1977 ANNUAL REPORT

ON

MECHANIZATION OF CLOSE-GROWN TOBACCO

by

William H. Johnson, Professor
Dept. of Biological and Agricultural Engineering
North Carolina State University
Raleigh, North Carolina

Submitted To:

Carreras Rothmans Limited
Christopher Martin Road
Basildon, Essex, England

Distribution:

Dr. F. J. Hassler
Dr. T. J. Mann
Mr. B. C. Akehurst

TABLE OF CONTENTS

# 1977 ANNUAL REPORT --- MECHANIZATION OF CLOSE-GROWN TOBACCO

## I. INTRODUCTION

This report describes the fourth year of research and development on Mechanization of Close-Grown Tobacco at N. C. State University. The project, initiated in 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, field tests have been conducted to evaluate the effect of various parameters such as seed size and pre-treatment, coating process, weed control method, seeding density, mulch type and density, and seedbed cover on uniformity of seedlings. While improvements have been obtained due to control of various factors, further research has been indicated to obtain levels of uniformity to permit mechanical lifting of the plants.

B. Materials and Methods. Field studies were continued in 1977 at the Lower Coastal Plains Tobacco Research Station, Kinston, N. C. Specific objectives for the studies were (1) to improve the land site and field layout for mechanized operations, (2) to study the effect of seed sizing and pre-treatment, mulch application rate and seeding density on uniformity of seedling development, and (3) to develop further knowledge regarding micro-environment and field factors which influence seed germination and early growth of tobacco seedlings.

Approximately 1.0 acres were used for this study. The land site was the same as used in 1976; however, plans were developed to permit bed layout, fumigation and seeding on a near "flat" (slightly sloping) field surface rather than trying to shape the field with a curved contour such that beds were higher than the irrigation lanes as in 1976. The bed lay-out system had the following characteristics:

Center-to-center tractor wheeel spacing----------------- 86"

Effective width fumigated------------------------------- 60"

Width of tilrovated bed--------------------------------- 56"

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

Width of seeded zone------------------------------------ 36"

Care was necessary to assure no admixing of treated with untreated soil during tilrovating and seeding, with steering error of $\pm$ 2" maximum assumed. The field layout consisted of parallel beds of approximately 200 ft length with irrigation lanes located between the 2nd and 3rd, 7th and 8th, and 12th and 13th beds.

Equipment used in 1977 for fumigation, fertilizing, bed-forming and seeding were the same as for 1976. A Finn Hydro-Seeder was procured to permit mechanized application of a hydromulch following seeding. It was postulated that a fiber mulch overlay would aid in moisture control and reduce seed displacement during application of water prior to covering.

While land preparation was completed during the Fall of 1976, actual fumigation was delayed until February of 1977 due to rain and cold weather. Following discing and marking off the beds, fertilizer was applied with a Gandy distributor at the rate of 2400 lb/acre of 12-6-6 to 5' bed width. The fertilizer was tilrovated into the upper three to five inches of soil. Then methyl bromide was injected into the soil at the rate of 430 lb/acre and covered with 2.0 mil solid plastic. All operations were conducted under favorable conditions (Feb. 10-11).

The beds remained covered until Feb. 23, at which time the first seeding trial was begun. Plans were made to conduct two seeding trials with 12 beds/trial. The experimental plan consisted of 4 seed treatments x 3 mulch rates, with one seed treatment and one mulch rate combination per bed. The two seeding trials (Feb. 23 and March 17) provided a replication of the basic experiment.

The 4 seed treatments were the same as used in the 1976 study, consisting of G-28 variety, coated by Asgro Seed Co., to provide four seed lots as follows:

| Lot No. | Description | % Germination |
|---|---|---|
| 1 | G-28, sized 473-500 micron, untreated | 91 |
| 2 | G-28, sized 473-500 micron, treated | 95 |
| 3 | G-28, unsized 354-563 micron, untreated | 89 |
| 4 | G-28, unsized 354-563 micron, treated | 93 |

Treated seed were obtained by soaking under light for 48 hours followed by drying to constant weight under room conditions. Laboratory tests had shown improved dark germination for seeds pre-treated in this manner. Three mulch rates tested were 1600, 2400 and 3200 lb/acre.

Procedures for each of the seeding trials were basically the same. After removal of the solid polyethylene cover, the beds were tilrovated and seeded. The seeder provided 18 rows on the pre-formed bed, in four bands. Two bands provided 4 rows at 2" between-row and 1 1/2" within-row spacings; whereas the other two bands provided 5 rows at 1 1/2" between-row and 1 1/2" within-row spacings. Hydromulch (Superior Turfiber) was mechanically sprayed onto the bed surfaces, then water was mechanically applied with a portable water wagon with pressure boom to obtain approximately 0.5-inch $H_20$ on the seeded bed. Perforated plastic with 3/8" holes on 3" centers was used to cover all beds. Following covering, irrigation was used only on extremely warm days for evaporative cooling of the beds. On April 14, polyethylene covers were removed and replaced by cotton covers. Plants grew well without further attention except for irrigation until ready for pulling in early May.

Seedling samples were collected at the time most plants had grown to the size suitable for transplanting. For sample collection, five sampling sites were located for each bed. At each sampling site, two samples of tobacco plants were collected from the two central bands which represented two plant densities. The collection area was 12" long x 6" wide for each sample.

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

C. <u>Results and Discussion</u>. The effects of seed treatment, seeding density and mulching rate on the germination percentage are shown in Table 1. Seed treatment appeared to reduce germination percentage for unsized seed; however, no significant effect was observed for sized seed. The effect of seeding density on the germination percentage was not significant. In all seedings, heavier mulching appeared to retard germination. This was probably due to the fact that tobacco seeds were unable to germinate and grow through the heavy mulch.

The effects on various transplant parameters due to seed treatment, seeding density and mulching rate are shown in Table 2. No significant difference in plant size was observed between seed treatments. The plant size in the low seeding density group was slightly larger than that in the high seeding density group. The effect of mulching rate on transplant parameters was highly significant. In the high mulching rate group, plants were heavier and stems were shorter and larger due to lower germination percentage. The plant size and style were affected mainly by plant population, which agrees with the 1976 tests.

The coefficients of variability for various transplant parameters are shown in Table 3. There was no significant difference in plant uniformity between seed treatments except for the sized untreated seeds which had higher coefficients of variability for all parameters measured. Plants in the low seeding density group were more uniform than plants in the high density group, and plants in the high mulching rate group were less uniform than the plants in the low and medium mulching rate groups. Plant size expressed in extended length or stem diameter was more uniform than expressed in weight or stem diameter.

In order to determine the degree of improvement in uniformity due to the overall mechanized production system, two control plant beds were prepared with all operations performed conventionally (fumigation, hand fertilization, hand seeding, wheat straw mulch application, etc.). Table 4 shows the plant characteristics and coefficients of variability for the conventionally grown plants, in which G-28 unsized and untreated coated seed were used. Comparison of this data with that of Table 3 shows that uniformity was considerably improved with the mechanized system. This was expected due to more uniform conditions established with the mechanized system, including seed placement, soil compaction, soil moisture content, etc. Comparison of uniformity data of 1977 with that of 1976 showed a small improvement with a reduction of about 2 to 4% in the

CV for most plant parameters. This is believed to be due to improved uniformity associated with the hydromulch and portable watering prior to covering.

Table 5 shows the correlation coefficients between various transplant parameters. It is apparent that the extended length was highly correlated with the stem length and the correlation between the plant weight and the stem diameter was also high. This implies that two of the four parameters measured (either stem length or extended length and plant weight or stem diameter) may be used to express the size and style of a plant.

During the experiment, several observations were made which relate to uniformity of seedlings produced. Immediately after seeding and covering the beds for the first seeding trial, heavy rain caused loosening and sagging of the covers. Water then moved through the perforated polyethylene and flooded low lying portions of the beds. Also, the sagging covers contacted the bed surface and interfered seriously with seed germination and early growth. Attempts to elevate covers were only partially successful. These observations showed the importance of having (1) a bed profile with adequate clearance between the cover and seeded bed surface, and (2) covers installed such that sagging during heavy rainfall will not occur. It is also possible that slope of the cover to permit rapid movement of water to the bed sides is important.

Several areas of the field site were still too low and caused problems due to water standing between the beds. Proper shaping of the field to assure effective runoff must be emphasized.

Late season observation of beds showed uneven growth which was believed to be due to uneven water application with overhead irrigation. Soil samples were therefore taken at sites representing small, medium and large plants. Average moisture contents showed that sites having small, medium or large plants had moisture contents of 4.9, 5.2 and 7.0% respectively. Improved uniformity in late season water application thus appears highly important.

## III. EFFECTS OF TRANSPLANT VARIABILITY

A. Background. A preliminary study was conducted in 1976 to determine the effect of transplant variability on yield. Three lots of sized plants (small, medium and large) and two lots of variable plants were grown under replicated trials. Results indicated that variability of final stem height and final yield were not affected by initial transplant variability, measured in terms of extended length of transplant. It should be noted that in the process of selecting the transplants, an attempt was made to discard unusually spindly and stocky transplants. The factor of plant stockiness, which relates plant height to a second factor such as stem diameter or weight, could conceivably influence plant performance. For this reason, the study was continued in 1977 to examine the effect of two parameters, extended length and stem diameter, on growth and final plant size and yield.

B. Materials and Methods. Ten groups of different sizes of seedling were used for experiments in 1977. Seedlings in groups 1 to 9 were selected on the basis of extended length and stem diameter. Group 10 was obtained by mixing an equal number of plants from each of the nine selected groups. The ranges of extended length and stem diameter for each group are given in Table 6. Twenty-three plants per group were transplanted into a row in the field. Each row was considered to be a replication with three replications per group. The central stem height for each plant was measured four times between transplanting and flowering. Tobacco leaves were primed twice and cured leaf weight was measured for each plant.

C. Results and Discussion. Table 6 shows the initial plant sizes, stem heights at various times after transplanting, and cured weights and their coefficients of variability. In general, the taller plants remained taller until flowering and the taller plants were also more uniform.

The final yield was affected by the initial length of the plant; however, no definite trend was observed, since the average yield in the intermediate group was the lowest. Furthermore, within the same length group, the plants with larger stem diameter resulted in higher yields. As shown in Table 6, the effects of initial extended length and stem diameter on the uniformity of yield were not significant. The coefficient of variability for stem height for Group 10 was higher in the beginning; however, it decreased as the plants grew. The coefficient of variability for the final yield in this group was higher than the average.

Two factors which probably influenced the results in 1977 include weather and method of tagging plants. Weather was unusually dry following transplanting, and an unusually large number of the small plants having small stem diameters died. These were replanted. Also, in order to maintain plant identity following initial measurements of extended length and stem diameter, a string with tag was attached to the stem. This string did not deteriorate, as expected, and girdling occurred in a number of plants as their size approached that of the fully mature plant. This study will be continued during 1978.

IV. CHEMICAL TOPPING OF DIRECT SEEDED, HIGH DENSITY, CGT

A. Background. Previous work on direct seeding has emphasized plant establishment, determination of yield potential at various plant populations, and effect of plant population on chemical characteristics. One of the problems noted in regards to high density close-grown tobacco (e.g., at 400,000 plants/acre or higher) has been the inordinately large amount of lower leaf loss, due to rapid senescence of leaves beneath the dense canopy. As a result, the harvested plants have generally been tall with leaves remaining only near the top. Leaf to stalk ratios have been low and alkaloid levels also lower than desirable. It was therefore of interest to examine the potential of chemical topping at various stages of plant development as a means of further regulating leaf chemistry and physical properties. It was postulated that very early chemical topping might maintain a low plant canopy, minimize bottom leaf loss, and accelerate alkaloid synthesis and thereby increase leaf nicotine percentages.

B. Materials and Methods. Following collection of samples from the field study on mechanized transplant production, several of the beds were sprayed with 4 to 5% concentrations of Royaltac with initial applications made on June 6, 13, 15 and 22 to provide various topping heights between 80 and 115 cm. Approximately 7-10 days after a given initial application of Royaltac, the beds were sprayed with MH-30 at the normal concentration (2%). Three harvests were made on July 21, August 2 and August 12 to obtain three stages of maturity for each of three topping levels (low, medium and high). Tobacco was bulk cured in racks following a typical flue-curing schedule.

C. Results and Discussion. Table 7 provides data on average height at harvest, yield, % total alkaloids, and % leaf in cured tobacco. Differences in topping height were largest between the low and medium topped tobaccos with less difference between medium and high topped. This is also reflected in the yield and chemical data. Yields were highest for the high topped for the early harvest (No. 1) but highest for medium topped for later harvests. Actual yields between about 5000 to 6000 lbs/acre were obtained with effective values as high as 14,800, assuming full land utilization. Chemical topping showed definite effects on % total alkaloids with higher values for low topped. Lamina values for % total alkaloids increased with delayed harvest as expected; however, values for midrib and lamina appeared to decline between the 2nd and 3rd harvests. It was of interest to note that lamina alkaloid percentages of 2.38 could be obtained with effective plant populations of more than 1 million/acre. Percent sugars (not shown) were generally low for lamina, intermediate for stems and highest for stalks. Leaf/stalk ratios were more favorable for low topped tobacco with over 55% leaf obtained in each harvest. As to be expected, delayed harvest caused a decrease in % leaf which was likely due to lower leaf senescence. Further research will be necessary to determine the potential significance of early chemical topping to smoking characteristics of tobacco converted into sheet; however, the above findings appear promising from the standpoint of alkaloid control in close-grown tobacco.

V. LATE SEASON TRIALS ON DIRECT SEEDING

A. Background. Previous studies on direct seeding have generally involved seeding during the frost period, with the necessity to use covers to facilitate germination and for plant protection. An objective for the 1978 tests was to examine late season seeding and plant establishment with and without a cover. It was considered that with the use of a hydromulch following seeding, soil moisture could be maintained at the desired level more easily with less chance of soil erosion and seed displacement.

B. Materials and Methods. Ten beds were seeded at the Lower Coastal Plains Tobacco Research Station, Kinston, N. C. on April 13, 1977 following the frost period. Speight G-28 (coated seed) were seeded following similar procedures as described for mechanized transplant production, but with either two or four rows seeded. Beds were mulched at 2400 lb/acre and two of the ten beds covered with nylon and polyester covers; whereas eight beds were left uncovered. Irrigation was applied for 15 to 30 minutes around 11:00 A.M. and 2:00 P.M. daily during clear days until germination was complete.

C. Results and Discussion. Observations showed that tobacco seed germination can be successfully accomplished following the frost period without the use of a cover; however, better results were obtained under the porous covers. Under open conditions, seed displacement due to impacting water droplets appeared to be a major problem and germination was greatly dependent on location relative to the overhead irrigation sprinklers. Some areas having less impact damage gave good results. It is possible that improved moisture control methods might improve overall performance. Germination and growth under the porous covers were excellent with no indication of impact damage. Because of extreme variations in plant stand, tobacco plants were not harvested; however, many grew to apparent full size by late July. The tobacco was also of low quality at that stage due to adverse weather conditions during June and July.

## VI. FIELD PRODUCTION OF CLOSE-GROWN TOBACCO

A. Background. Plans were developed to produce during 1977 commercial trials of CGT, both flue-cured and Oriental, for company evaluation. Because of similarity of concept in the production of close-grown tobacco and production of Oriental (populations of 80,000 - 100,000/ acre), it was of interest to examine the production of Oriental tobacco with a standard layout of 4 rows on 86" spaced beds, but at about twice the normal CGT population of 39,000 (effective). Objectives were (1) to produce the respective tobacco crops at the Oxford Tobacco Research Station under mechanized operations of fertilizing, bedforming, transplanting, cultivation, application of chemicals, topping, harvesting and curing with emphasis on producing a quality product at high yield, (2) to prepare cured materials for subsequent company evaluation.

B. Materials and Methods. Approximately 1.0 acre each of the flue-cured varieties, G-28 and LA-53, were produced following the same basic procedures as described in the previous reports. Discing, turning and harrowing operations were completed in March and April. Pre-plant chemical applications included Paarlan for weed control, Mocap for nematodes and wireworm control, and Di-System for systemic insecticide control.

Fertilizer was broadcast and disced in with an applied rate of 800 lb/acre of 8-8-24. Beds were tilrovated to a four-inch depth and pre-bedded to provide 86" center-to-center bed spacing.

Transplanting was carried out during the period May 4 to May 6, with four rows transplanted two passes per bed, rows 16 inches apart with plants approximately 10 inches within the row. This provides an effective plant population of 39,000/acre (32,400 actual).

At about two and four weeks after transplanting, the tobacco was cultivated and topdressed (15-0-15) to bring total N to about 150 lb/acre. Enide was sprayed onto irrigation lanes to reduce late season weed and grass development.

Several applications of Off-Shoot T sucker control chemical were made along with hand suckering to control secondary growth. MH-30 was not applied. Topping was done mechanically with a Powell Hi-Trac machine, topping as high as possible.

Tobacco was harvested by cutting with a sickle-bar mower and packing the whole plants into bulk racks. Curing followed the typical management schedule for flue-curing and was generally completed within 5 to 7 days after harvest. Cured materials were conditioned and processed for company evaluation.

A secondary small plot of LA-53 variety was rattooned following early harvest in order to note the yield increase and change in product characteristics associated with double cropping. This material was first harvested in a somewhat immature stage to enable an adequate period for second growth. It was noted that each plant from the early harvest provided several secondary shoots; however, much of the crop harvested at more normal maturity failed to rattoon.

Experimental procedures for production of the Oriental tobacco (Smyrna) were the same as described above for G-28 and LA-53 with the following exceptions:

1. Approximately 0.5 acre of tobacco was transplanted mechanically to provide an effective plant population of 39,000/acre; then tobacco plants were hand-set between those already transplanted to provide a total of 78,000/acre (64,800/acre actual).

2. One-half of the field plot was topdressed to bring total N to about 150 lb/acre; whereas one-half of the plot was not topdressed.

Tobacco was harvested by cutting with a sickle-bar mower and packing the plants into bulk racks. Bulk curing followed a slightly reduced temperature schedule during yellowing and drying. Following curing, the tobacco was conditioned and processed for commercial evaluations.

C. Results and Discussion. Observations during growth indicated that two major problems (weather related) decreased yield potential and leaf quality at harvest of the flue-cured crop. Considerable root damage was incurred due to excessively heavy rainfall early in the season; furthermore, hot, dry weather during maturation was experienced. Consequently, bottom leaf deterioration was unusually high, although the crop was irrigated and the tobacco grew and matured non-uniformly throughout the field.

Yield data showed that G-28 averaged 4118 lb/acre (3120 to 5567 range) and that LA-53 averaged 4537 lb/acre (4053 to 5177 range). The rattooned LA-53 yielded a total of 6595 lb/acre. All yields were considerably lower than normal due to the adverse growing conditions.

For the Oriental tobacco, adverse weather also probably decreased yield potential and leaf quality at harvest. Yield data showed that the low nitrogen and high nitrogen treatments averaged 2365 and 3404 pounds per acre, respectively. Qualitatively, color stability was much better during curing for the tobacco which was not topdressed, and cured leaf color appeared more uniform and brighter. The topdressed Smyrna cured to a dull, brown color and appeared to have less texture and elasticity.

Evaluation on the cured products will be made to obtain estimates of yield, leaf chemistry and suitability for use in sheet manufacture.

## VII. STUDY OF SYSTEM LAYOUT AND CERTAIN FIELD VARIABLES FOR PRODUCTION OF CLOSE-GROWN TOBACCO

A. Background. Previous work in close-grown tobacco research in North Carolina has emphasized a 4-row on-bed system layout; whereas research in Canada has involved a 2-row (twin row) layout with 4 ft. spacing between the center line of 2-row pairs. It has been observed that a major problem with the 4-row system is the large amount of bottom leaf loss, presumably resulting from reduced light intensity as the upper leaves mature and develop. While some lower leaf loss is associated with wider spaced rows (as in the Canadian layout), this loss was believed to be less than that of the 4-row system. It was therefore of interest to study various layout systems and their effects on yield, lower leaf losses, and leaf quality. In addition, the effects of various topping levels and within-row spacings were of interest, particularly since these factors should significantly affect bottom leaf loss due to shading within the canopy of leaves.

B. Materials and Methods. A field experiment was designed to study four bed or system 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, center-to-center bed spacing 86", 4 rows at 16" between rows, 36" clearance between outside rows of adjacent beds.

2. 3-row on bed: same as 1 except 3 rows at 24" between rows.

3. 3-row flat: same as 2 except planted flat.

4. 2-row flat: center-to-center spacing between 2-row pairs of 48", 2 rows at 12" between rows.

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

Plant populations for the different treatments were as follows:

| Layout | Spacing | Plant Population Actual/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 |

Cultural practices were established following the basic plan of previous studies in CGT. Following land preparation, pre-plant chemicals (Mocap, Di-Syston, and Tillam) and pre-plant fertilizer (800 lb/acre, 8-8-24) were incorporated. The various plant layouts were established by modifying standard 2-row transplanting equipment. Beds were transplanted May 9-10, 1977.

Two cultivations and sidedressing were made at approximately three and five weeks after transplanting, with total N of 150 lb/acre established.

Insect control for budworms and hornworms involved spray application of Lanate (mid-June) and Orthene (mid-August).

Plots were handtopped and sucker control chemicals (Off-Shoot T and Royal MH) applied.

Harvest of plots were made when a given plot had reached maturity nad ripeness adjudged to be most suitable for the entire plant. Tobacco was bulk cured in a whole plant form in racks under a typical flue-curing schedule of 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 PMI (particulate matter index) for lamina. Table 8 shows the effect of the various layouts on yield/acre (actual). For all layouts, increasing topping height increased yield significantly with up to 2000 lb/acre increase with increase in topping height from 18" to 36". The closer spacing (9 in.) gave varying yield increases over the wider spacing with an average increase of between 200 and 400 lb/acre. The planting layouts showed significant differences with increasing yields obtained for the 3-row on flat, 3-row on bed, 4-row, and 2-row, respectively. Total yield could be misleading, however; and value of leaf tobacco based on government grades may provide a better indication of quality-yield effects.

Nicotine analyses for lamina from three stalk positions showed that values were somewhat higher than in previous years' work. As shown in Table 9, nicotine values were generally in the range of 1.7 to 2.5 for

for bottom leaves, 2.3 to 3.3 for middle leaves and 3.0 to 4.0 for top leaves. Previous data has shown values of lamina about 1.0 to 1.5 percent lower. Dry weather during growth and/or lower topping height and lower plant population could explain the higher values. Nicotine generally increased for lower topping height and lower plant population. Other evaluations are currently underway.

VIII. TESTS ON MECHANICAL TOPPING AND WHOLE PLANT HARVEST OF CLOSE-GROWN TOBACCO

A Powell Hi-Trac self-propelled topper-sprayer was procured to permit study of mechanical topping of close-grown tobacco. Initially, plans were to mechanically top the tobacco in the system layout study (Section VII). It was found, however, that excessive damage occurred for the very low topping heights of 18 and 24 inches; and the decision was made to use the machine only for high topped field plantings.

The topping heads were adjusted to permit topping of two alternate rows (e.g., rows 1 and 3) of the 4 rows on the bed. Two passes were made in opposite directions. No problems were experienced in regards to discharge of the clipped material.

Preliminary tests were made with a one-row pull behind stalk harvester developed for burley tobacco. As presently designed, this machine would not work satisfactorily for the 4-row on bed layout, since the wheels and support frame engage and damage the adjacent rows. In addition, it appeared that the cutting blade was underpowered to handle the high density crop, although satisfactory cutting and elevating of stalks was obtained for short distances of cutting. Further work would be necessary to utilize this machine.

## IX. RESEARCH PLANNED FOR 1978

A. Mechanized Transplant Production and Direct Field Seeding. This work will be continued with the objectives (1) to examine further the effect of seeding density (plant population) on uniformity of seedling development, (2) to determine the effect of no mulch in comparison with at least two types of hydromulch for moisture retention and improved germination, and (3) to study the use of solid vs perforated plastic as plant bed cover in relation to system management. In addition, late season trials of direct field seeding will be continued with the objective of producing a satisfactory stand of plants and with growth to the harvest stage. Both flue-cured and Oriental tobacco types will be tested.

The effect of transplant variability on growth, yield and quality will be continued along the same lines as in 1977. A system of leaf tagging will be tried to avoid the problem of stem damage observed in 1977.

Continued trials of chemical topping will be of interest, particularly in relation to lower plant populations. Following completion of the transplant production study, selected beds will be retained for use in chemical topping trials.

B. Study of System Layout and Field Variables. This study initiated in 1977, will be repeated to provide a second year's data. Weather conditions of 1977 were a typical and variability among the field blocks for replications was greater than desired. Procedures will be basically the same as in 1977.

TABLE 1. Effects of seed treatment, seeding density and mulching rate on the germination percentage of tobacco seed (1977).

| | SEEDING NO. 1 | SEEDING NO. 2 | AVERAGE |
|---|---|---|---|
| Sized Untreated | 76.4 | 77.7 | 77.1 |
| Sized Treated | 73.4 | 78.4 | 76.1 |
| Unsized Untreated | 73.4 | 82.3 | 78.0 |
| Unsized Treated | 72.5 | 73.4 | 73.1 |
| Low Seeding Density | 75.9 | 76.7 | 76.3 |
| High Seeding Density | 72.4 | 78.8 | 75.6 |
| Low Mulching Rate | 89.8 | 90.8 | 90.5 |
| Medium Mulching Rate | 78.0 | 82.6 | 80.3 |
| High Mulching Rate | 54.1 | 60.3 | 57.4 |
| Average | 74.0 | 77.9 | 76.0 |

TABLE 2. Effects of seed treatment, seeding density and mulching rate on transplant parameters (1977).

| | PLANT WEIGHT (g) | EXTENDED LENGTH (cm) | STEM LENGTH (cm) | STEM DIAMETER (mm) |
|---|---|---|---|---|
| Sized Untreated | 9.1 | 20.6 | 7.1 | 5.7 |
| Sized Treated | 9.2 | 20.8 | 6.9 | 5.5 |
| Unsized Untreated | 9.2 | 21.7 | 7.6 | 5.7 |
| Unsized Treated | 9.1 | 20.3 | 6.8 | 5.8 |
| Low Seeding Density | 9.9 | 21.1 | 7.2 | 5.8 |
| High Seeding Density | 8.5 | 20.7 | 7.1 | 5.5 |
| Low Mulching Rate | 7.6 | 20.5 | 7.1 | 5.3 |
| Medium Mulching Rate | 9.2 | 21.6 | 7.4 | 5.7 |
| High Mulching Rate | 11.4 | 20.4 | 6.7 | 6.1 |
| Average | 9.4 | 20.8 | 7.1 | 5.7 |

TABLE 3. Effects of seed treatment, seeding density and mulching rate on the uniformity (coefficient of variability) of tobacco seedlings (1977).

| | COEFFICIENT OF VARIABILITY (%) | | | |
|---|---|---|---|---|
| | PLANT WEIGHT (g) | EXTENDED LENGTH (cm) | STEM LENGTH (cm) | STEM DIAMETER (mm) |
| Sized Untreated | 78.4 | 35.1 | 57.6 | 29.0 |
| Sized Treated | 67.8 | 30.6 | 53.0 | 28.7 |
| Unsized Untreated | 68.3 | 30.4 | 52.4 | 28.3 |
| Unsized Treated | 66.2 | 29.8 | 50.9 | 26.8 |
| Low Seeding Density | 68.1 | 30.9 | 52.9 | 27.5 |
| High Seeding Density | 71.6 | 32.2 | 54.5 | 28.6 |
| Low Mulching Rate | 63.4 | 31.4 | 54.1 | 27.1 |
| Medium Mulching Rate | 68.9 | 29.7 | 51.1 | 26.6 |
| High Mulching Rate | 69.3 | 34.4 | 56.9 | 29.3 |

TABLE 4. Plant size and uniformity (coefficient of variability) of tobacco seedlings grown in the conventional plant bed.

| | SAMPLE NO. | PLANT WEIGHT (g) | EXTENDED LENGTH (cm) | STEM LENGTH (cm) | STEM DIAMETER (mm) |
|---|---|---|---|---|---|
| Plant Size | 1 | 5.7 | 12.6 | 3.6 | 4.2 |
| | 2 | 9.8 | 16.9 | 6.4 | 5.4 |
| | Ave. | 7.8 | 14.8 | 5.0 | 4.8 |
| | | (%) | (%) | (%) | (%) |
| Coefficient of Variability | 1 | 131.0 | 56.7 | 81.5 | 51.4 |
| | 2 | 110.8 | 48.4 | 68.3 | 43.1 |
| | Ave. | 120.9 | 52.6 | 74.9 | 47.3 |

TABLE 5. Correlation coefficients between transplant parameters.

| | Seeding No. 1 | Seeding No. 2 |
|---|---|---|
| Weight and extended length | 0.750 | 0.759 |
| Weight and stem length | 0.731 | 0.693 |
| Weight and stem diameter | 0.852 | 0.868 |
| Extended length and stem length | 0.919 | 0.918 |
| Extended length and stem diameter | 0.793 | 0.806 |
| Stem length and stem diameter | 0.738 | 0.706 |

TABLE 6. Average stem height, average yield and coefficient of variability for various sizes of tobacco transplants.

| Group No. | Plant size before transplanting | | | | Stem height (no. of days after transplanting) | | | | | | | | Yield | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Extended Length | | Stem Diameter | | 27 Days | | 42 Days | | 45 Days | | 56 Days | | Cured Weight per plant | CV |
| | Range (cm) | CV (%) | Range (mm) | CV (%) | Height (cm) | CV (%) | Height (cm) | CV (%) | Height (cm) | CV (%) | Height (cm) | CV (%) | (g) | (%) |
| 1 | 17-22 | 7.2 | 3.5-5.0 | 4.8 | 6.9 | 26.0 | 36.5 | 31.5 | 58.9 | 25.8 | 74.3 | 21.8 | 149 | 29.9 |
| 2 | 17-22 | 6.9 | 5.1-6.5 | 7.8 | 8.6 | 32.1 | 40.2 | 29.2 | 63.2 | 28.7 | 77.5 | 23.3 | 149 | 34.1 |
| 3 | 17-22 | 7.5 | 6.6-8.0 | 5.4 | 12.1 | 46.8 | 50.3 | 28.9 | 77.1 | 24.7 | 90.3 | 18.0 | 173 | 28.5 |
| 4 | 23-28 | 6.7 | 4.5-6.0 | 5.9 | 9.3 | 30.8 | 42.4 | 26.7 | 65.1 | 23.2 | 79.4 | 19.9 | 124 | 32.0 |
| 5 | 23-28 | 5.6 | 6.1-7.5 | 6.5 | 12.2 | 32.5 | 55.3 | 27.0 | 79.5 | 21.2 | 89.4 | 13.5 | 136 | 40.4 |
| 6 | 23-28 | 5.5 | 7.6-9.0 | 4.7 | 17.3 | 36.5 | 65.3 | 28.3 | 88.8 | 20.7 | 94.1 | 14.5 | 164 | 27.6 |
| 7 | 29-34 | 3.5 | 5.6-7.0 | 5.5 | 14.4 | 31.4 | 60.1 | 23.8 | 88.4 | 18.3 | 95.2 | 14.3 | 162 | 30.7 |
| 8 | 29-34 | 3.7 | 7.1-8.5 | 5.1 | 16.8 | 22.3 | 65.4 | 18.7 | 94.6 | 16.1 | 101.4 | 10.3 | 183 | 29.7 |
| 9 | 29-34 | 5.4 | 8.6-10.0 | 4.0 | 19.0 | 33.3 | 73.3 | 23.7 | 98.7 | 15.0 | 102.6 | 12.3 | 184 | 29.0 |
| 10 | 17-34 | 18.0 | 3.5-10.0 | 17.1 | 12.4 | 40.4 | 52.3 | 32.6 | 80.1 | 26.4 | 91.8 | 16.8 | 171 | 37.0 |

CV = Coefficient of Variability

TABLE 7. Average height at harvest, yield, and percent toal alkaloids for chemically topped, high density close-grown tobacco.

| HARVEST NO. | TOPPING HEIGHT (cm) | | YIELD (lb/acre) | | % TOTAL ALKALOIDS | | | % LEAF |
|---|---|---|---|---|---|---|---|---|
| | | | ACTUAL | EFFECTIVE | LAMINA | STEMS | STALK | |
| 1 | Low | 80 | 4048 | 9656 | 1.81 | 0.71 | 0.43 | 63.8 |
| | Medium | 104 | 5622 | 13401 | 1.63 | 0.49 | 0.25 | 57.4 |
| | High | 114 | 5740 | 13700 | 0.78 | 0.21 | 0.13 | 51.3 |
| 2 | Low | 87 | 5178 | 12439 | 2.21 | 0.91 | 0.36 | 62.9 |
| | Medium | 102 | 6168 | 14789 | 1.34 | 0.94 | 0.26 | 52.5 |
| | High | 110 | 5445 | 12980 | 1.33 | 0.32 | 0.22 | 51.7 |
| 3 | Low | 74 | 4732 | 11310 | 2.38 | 0.56 | 0.24 | 55.8 |
| | Medium | 104 | 5574 | 13323 | 2.07 | 0.55 | 0.18 | 52.4 |
| | High | 108 | 4980 | 11886 | 1.52 | 0.53 | 0.18 | 46.0 |

TABLE 8. The effects of field layout, plant spacing and topping height on the final yield.

| LAYOUT | PLANT SPACING (in) | TOPPING HEIGHT (in) | YIELD (LBS/AC) | | |
|---|---|---|---|---|---|
| | | | | AVE. | AVE. |
| 4 row on bed | 9 | 18 | 3939 | 5061 | 4873 |
| | 9 | 24 | 4705 | | |
| | 9 | 30 | 5400 | | |
| | 9 | 36 | 6198 | | |
| | 18 | 18 | 3847 | 4884 | |
| | 18 | 24 | 4711 | | |
| | 18 | 30 | 5172 | | |
| | 18 | 36 | 5804 | | |
| 3 row on bed | 9 | 18 | 3941 | 4821 | 4701 |
| | 9 | 24 | 4453 | | |
| | 9 | 30 | 5154 | | |
| | 9 | 36 | 5735 | | |
| | 18 | 18 | 3540 | 4580 | |
| | 18 | 24 | 4434 | | |
| | 18 | 30 | 4842 | | |
| | 18 | 36 | 5502 | | |
| 3 row on flat | 9 | 18 | 3396 | 4701 | 4523 |
| | 9 | 24 | 4682 | | |
| | 9 | 30 | 4741 | | |
| | 9 | 36 | 5983 | | |
| | 18 | 18 | 3409 | 4344 | |
| | 18 | 24 | 4215 | | |
| | 18 | 30 | 4632 | | |
| | 18 | 36 | 5120 | | |
| 2 row on flat | 9 | 18 | 4556 | 5662 | 5439 |
| | 9 | 24 | 5345 | | |
| | 9 | 30 | 5865 | | |
| | 9 | 36 | 6881 | | |
| | 18 | 18 | 4037 | 5215 | |
| | 18 | 24 | 5313 | | |
| | 18 | 30 | 5348 | | |
| | 18 | 36 | 6163 | | |

TABLE 9. The effects of field layout, plant spacing and topping height on the nicotine content.

| Leaf Position | Spacing: | 9 | | | | 18 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Topping Ht. | 18 | 24 | 30 | 36 | 18 | 24 | 30 | 36 |
| | Layout | | | | | | | | |
| Bottom | 4 row | 2.32 | 2.08 | 2.04 | 1.65 | 2.20 | 2.40 | 2.26 | 1.90 |
| | 3 row | 2.14 | 2.24 | 1.73 | 2.01 | 2.14 | 2.66 | 2.29 | 2.18 |
| | 3 row-fl. | 2.07 | 2.18 | 2.03 | 2.14 | 2.30 | 2.35 | 2.06 | 2.01 |
| | 2 row | 2.52 | 2.43 | 1.76 | 1.80 | 2.51 | 2.44 | 2.08 | 1.90 |
| Middle | 4 row | 3.11 | 3.18 | 2.69 | 1.98 | 2.91 | 3.73 | 2.73 | 2.32 |
| | 3 row | 27.6 | 2.98 | 2.60 | 2.56 | 3.21 | 3.05 | 2.92 | 2.52 |
| | 3 row-fl. | 2.56 | 3.06 | 2.72 | 2.60 | 2.87 | 2.81 | 2.43 | 2.47 |
| | 2 row | 3.43 | 3.36 | 2.87 | 2.46 | 2.94 | 3.38 | 2.76 | 2.73 |
| Top | 4 row | 3.48 | 3.66 | 3.14 | 2.80 | 3.83 | 4.13 | 3.30 | 2.44 |
| | 3 row | 3.17 | 3.65 | 3.08 | 3.22 | 4.05 | 3.69 | 3.48 | 2.93 |
| | 3 row-fl. | 3.22 | 3.59 | 3.08 | 3.00 | 3.54 | 3.45 | 3.14 | 3.09 |
| | 2 row | 3.74 | 3.98 | 3.08 | 3.00 | 4.00 | 3.70 | 2.90 | 2.63 |

NORTH CAROLINA STATE UNIVERSITY | AT RALEIGH
SCHOOL OF AGRICULTURE AND LIFE SCIENCES

Agricultural Experiment Station
Box 5847 Zip 27607

August 3, 1978

MEMORANDUM TO: Dr. W. H. Johnson

FROM: Thurston J. Mann Thurston J. Mann/bf

SUBJECT: Report to Carreras Rothmans - 1977

Thank you for a copy of your 1977 report. It is most interesting.

bf

June 6, 1978

Dr. F. J. Hassler
Dept. of Bio. & Agr. Eng.
NCSU Campus

Re: Report to Carreras Rothmans - 1977

Dear Dr. Hassler:

Enclosed herewith is a copy of the 1977 Annual Report to Carreras Rothmans which deals with mechanization of close-grown tobacco. Basil Akehurst was here last week and received his copy at that time.

Sincerely,

William H. Johnson
Professor

WHJ/am

Enclosure

cc: Dr. T. J. Mann