Journal of the Korean Society of
Tobacco Science. Vol. 9. No. 2(1987)
Printed in Republic of Korea.

Changes of Chemical Constituents at Various Stages of Maturity for Flue-cured Tobacco

Jeong, Kee Taeg, Yoo Sun Ban, and Jeong Duk Lee

Eumseong Experiment Station
Korea Ginseng & Tobacco Research Institute.
(Received Aug. 25, 1987)

황색종 잎담배에서 성숙에 따른 엽중 화학성분의 변화

정 기 택 · 반 유 선 · 이 정 덕

한국인삼연초연구소음성시험장

초 록

황색종 잎담배의 성숙과 노쇠(이식후 50일부터 106일까지)에 따른 생엽중 전분, 전당, 니코틴 및 전질소의 함량 변화와 이들 성분간의 관계를 조사한바, 전분함량은 두 품종 모두 각 엽위에서 성숙함에 따라 증가하였으나 노쇠함에 따라 감소하였다. 전질소 함량은 성숙함에 따라 감소하였으나 니코틴 함량은 점점 증가하였다. 전당 함량은 성숙함에 따라 감소하는 경향이었다. 전분 함량은 전질소 함량과는 부의 상관을 보였으나 니코틴 함량과는 정의 상관이 인정되었다. 전질소 함량과 니코틴 함량은 부의 상관이 인정되었다. 그러므로 수확기를 관행보다 5-7일 늦추는 것은 건엽에서 환원당과 니코틴의 비를 더 좋게 하는 방법일 것이다.

ABSTRACT

This study was conducted to investigate the changes of starch, total sugar, nicotine, and total nitrogen contents in green leaves at various stages of maturity(50-106 days after transplanting), and to relate between chemical constituents for flue-cured tobacco(Cv. NC82 and BY4).

For the two cultivars and all stalk positions, starch contents increased with maturation, but decreased with senescence. Nicotine contents increased, while total nitrogen contents decreased with delay of harvest. Total sugar contents had a tendency of decrease.

For the two cultivars, starch correlated negatively with total nitrogen, and positively with nicotine. Total nitrogen correlated negatively with nicotine.

A delay of 5 to 7 days than conventional harvesting time would reach to the better ratio of the reducing sugar to nicotine ratio.

INTRODUCTION

A general definition of quality is the total properties of any particular entity that adapts it to its intended use. Paraphrasing this definition for flue-cured tobacco, quality is the sum of its physical and chemical attributes that best suits it for the manufacture of cigarettes. Much has been written about the chemical quality of tobacco and although much is known about the role many of the chemical constituents play in affecting tobacco quality, "chemical quality" has never been defined to the satisfaction of all tobacco interests(13). No single chemical quality index has been found to be applicable to all grades, types, or blends of tobacco(1). Instead, "quality" represents a balance of essential properties that varies with person, time, and locality : and "taste" refers to a balance of major chemical constituents (15).

Nicotine, nitrogen, and sugars are recongnized as being important to flue-cured tobacco quality, and ranges for each of these constituents are used as the criteria for new cultivars to be eligible for release(3). Tso pointed out that for desirable quality flue-cured tobacco, the ratio of total nitrogen to nicotine should be less than 1.0(15). Weybrew et al(17) reported that the key to flue-cured quality is the time of the metabolic transition from nitrate reduction to starch accumulation. And they concluded that the best tobaccos are compositionally balanced with respect to sugars and nicotine(ratio, S/N=6-8).

Sugar contents in cured tobacco are related to starch contents in harvested leaves. Glucose is the product of starch hydrolysis during curing and, its concentration in the cured leaf is directly proportional to starch accumulation in the green leaf at harvest. The conversion factor is approximately 0.6(17). Therefore, to know the sugar content for cured leaves, investigation for starch and other constituents in green leaves is important during maturation and scenesence in flue-cured tobacco.

The objective of this study was to investigate the changes of starch, total sugar, nicotine, and total nitrogen contents in green leaves at various stages of maturity, and the relationship between chemical components.

MATERIALS AND METHODS

The experiment was conducted at the Eumseong Experiment Station,

Korea Ginseng and Tobacco Institute in 1986. The cultivars were NC82 and BY4. Tobaccos were grown according to conventional production practices. Leaves were harvested weekly from 50 days to 106 days after transplanting. Harvested leaves were classified by stalk positions;Lugs, cutters, leaf, and tips were 4-5 th, 8-9 th, 12-13 th, and 16-17 th leaf from bottom, respectively. The leaves were dried in dry oven at 80℃. The mid-ribs were removed from the tobacco leaves immediately after drying, and all sample were ground to pass 1-mm sieve and redried prior to analysis.

Samples were analyzed for total nitrogen (Modified kjeldahl method ; 7), for starch(8), and for nicotine and total sugar(9). All these contents were calculated percent for dry weight basis.

RESULTS AND DISCUSSION

Changes of chemical constituents

Starch: Changes of starch contents in leaves at various stages of maturity are shown in Figure 1. Starch contents for the two cultivars and all stalk positions increased with maturation, but decreased with senescence. The time when they were the highest content in each stalk position were 71 days after transplanting(DAT) for lugs, 85 DAT for cutters and leaf, and 85-92 DAT in NC82 and 99 DAT in BY4 for tips, respectively. These times were coincident with conventional harvest time for all stalk positions, respectively. Of the stalk positions,cutters and leaf were higher contents than lugs and tips, and lugs was the lowest. Weybrew and Woltz(19) reported that starch content was the highest in middle leaves and followed by upper, and the lowest in lower at harvest for

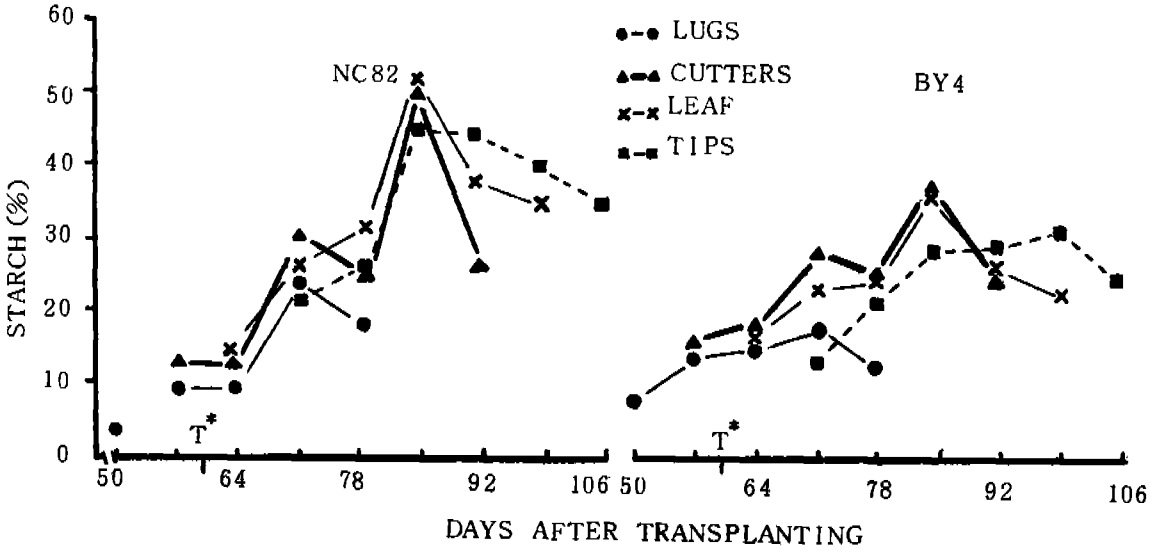

Fig.1. Changes of starch contents in green leaves at various stages of maturity for flue-cured tobacco (* : Topping time).

fluecured tobacco, and that starch contents for three stalk positions increased with delay of harvest, but tended to decrease slightly in senile leaves.

The mean value for starch content was higher in NC82 than in BY4; Starch accumulation reached about 50% for the leaf of NC82, and about 36% for the cutters of BY4. Ripe leaves at harvest averaged about 42% for NC82, and 30% for BY4. Weyberew(20) reported that if starch content of harvested leaves reached 30%, quality would be excellent ; The tobacco would analyze about 3% nicotine and 18% sugars and would yield a balanced and full-flavored smoke, and that if it reached 40%, the tobacco would analyze about 2% nicotine and 24% sugars and would unbalance and would insipid and biting. Therefore, this result indicate that BY4 would yield more a balanced and full-flavored smoke than NC82.

Total nitrogen and Nicotine : Changes of total nitrogen and nicotine contents in green leaves at various stages of maturity are shown in Figure 2 and 3. Total nitrogen contents decreased with maturation for the cultivars and all stalk positions (Figure 2), while nicotine contents gradually increased (Figure 3). Total nitrogen and nicotine contents increased with priming at conventional harvesting time.

Levels of nitrogenous constituents, except alkaloids, decreased as the

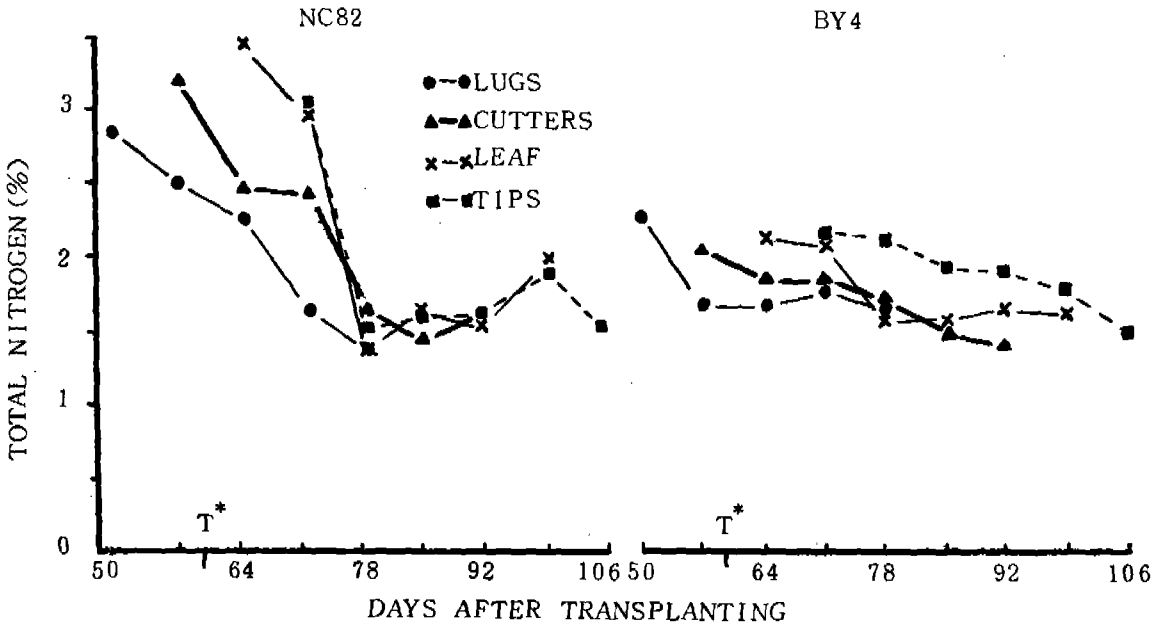

Fig.2. Changes of total nitrogen contents in green leaves at various st stages of maturity for flue-cured tobacco. (* : Topping time).

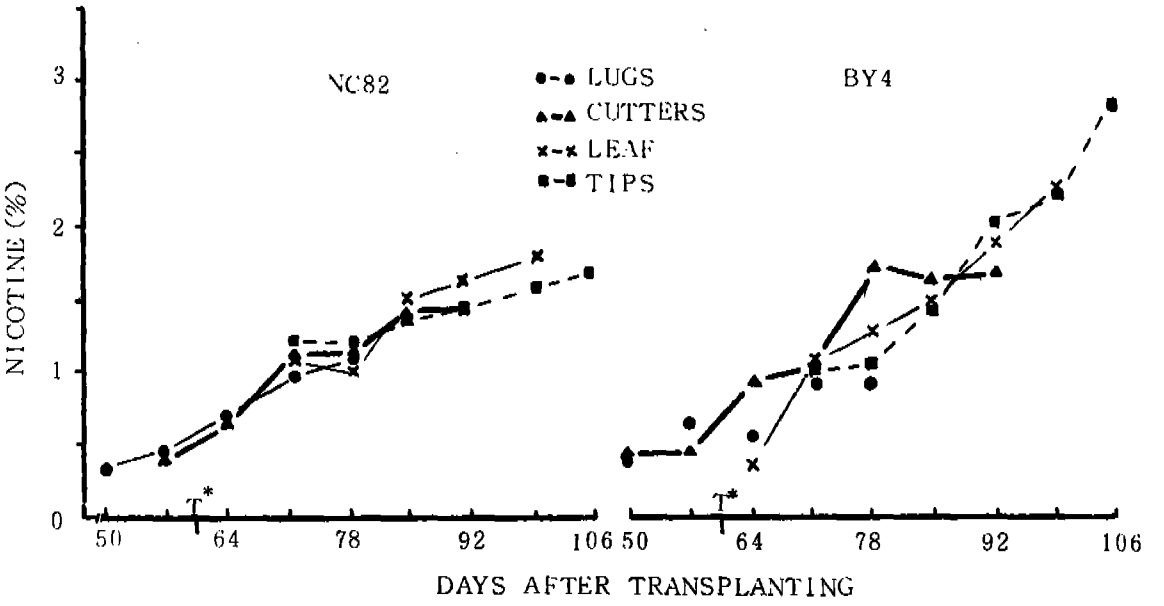

Fig.3. Changes of nicotine contents in green leaves at various stages of maturity for flue-cured tobacco.(* : Topping time).

leaves matured (2,4,5). Alkaloids increased as the leaves matured (2,4,5, 11), but the ratio of change was less than that for other nitrogenous constituents (11). Walker(16) reported that total chlorophyll and the nitrogenous constituents, except alkaloids, decreased with delay of harvest and increased with priming.

Total nitrogen contents of NC82 declined drastically after topping (61 DAT). BY contrast, those of BY4 declined slowly. However, nicotine contents of BY4 and NC82 increased. The ratio of increase of nicotine content for NC82 was less than that for BY4 after topping. Yoshida (21,22) reported that the nicotine was synthesized using the nitrogen present absorbed before and after topping, and nitrogen absorbed after topping was effectively incorporated into nicotine, comparing with nitrogen absorbed before topping.

In this respects, the differences of changes of the nicotine and total nitrogen between the cultivars at various stages of maturity may be because of the differences of nitrogen absorbing ability for them before and after topping.

Total sugar ; Changes of total sugar contents in green leaves at various stages of maturity are shown in Figure 4. Total sugar contents tended to decrease at the beginning of maturity and increased at the end of maturity. This result was agreed with that sugars reach a maximum prior to maturity and even start to decrease

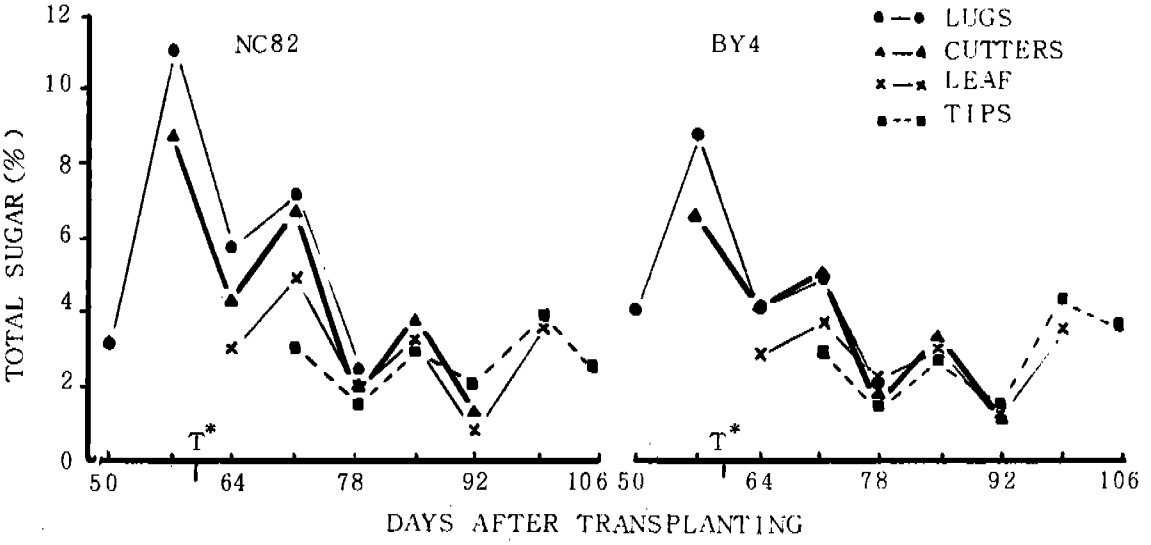

Fig.4. Changes of total sugar contents in green leaves at various stages of maturity for flue-cured tobacco.(* : Topping time)

at topping (4,5), and that the content of ethanol-soluble sugars decreased temporarily at beginning of maturity and increased at the end of maturity (6).

For the two cultivars and all stalk positions, starch contents increased with maturation (Figure 1), but total sugar contents decreased (Figure 4). The change of starch contents in green leaves was more clear than that of total sugar. Kakie (6) reported that total saccharide content increased with leaf maturity and its major component was starch. Weybrew et al (18) reported that starch is hydrolyzed enzymatically into glucose during curing, and only 60 percent of starch is recovered as reducing sugars in cured tobacco.

Therefore, to predict the sugar contents of cured leaves from harvested leaves for flue-cured tobacco, we suggest that starch contents of green leaves may be more important than sugar contents of those, and more related to sugar contents of cured leaves.

Relationship between constituents

For all stalk positions in two cultivars, starch correlated negatively with total nitrogen (Figure 5), and positively with nicotine at various stage of maturity. (Figure 6)

Photosynthesis is the source of the energy required for the reduction of nitrate (10). During early growth the demands for reduced nitrogen are high, almost all of the photosynthate is utilized for this reduction ; there is little surplus to be stored as starch. Only when the pool of

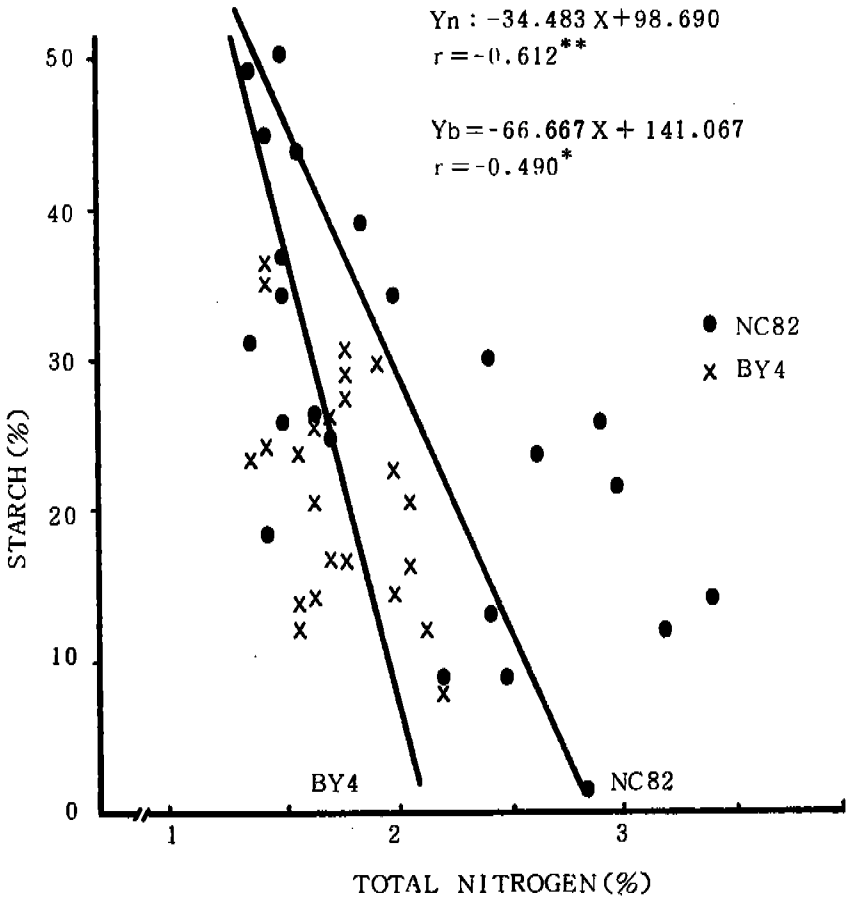

Fig.5. Relationship between starch and total nitrogen contents in green leaves at various stages of maturity for flue-cured tobacco.

NO^-_3 within the tissue diminishes-normally as the external reserves approach depletion, or temporarily when drought limit nitrogen uptake-is any excess of photosynthate converted into starch. Thus, physiologically, starch accumulation follows nitrate reduction although the transition is not discrete (17). These reports means that starch accumulation occurs only when the external nitrogen reserves approach depletion. Therefore, the negative correlation between starch and total nitrogen due to the decrease of nitrogen content stimulate the increase of starch content in green leaves.

Total nitrogen correlated negatively with nicotine for all stalk positions in two cultivars (Figure 7). Noguchi et al (12) reported that the nitrogenous

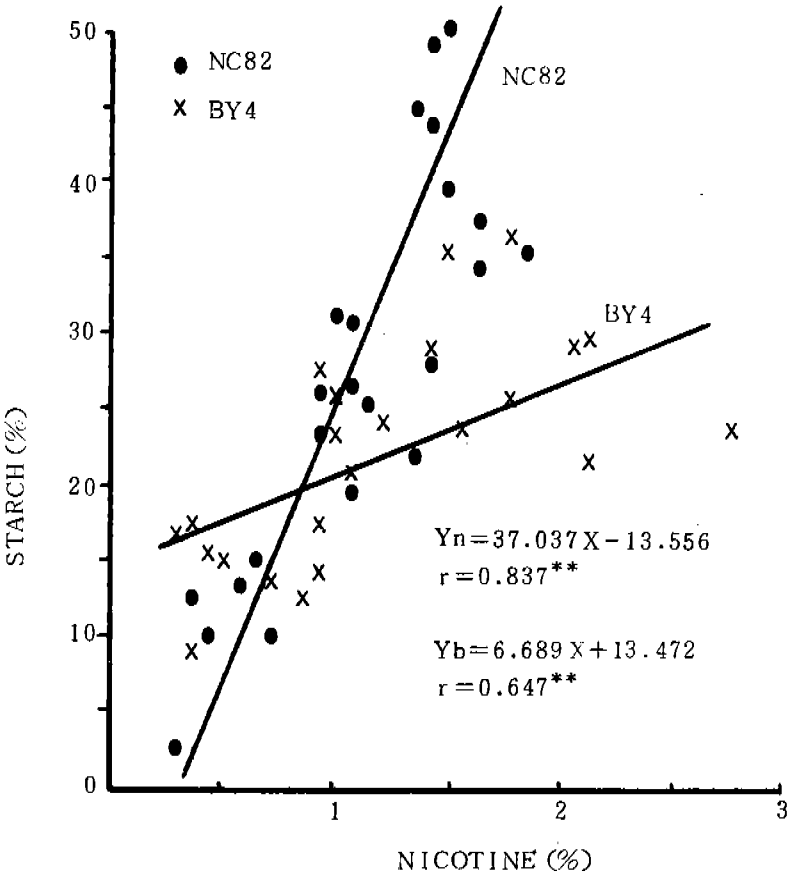

Fig.6. Relationship between starch and nicotine contents in green leaves at various stages of maturity for flue-cured tobacco.

components of green leaves decreased with delay of harvest, except the soluble nitrogen fraction which includes nicotine. The general decrease in the nitrogenous fractions in leaf lamina associated with increasing maturity appeared to be related to depletion of available soil nitrogen and normal physiological changes which accompany maturation and senescence of plants(14). These result means that the nicotine is synthesized using the nitrogen which absorbed both before and after topping. Therefore, the negative correlation between total nitrogen and nicotine due to the nicotine is synthesized using the nitrogen in the leaves after topping. The positive correlation between starch and nicotine due to the starch accumulation by the nitrogen depletion and nicotine synthesis after topping.

As seen from this experiment, tobaccos harvested at conventional time

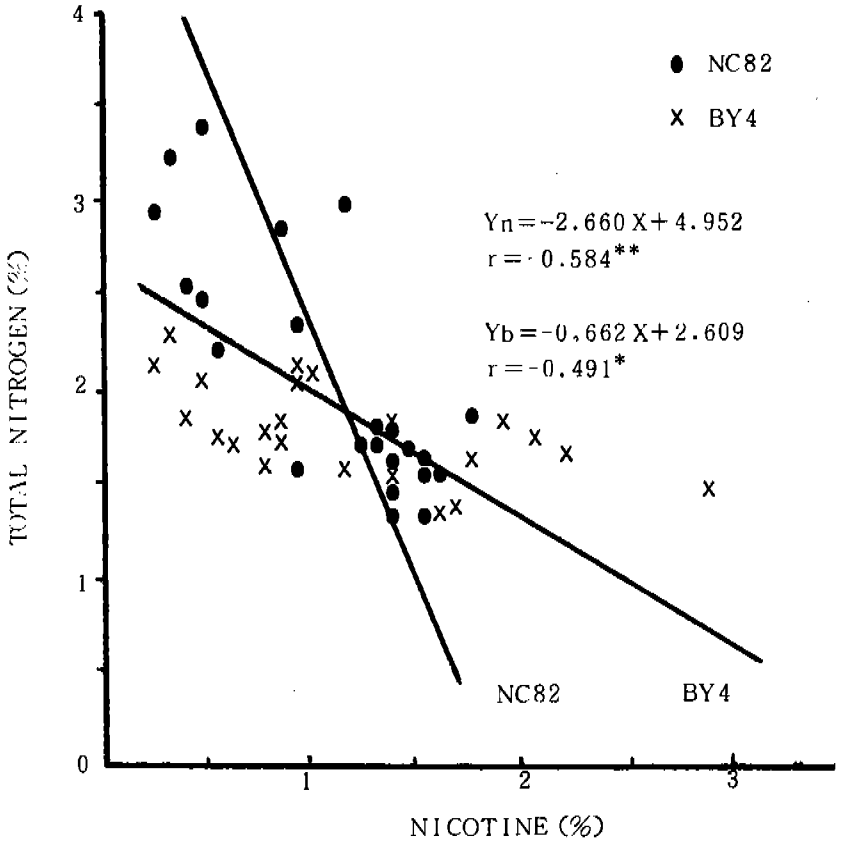

Fig.7. Relationship between total nitrogen and nicotine contents in green leaves at various stages of maturity for flue-cured tobacco.

for each stalk position contain high starch (NC82 ; 42%, BY4 ; 30%) and low nicotine (NC82 ; 1.1%, BY4 ; 1.3%,). However, the late harvested (7 days) tobacco contain lower starch(NC82 ; 31% BY4 ; 21%) and higher nicotine (NC82 ; 1.2% , BY4 ; 1.5%) than the conventional harvested tobacco. A delay of 5 to 7 days than conventional harvesting time would reach to the better ratio of the reducing sugar to nicotine ratio.

LITERATURE CITED

1. Abdallah, F. Can tobacco quality be measured ? Lockwood Publishing Co.. Inc., New York, 29-34. 1970.
2. Bowman, D.R., B.C. Nicholls. and R.N. Jeffrey. Univ. Tech. Bull. 291. 1958.
3. Flue-cured Tobacco Quality Committee Report, December, 1980 meeting.

4. Ishitoya, K., and S. Matsuyama. Bull. Okayama Tob. Expt. Sta., Japan Monopoly Crop. 235. 1955.
5. ibid : 156. 1957.
6. Kakie, T. Bull. Okayama Tobacco Experiment Station, No. 37:37-93. 1976.
7. Kim, C.H. Dambae Seongboon Boonseok Bub, Korea Tobacco Research Institute:15-16. 1979.
8. ibid : 76-78. 1979.
9. Kim, S.I., K.J. Hwang, and C.H. Kim. J. Korea Society of Tob. Sci. Vol. 4-1 : 73-78. 1982.
10. Klepper, L.D., D. Flesher, and R.H. Hageman. Plant Physiol. 48: 580-590. 1971.
11. Mosely, J.M., W.G. Woltz, J.M. Carr, and J.A. Weybrew. Tob. Sci. 7:67-75. 1963.
12. Noguchi. M., K. Yamamoto, and E. Tamaki, Tob. Sci. 8:8-12. 1964.
13. Spears, A.W., and S.I. Jones. Recent Adv. in Tob. Sci. 7:19-39. 1981.
14. Terrill, T.R. Tob. International : 72-76, April 18. 1975.
15. Tso, T.C. Physiology and Biochemistry of Tobacco Plant. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, PA. : 305-307. 1972.
16. Walker, E.K. Tob. Sci. 12:58-65. 1968.
17. Weybrew, J.A., W.A. Wanismal. and R.C. Long, Tob. Sci. 27:56-61. 1983.
18. Weybrew, J.A., W.G. Woltz, and R.J. Monros, N.C Agricultural Research Service, N.C. State University, Tech. Bull. 275. Feb. 1984.
19. Weybrew, J.A., and W.G. Woltz, Tob. International, March 21:46-51. 1975.
20. Weybrew, J.A. The key to quality -The timing of the transition, Report to North Carolina Tobacco Foundation March 20, 1979.
21. Yoshida, D. Plant Cell Physiol. .3:391-5. 1962. 1962.
22. Yoshida, D. Soil Sci. Plant Nut. 9:21-24. 1963.