plastic	15.27	25.43	10.37	6.22
Mulch				
no mulch	15.00	23.61	8.92	6.12
Turfiber	13.34	22.04	8.52	5.96
Jacklin	12.78	20.61	6.94	6.03
Between-row spacing				
3"	14.88	22.36	8.35	6.25
2"	12.79	21.95	8.04	5.87
Within-row spacing				
1.5"	12.57	22.03	8.18	5.72
2.25"	15.50	22.28	8.17	6.53
Overall	13.72	22.13	8.18	6.04

Table 3. The effect of cover, mulch and seed spacing on the coefficient of variability of tobacco seedlings (1978).

Factor	Coefficient of Variability (%) Plant Weight	Extended Length	Stem Length	Stem Diameter
Cover				
solid plastic	98	56	101	38
perforated plastic	93	46	77	37
Mulch				
no mulch	90	49	83	38
Turfiber	107	60	102	38
Jacklin	90	46	77	36
Between-row spacing				
3"	96	53	90	37
2"	96	53	90	36
Within-row spacing				
1.5"	97	55	93	37
2.25"	93	50	87	36
Overall	97	53	91	37

Table 4. Correlation coefficients between transplant parameters. (Seeding 2, 1978).

Parameters Correlated	CV (1978)	(1977)
Weight and extended length	.85**	.75**
Weight and stem length	.76**	.71**
Weight and stem diameter	.80**	.86**
Extended length and stem length	.94**	.92**
Extended length and stem diameter	.73**	.80**
Stem length and stem diameter	.64**	.72**

Table 5. Problems associated with various types of plantbed cover.

Factor	Problem	Cover: Solid Plastic	Perforated Plastic	Nylon
Water	1) Non-uniform water entry		X	
	2) Excess water entry due to rain or irrigation		X	X
	3) Need for supplemental water before removal		X	X
Temperature	1) High, >110°F	X		
	2) Moderate, >100°F	X	X	
Physical	1) Ponding of water on cover	X		
	2) Sagging of cover when wet			X
	3) Cover adhering to soil after heavy rain		X	X

Table 7. The effects of field layout, plant spacing, and topping height on the final yield of close-grown tobacco.*

Layout	Plant Spacing (in)	Topping Height (in)	Yield (lbs/acre) R1	R2	R3	R4	Ave.	Ave.	Ave.
4-row on bed	9	18	4133	3493	3341	3656	3656	4258	4062
	9	24	4730	3862	3429	4231	4063		
	9	30	5478	4350	4340	4643	4703		
	9	36	5109	4491	5044	3786	4608		
	18	18	3504	3135	3091	3390	3280	3866	
	18	24	3287	3265	3970	4003	3631		
	18	30	4805	4014	3960	3873	4163		
	18	36	5185	3151	4925	4296	4391		
3-row on bed	9	18	3048	3515	3103	3287	3238	3828	3640
	9	24	3255	4556	3537	2474	3456		
	9	30	4549	4133	4600	4025	4327		
	9	36	4730	4242	4177	4014	4291		
	18	18	3255	3320	2072	3048	2924	3453	
	18	24	2842	4220	2636	3971	3417		
	18	30	4133	4112	2539	4112	3724		
	18	36	3558	3916	2875	4643	3748		
3-row on flat	9	18	2929	4030	2484	3385	3298	3780	3726
	9	24	3054	3895	3884	4448	3570		
	9	30	3233	4556	3721	4123	3908		
	9	36	3352	5207	4513	4296	4342		
	18	18	3081	3818	2474	3407	3195	3673	
	18	24	3211	4144	2625	4188	3542		
	18	30	4231	4198	3482	3797	3927		
	18	36	3472	4274	3287	5077	4028		
2-row on flat	9	18	3282	3612	3408	3675	3494	3936	3783
	9	24	3802	3491	4132	3627	3763		
	9	30	3714	4084	3792	4618	4052		
	9	36	4123	4667	4385	4570	4436		
	18	18	3384	3423	2955	3354	3279	3629	
	18	24	3627	3714	2936	3442	3430		
	18	30	4443	3763	3423	3802	3858		
	18	36	3578	3831	3841	4550	3950		

*Determinations based on actual land use exclusive of irrigation lanes.

Table 6. Average values of cured weight/plant, price index, and coefficient of variability (CV) for various sizes of tobacco transplants.*

Group No.	Plant Size Before Transplanting Extended Length Range (cm)	Stem Diameter Range (mm)	Cured Wt/ Plant (g)	Price Index** $/kg Bottom	Top	Price CV Bottom	Top
1	17-23	4.5-5.7	185.66	2.23	2.85	10.43	6.94
2	17-23	5.8-7.1	189.71	2.33	2.88	8.61	4.20
3	17-23	7.2-8.6	187.57	2.33	2.89	11.45	4.05
4	24-30	5.0-6.3	178.57	2.35	2.91	9.61	4.11
5	24-30	6.4-7.8	184.68	2.36	2.91	8.31	4.50
6	24-30	7.9-9.4	176.51	2.45	2.91	9.25	4.35
7	31-37	6.0-714	181.37	2.30	2.95	8.68	3.64
8	31-37	7.5-9.0	173.05	2.45	2.85	9.24	7.0
9	31-37	9.1-10.7	186.58	2.35	2.89	11.04	6.05
10	17-37	4.5-10.7	186.61	2.39	2.90	9.10	3.6

*Average over three replications.

**Based on average prices paid for various grades of untied, flue-cured for 1977 and 1978, types 11, 12, 13 and 14 combined through 9-14-78.