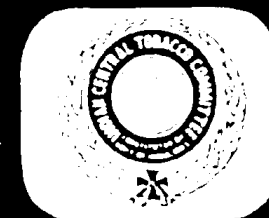
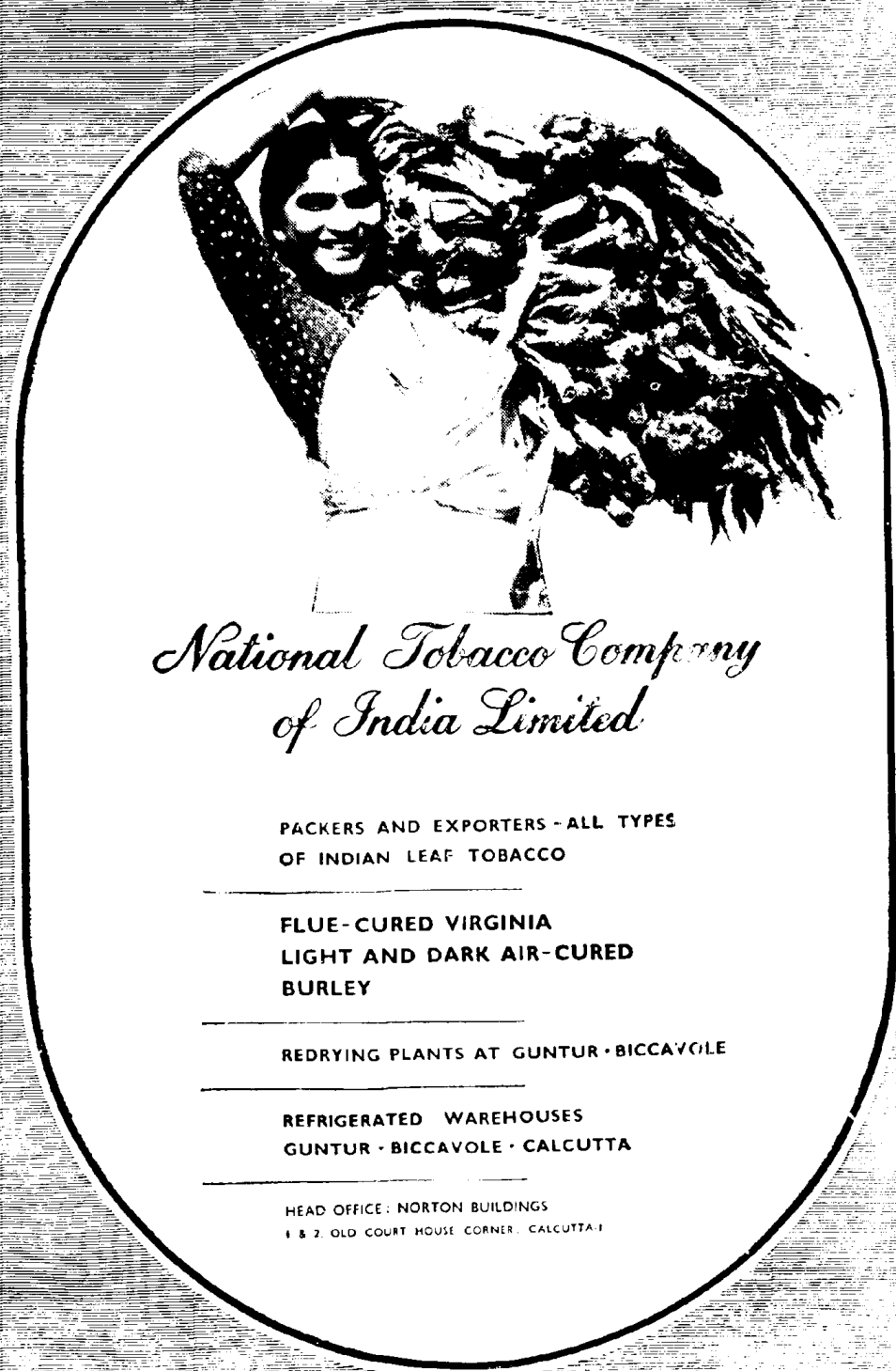


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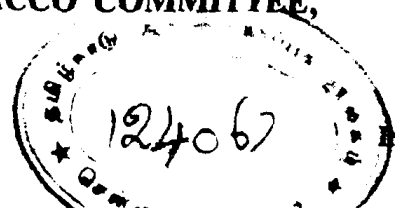
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INDIAN TOBACCO

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THIS ISSUE

Opens with an article which gives a bird's-eye-view of the role of tobacco in the country's economic progress. An optimistic note that the production of good quality tobacco will command wider market in the world is struck with confidence.

The other articles discuss the breeding of improved variety of Flue-cured Tobacco, the effects of cultural and manurial, nitrogenous and phosphatic treatments on the yield and quality of Motihari tobacco. In the last article an attempt has been made to probe into the effects of nitrogen and phosphorus manuring on the yield of Hookah tobacco.

Seminar Notes and Gleanings from World Literature on Tobacco besides other informative notes, contribute to give the reader a rich food for thought.

M. S. PATEL,
Secretary.

INDIAN TOBACCO

Role of Tobacco in the Economy of India

I. INTRODUCTION

Tobacco is said to have been introduced in India in the beginning of the 17th century by the Portuguese missionary. It was first successfully grown for commercial purposes in Gujarat and Bombay. It appears to have been grown throughout the Deccan for about a century, before it spread to other parts of the country. The F.C.V. tobacco was introduced first by Indian Leaf Tobacco-Development Company in Andhra Pradesh. It has now spread to Mysore and Gujarat States.

2. INDIA'S PLACE IN WORLD TOBACCO

India's position in the world tobacco production is the third after the U.S.A. and China and she holds the fifth rank in her export trade of tobacco, the first four being the U.S.A., Federation of Rhodesia and Nyasaland, Turkey and Greece.

3. ACREAGE AND PRODUCTION

(a) From the point of view of importance of acreage and yield, Indian tobacco occupies the sixth place amongst India's exportable commercial crops as indicated in the Table 1 given below and Chart I.

The area under tobacco represents not more than 0.5% of the total crop area in the country. Nevertheless, it is a crop of very great importance to the trade, to the industry, to labour and to the cultivators. From the point of view of revenue, it is of considerable importance to the Union Government. The total area under tobacco production and the yield per acre are steadily increasing from 1957-58 onwards as can be seen from the figures already furnished.

(b) The production and acreage of tobacco relating to important States of the Indian Union are furnished below :—

Dr. M. S. PATEL ¹ and
V. NAGARATHNA ²

¹ Secretary, Indian Central Tobacco Committee and Member, Tobacco Export Promotion Council.
² Statistician, Indian Central Tobacco Committee.

DIFFERENT CROPS ARRANGED IN ORDER OF THEIR
PLACES IN RESPECT OF ACREAGE & PRODUCTION
(1958-59 & 1959-60)

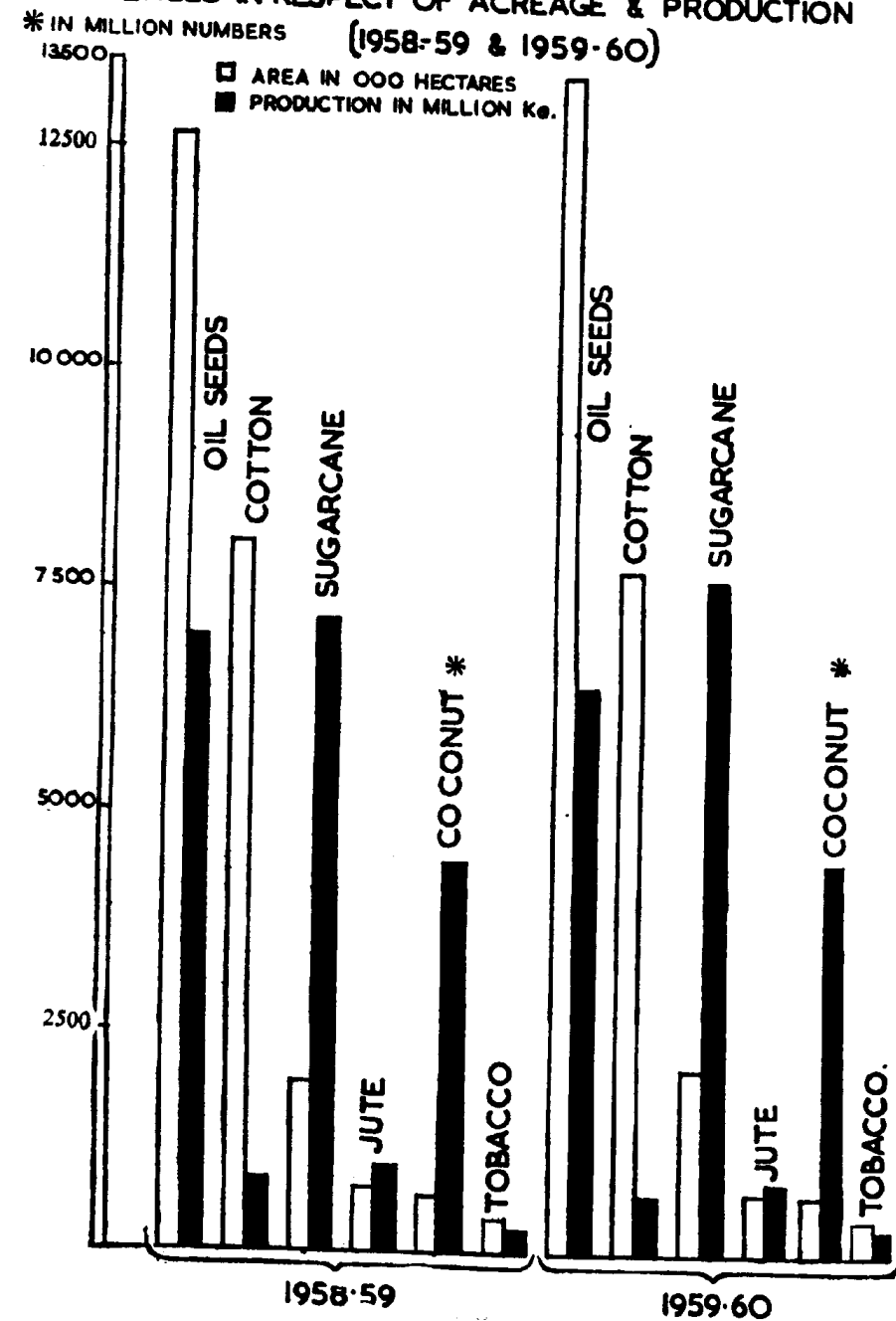


CHART I

TABLE 1.

Commodities.	1957-58		1958-59		1959-60	
	A	P	A	P	A	P
Oil seeds	12283	6148	12658	7018	13393	6454
Cotton	8096	843	8067	833	7794	682
Sugarcane	2057	6981	1945	7227	2096	7701
Jute	705	735	733	936	691	825
Coconut	661	4483*	652@	4411@	652@	4411@
Tobacco	353	241	363	265	378	286
Tea	317@	296@	317@	296@	317@	296@
Areca nut £	105	88	107	88	107	90

NOTE : * in million numbers ; @ Average for the last two years, 1955-56 and 1956-57.

1 Hectare = 2.47 acres ; 1 Kg. = 2.2046 lb.

A = Area in 000 hectares.

P = Production in million Kg.

£ Figures are subject to revision.

Source :—Agricultural Situation in India.

TABLE 2. Acreage & Production of Tobacco in the Important States of Indian Union. (1958-59 & 1959-60)

States	1958-59			1959-60		
	Area in 000 Hectares	Production in 000 kg.	Percentage of production in the total	Area in 000 Hectares	Production in 000 kg.	Percentage of production to the total
Andhra Pradesh	145.4	110,750	41.8	149.8	117,863	41.3
Gujarat	61.1	43,690	16.5	66.8	46,720	16.4
Mysore	41.3	24,386	9.2	41.7	25,402	8.9
Madras	14.6	20,321	7.7	15.8	22,353	7.8
Bihar	16.2	14,225	5.3	18.2	15,241	5.3
Uttar Pradesh	17.0	13,209	5.0	17.4	13,209	4.6
West Bengal	15.8	11,177	4.2	15.4	11,177	3.9
Maharashtra	22.7	10,161	3.8	23.5	14,243	5.0
Other States	29.1	17,272	6.5	29.5	19,304	6.8
TOTAL	363.2	265,191	100%	378.1	285,512	100%

Source :—Directorate of Economics & Statistics, New Delhi.

It would be noticed from the table, given above, that in regard to the production of tobacco, Andhra Pradesh occupies the foremost place, contributing about 41% to the total production. Gujarat with about 16% of the total production ranks second in the country's production of tobacco. Next in order of importance are the States of Mysore, Madras, Bihar, Maharashtra, U.P. and West Bengal.

4. ECONOMIC IMPORTANCE

It is estimated that there are about 10 lakhs of tobacco growers and about 7 lakhs of curers and as such the crop has become the main stay of agriculturists in areas where its production is concentrated. It brings to the growers an annual income of about Rs. 50 crores (Fig. 1).

5. EMPLOYMENT

Indian tobacco is consumed in various forms such as bidis, cigarettes, cigars, cheroots,

hookah, chewing and snuff and for varied uses different types have been developed. Quantity of raw tobacco utilised in various tobacco industries during 1955-56 to 1959-60 is shown in Chart II. Large quantities are utilised in bidi manufacture. The per capita consumption of tobacco is roughly estimated at about 0.7 kilograms. With the exception of cigarette manufacture, on a factory scale, all other tobacco products consumed in India are manufactured on a cottage industry scale. At a rough estimate, Indian tobacco industry, as a whole, gives employment directly or indirectly to about three million people (Fig. 2).

6. EXCISE EARNINGS

(a) Tobacco is currently the third most important excised commodity in the country next to cotton and sugar as will be seen from the Table 3 and the Chart III, given below, which give the Union's excise revenues collected on cotton, sugar, tobacco, tea and coffee.

TABLE 3.

Commodities	1955-56	1956-57	(Revenue in crores of rupees)			1959-60
			1957-58	1958-59		
Cotton	29.8	52.2	66.0	62.3		61.3
Sugar	18.6	20.4	42.6	59.7		59.2
Tobacco	36.4	38.0	45.9	50.9		53.7
Tea	3.5	3.5	4.2	4.9		7.7
Coffee	0.9	1.2	1.3	1.4		1.5

Source :—Customs & Revenue Statements of the Indian Union.

Taxation of tobacco for revenue purposes was first thought of in 1943 with the introduction of Tobacco Excise Duty Act. During that year excise collections came to Rs. 9 crores

only. The excise earnings have since steadily increased from about Rs. 25.9 crores in 1949-50, to Rs. 53.7 crores in 1959-60. It may go up still further.



Fig. 1. Tobacco hands for redrying.



Fig. 2. Sand-screening equipment in use.

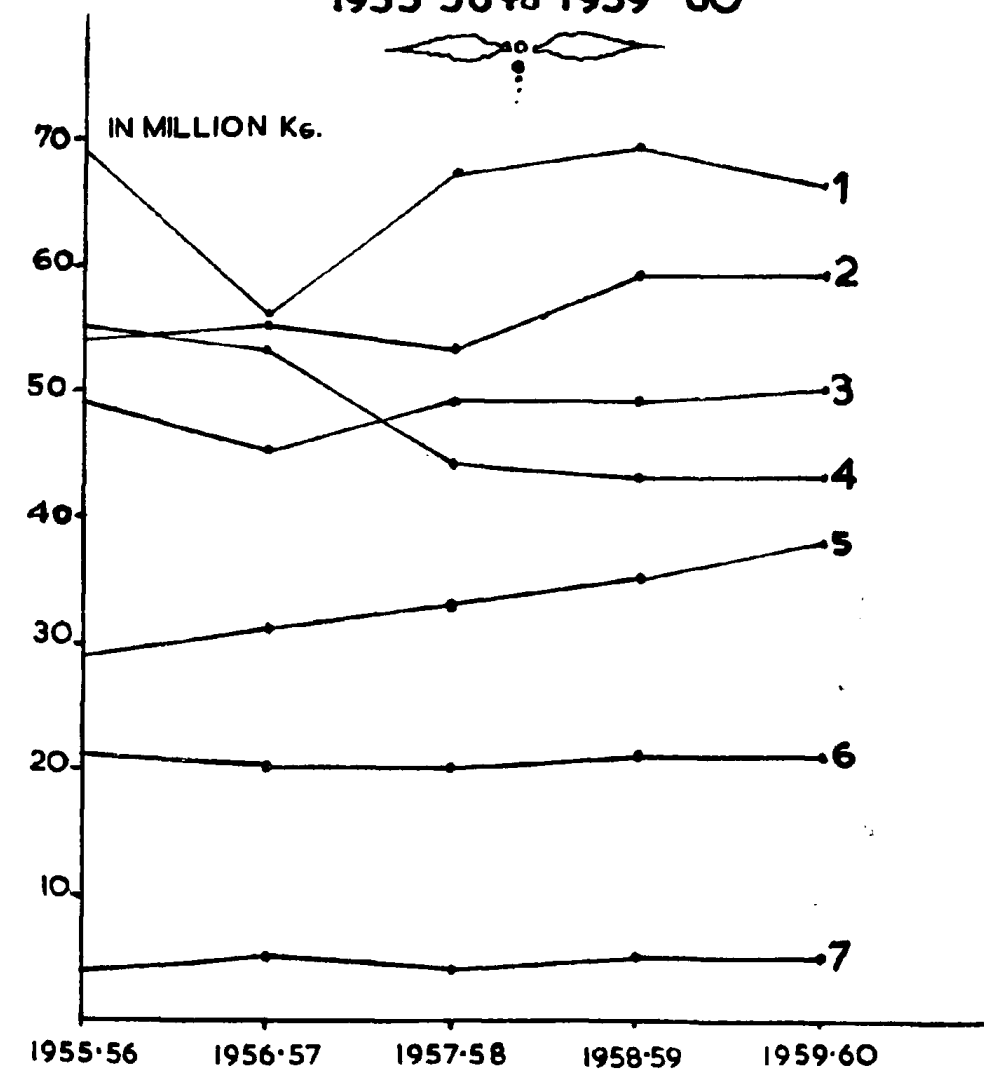


Fig. 3. Cutting machine operation. (p. 156)
—By courtesy of M/s. National Tobacco Company of India Ltd., Calcutta.



Fig. 4. Bidi making. (p. 156)

QUANTITY OF RAW TOBACCO UTILISED IN VARIOUS TOBACCO INDUSTRIES. 1955-56 to 1959-60



NOTE:

1. BIDI TOBACCO	4. HOOKAH TOBACCO
2. CHEWING TOBACCO	5. CIGARETTE TOBACCO
3. AGRICULTURAL PURPOSES	6. CIGAR & CHEROOT TOBACCO
	7. SNUFF TOBACCO

CHART II

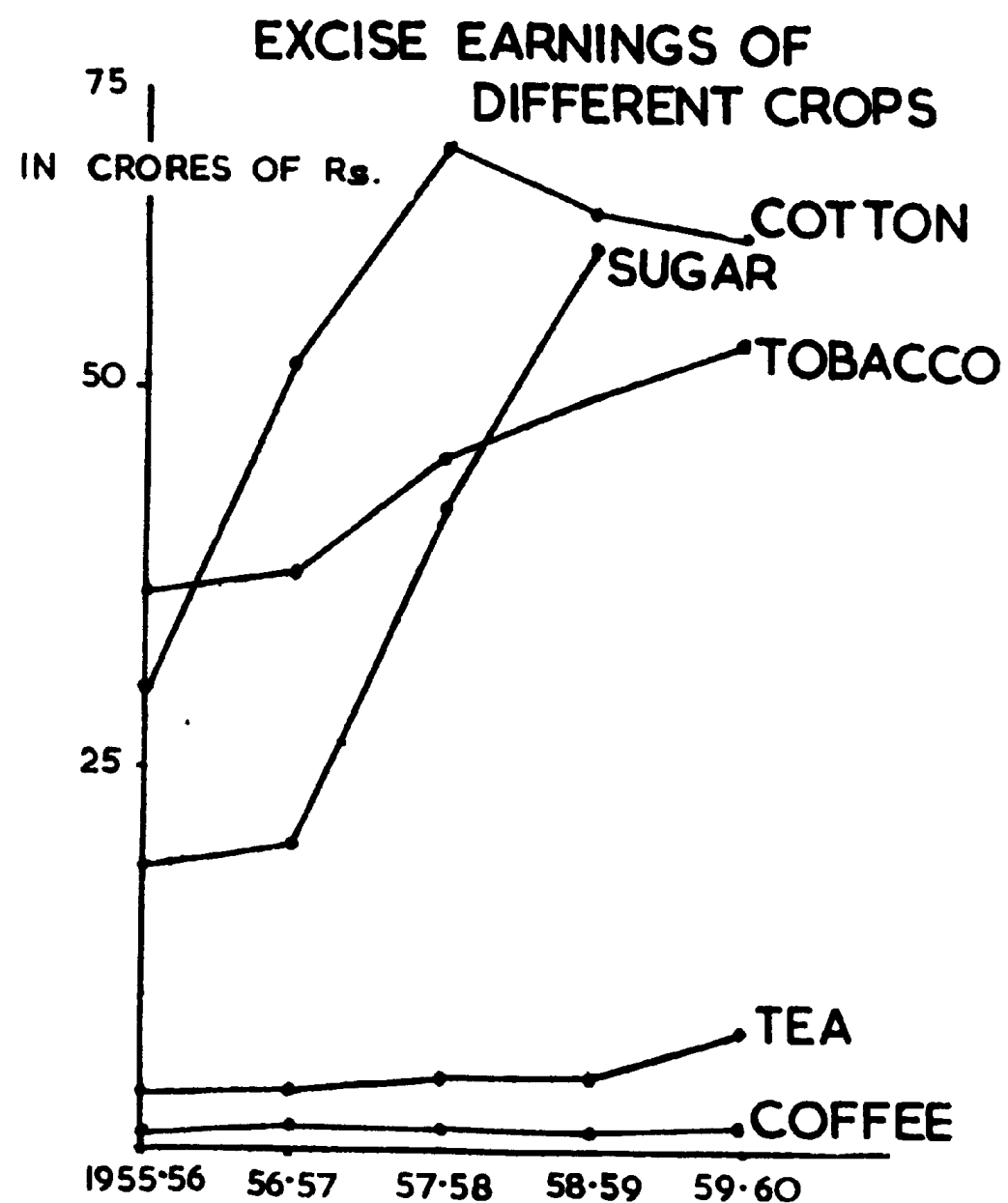


CHART III

(b) The major portion of the excise revenue tobacco and unmanufactured flue-cured Virginia is obtained from manufactured cigarettes, bidi ginia as shown in the Table 4, given below :

TABLE 4.

Years	Revenue from unmanufactured Flue-cured Virginia (Crores of Rs.)	Revenue from Cigarettes (Crores of Rs.)	Revenue from unmanufactured Bidi tobacco (Crores of Rs.)
1955-56	..	3.3	8.8
1956-57	..	3.8	9.7
1957-58	..	4.1	11.1
1958-59	..	4.4	13.0
1959-60	..	5.0	15.5

7. FOREIGN EXCHANGE EARNINGS

Tobacco is also the 9th most important foreign exchange earner. Its contribution in this line amounted to Rs. 14.5 crores during

1959-60. Taking however only commercial crops into account, tobacco ranks 6th important commodity earning foreign exchange. The values and the export duty/cess realised on these crops are as follows :

TABLE 5.

* Year Commodities	1959 Value in Crores of Rs.	1958-59 *Export duty in 000 Rs.	1958-59 *Cess in 000 Rs.	1960 Value in Crores Rs.	1959-60 *Export duty in 000 Rs.	1959-60 *Cess in 000 Rs.
Jute	111	4	..	142	2,997	..
Tea	126	1,49,811	10,907	120	1,13,200	9,459
Cotton	83	16,351	111	74	5,269	65
Fruits & Vegetables	21	..	..	25	..	..
Oil—vegetable, mineral and animal	18	N.A.	N.A.	16	N.A.	N.A.
Tobacco	13.8	..	808	15.7	..	727

* Financial year.

N.A. = Not available.

NOTE : No export duty is charged on manufactured and unmanufactured tobacco.

Source :—1. Commerce, 2. Customs & Excise Revenue statements of the Indian Union, 3. Annual Reports of the Commodity Committees.

8. TRADE

(a) EXPORTS AND EXPORT DUTY

Indian tobacco is exported to over 50 countries all over the world. The exports represent only about 16% of the country's total tobacco production. During the year 1959-60, about 41.1 million Kgs. of tobacco were exported from India, of which Virginia tobacco alone accounted for about 75 to 80 per cent. The most important markets for Indian tobacco are the U.K., Aden, the U.S.S.R., Belgium, the Netherlands, the Irish Republic, Hongkong, Egypt, Ceylon, French West Africa, Singapore, West Germany and Saudi Arabia which put together import about 90% of Indian tobacco exports.

(b) IMPORTS AND IMPORT DUTY

India imports only small quantities of tobacco. The import duty is charged on all forms of tobacco imported into India and varies according to types and sources. Annually about Rs. 1.8 crores are being collected by way of import duty on tobacco.

9. MANUFACTURE

There are at present 14 cigarette factories working in the country with an annual turnover of about 3,700 crore pieces of cigarettes (Fig. 3. facing p. 153). Six cigarette factories are situated in Maharashtra, three in West Bengal, two in Andhra Pradesh, and one each in Mysore, Bihar and U.P. Production of cigarettes is rising year after year and an increase of about 40% over the last 5 years is observed. Only, however, a small quantity of cigarettes is exported and the remainder is utilised for domestic consumption.

The cigar and cheroot industries are confined mainly to the States of Andhra Pradesh and Madras and to a certain extent to West Bengal also. Bidi manufacture is perhaps the

biggest tobacco industry on cottage scale spread all over the country but concentrated in Madhya Pradesh, Gujarat, Maharashtra, West Bengal, Bihar, Mysore and Madras States (Fig. 4. facing p. 153). Uttar Pradesh, West Bengal and Punjab are well known for hookah industry while the snuff industry is concentrated in Maharashtra, Gujarat, Andhra Pradesh and Madras. Chewing tobacco manufacture is confined mostly to Madras, Gujarat, Maharashtra, U.P., Kerala, Orissa and Mysore.

10. BY-PRODUCTS OF TOBACCO INDUSTRY

Annually about 2.97 million Kg. of tobacco are cleared for destruction. Tobacco waste can be used for the extraction of Nicotine Sulphate, a powerful insecticide for agricultural crops and for agricultural purposes as manure after composting.

Indications have also been obtained that Nicotinamide, an important constituent of Vitamin B can also be made out of tobacco waste.

Another by-product of tobacco is its seeds. *Nicotiana tabacum* of Virginia type used in cigarette manufacture which is not topped at present gives seeds which could be used for oil. Roughly about 150,000 to 250,000 seeds per plant, about 1 oz. (25 gms.), are obtained.

Tobacco seed yield is estimated at 196 Kg. per hectare. The production of tobacco seed is largely confined to the State of Andhra Pradesh, wherein Virginia tobacco is mostly grown (Fig. 5).

According to the information received from Director of Agriculture, Andhra Pradesh, the quantity of tobacco seed available for commercial purposes in Andhra Pradesh during the years 1958-59 and 1959-60 was 8,636 metric tonnes and 6,858 metric tonnes respectively. The quantity of tobacco seed actually collected

for oil extraction during the above years was 6,613 metric tonnes and 5,050 metric tonnes respectively. Tobacco seed, apart from being used for cultivation purposes, can be used for extraction of oil and as cattle feed also. The oil extracted from the seed is devoid of nicotine and is edible. It is also used in soap making and for illumination purposes. It can be used with advantage as a drying oil, in place of linseed oil, in the manufacture of

VALUE OF EXPORTS, EXCISE REVENUE & IMPORT DUTY OF TOBACCO 1955-56 to 1959-60

INDIAN TOBACCO EARNINGS FROM ALL SOURCES ARE INCREASING

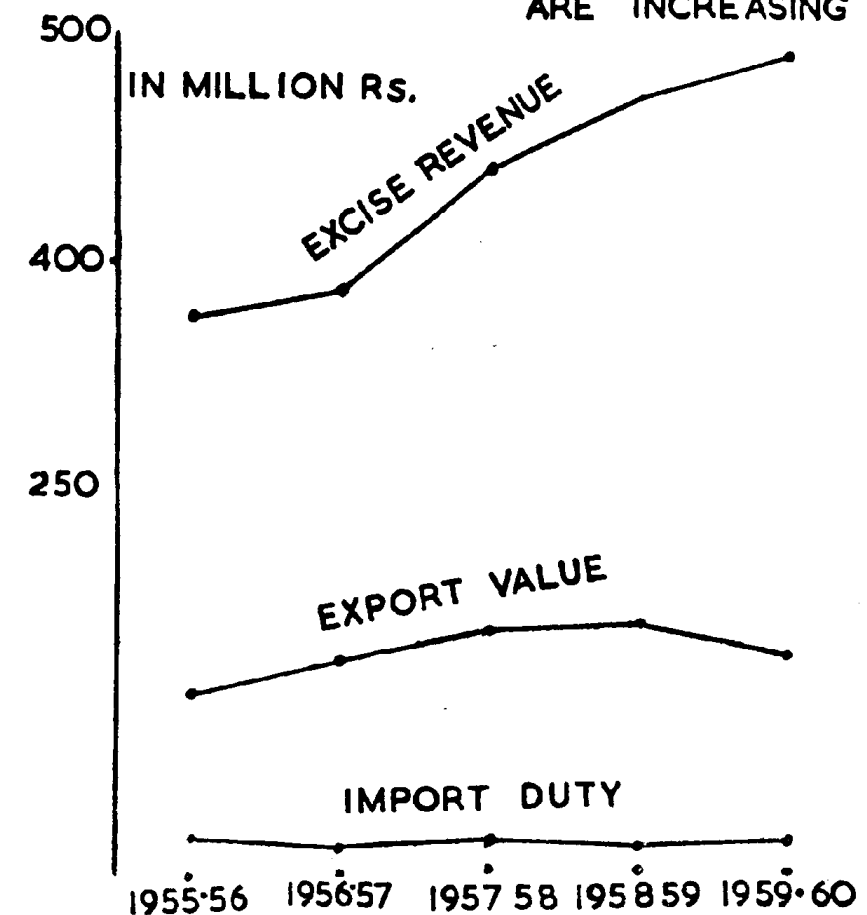


CHART IV

enamels, paints and varnishes. The oil-cake left over after extraction of oil can be used as manure for paddy and sugarcane and as cattle feed. Possibility of its being hydrogenised has also been strongly indicated for use as a cooking medium.

11. CONCLUSION

From the preceding facts it can be concluded that tobacco occupies a very important place in the agricultural economy of the country and revenue from it is steadily increasing as can be observed from Chart IV. It enriched the national exchequer with about Rs. 54 crores during 1959-60 by way of excise duty. An increase of about Rs. 2.2 crores is expected during 1961-62 as a result of recent change in excise tariff. The expansion of cigarette indus-

try is evidenced by the fact that there are as many as 120 brands of cigarettes in the market. Efforts are already under way to improve the quality of tobacco in line with the changing habits and preferences of consumers abroad and also to increase the yield per acre without increasing acreage, so that Indian tobacco attains greater and firmer competitive assertiveness in international markets and fetches higher returns to the farmer and increased revenues to the national exchequer.

ACKNOWLEDGMENT

The authors wish to acknowledge their gratitude to Sri A. N. Srivastava, M.Sc., Superintendent, Indian Central Tobacco Committee, for going through the manuscript.

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Fig. 5. Flue-cured Virginia crop of cigarette tobacco ready for harvest. (p. 156)



Dr. M. S. Patel, Secretary, Indian Central Tobacco Committee, explaining the budget to the Finance Sub-Committee of the Indian Central Tobacco Committee.



Breeding of an Improved Variety of Flue-Cured Tobacco by Genetic Analysis of Flowering Time in Harrison Special

G. S. MURTY¹,
B. R. MURTY², and
D. M. GOPINATH³

^{1, 2 & 3} Central Tobacco Research Institute, Rajahmundry.

In the flue-cured tobacco belt of Southern India, the predominant variety has been Harrison Special which was introduced nearly four decades ago. It was observed that this variety had accumulated considerable genetic variability for morphological characters such as leaf shape, position of the panicle, flower colour, and flowering time as well as leaf maturity (Kadam *et al*, 1952). Certain lines were isolated which were true-breeding for panicle habit and flower colour. Several intergradations of morphological types between *natu* and flue-cured were met with which probably resulted from introgression from the *natu*-types in the surrounding areas. The spread of these biotypes in an essentially self-pollinated crop like tobacco is likely to be due to the vigour, earliness and higher reproductive potential of the hybrids as compared to their flue-cured counterparts. An examination of the range of flowering time in the above study revealed parallel variation for flowering time ranging from 60 to 120 days in all the lines of Harrison Special collected from various sources. There was parallel variation in flower colour also. A strain which was being grown by some farmers as "Harrison Special — Early" really was not different from the other bulk populations of Harrison Special either in the mean or variance for flowering time. Since it is advantageous to evolve early strains to suit the black soils of this region where limitation of moisture would affect the curing behaviour, the present study was taken up to assess the genetic variability for flowering time in the bulk population of Harrison Special. The parent-progeny regression analysis was also done to estimate the heritability for this character since it would indicate the degree of genetic advance one could make for earliness in this variety.

MATERIAL AND METHODS

Twenty selections were made from a bulk population of Harrison Special, ten for early

and ten for late. The difference in flowering time between these two categories was nearly 30 days. Their progenies were grown next year and the date of first flowering was noted in each plant in a replicated trial of 3×20 R.C.B. design. Data on green and cured leaf yield and Total Bright Leaf Equivalent were also collected. There was significant shift in the flowering time in the next season in all the lines. To overcome at least partly this difficulty of seasonal variation for the analysis of regression, transformation of the original variate of days to flower from the date of planting to the standardised normal form was done (Frey and Horner, 1957). The parent-progeny regression was estimated for the new variate. Although this would not remove completely the seasonal effect, the comparisons were on an equal scale. Homogeneity of variances within the lines was tested by Bartlett's X^2 test.

RESULTS

The flowering data for the years 1956-57 and 1957-58 are presented in Table 1.

The flowering time in the early selections ranged from 53 to 59 days in 1956-57 and in the late lines it was 90 days. Next year, i.e. in 1957-58, the mean flowering time in the early lines ranged from 70 to 78 days. In the late lines the range was from 78 to 84 days. The 1957-58 season was very favourable due to increased rainfall and presumably because of this the difference between the two categories was narrower than in the parental selections.

The combined analysis revealed significant difference in the means between early and late lines. Either within the early lines or within the late lines, the differences were not significant. However, the variances within early lines were significantly different from each other (X^2 for 9 d.f. = 17.4961) whereas in the late

lines they were not significant. No relationship could be found between the means and the variances on the original scale (Table 1). Therefore, transformation of the original data was not attempted. In general, the variances were larger in the late lines; the greater variation in the climate during the later part of the season was probably responsible for this. The early lines E_3 , E_5 , E_8 and E_9 had very low variances which indicates that they were practically homozygous for the genes controlling this character.

The green and cured leaf yield did not differ among the lines (Table 2).

However, the Total Bright Leaf Equivalent was higher in the early lines (Table 2). Such improvement in quality could be due to better utilisation of soil moisture, although the yield potential which is primarily determined by the leaf number, size and the body remained the same.

The parent-progeny regression on the transformed scale was 0.3343 compared to 0.3287 on the original scale. Therefore, the heritability (additive part) for this character appears to be about 30 per cent. It would be possible to make advance for earliness upto the lower limit of 53 days which was met with in this study. In the late lines an upper limit appears to have been already reached.

DISCUSSION

This study established that the flue-cured tobacco variety Harrison Special as it is now grown is a collection of several bio-types varying in flowering time also. The question arises how these bio-types are being maintained in a more or less constant proportion for the past several years. The possible explanations are — (i) selective advantage of heterozygotes over the homozygotes, (ii) homeostatic properties of the populations, (iii) absence of relationship

TABLE 1. Mean flowering time in days from the time of transplanting in twenty isolates from Harrison Special bulk.

Selection	Mean flowering time				Variance (Vi)	Degrees of freedom	Log Vi
	in days		in standardised units				
	1956-57	1957-58	1956-57	1957-58			
A. EARLY SELECTIONS :							
E ₁	53	70.2	-1.5046	-2.2381	85.60	45	1.9325
E ₂	55	71.4	-0.9386	-1.2857	105.92	48	2.0253
E ₃	56	77.7	1.9601	-0.8095	40.17	56	1.6039
E ₄	59	70.9	-1.1549	0.6190	62.06	47	1.7928
E ₅	59	75.5	0.9616	0.6190	36.65	54	1.5641
E ₆	59	72.5	-0.4463	0.6190	106.13	56	2.0257
E ₇	59	73.7	0.1058	0.6190	90.98	55	1.9589
E ₈	59	74.7	0.5798	0.6190	59.60	51	1.7753
E ₉	59	74.4	0.4555	0.6190	35.99	55	1.5562
E ₁₀	59	73.4	-0.0184	0.6190	70.83	56	1.8502
Mean	57.7	73.4	..	..			
B. LATE SELECTIONS :							
L ₁	90	82.7	..	0.1779	124.49	46	2.0952
L ₂	90	78.5	..	-0.7702	103.01	52	2.0128
L ₃	90	84.0	..	0.4664	86.37	46	1.9364
L ₄	90	84.0	..	0.4664	101.78	49	2.0077
L ₅	90	84.0	..	0.4664	95.22	49	1.9787
L ₆	90	81.7	..	-0.0456	103.83	52	2.0152
L ₇	90	83.8	..	0.4165	53.67	47	1.7207
L ₈	90	79.4	..	-0.5380	94.34	49	1.9747
L ₉	90	80.6	..	-0.2777	126.51	50	2.1021
L ₁₀	90	80.2	..	-0.3645	120.73	49	2.0817
Mean	90.0	81.9	..	..			

S.E.M at 5% for main effects (Early vs. late) — 0.73 Highly significant.

S.E.M at 5% for sub-treatments — 2.30 Not significant.

S.E. as per cent. of mean — 5.14.

Bartlett's X^2 test for homogeneity of variances :

X^2 for early lines (9 d.f.) = 17.4961.

X^2 for late lines (9 d.f.) = 5.4990 (Not significant).

Parent-progeny regression on the transformed scale = 0.3343.

TABLE 2. Yield of Green Leaf, Cured Leaf, Bright Leaf, and Total Bright Leaf Equivalent in 1957-58, of isolates from Harrison Special Bulk.
(In Kg. per hectare.)

Harrison Special Early and late selections		Green leaf	Cured leaf	Bright leaf	Total Bright leaf Equivalent
(1) Early 1	..	4737	917	262	437
2	..	5451	887	185	368
3	..	6647	1216	225	511
4	..	5693	954	230	440
5	..	6551	1060	316	521
6	..	5708	897	180	343
7	..	5787	1085	227	430
8	..	5538	941	247	452
9	..	5896	951	217	440
10	..	6192	1077	267	484
Mean	..	5819	998	235	442
(2) Late 1	..	6568	971	247	445
2	..	6326	1008	203	393
3	..	5528	867	128	297
4	..	5787	988	193	373
5	..	5614	1003	173	425
6	..	6071	1008	158	373
7	..	5449	919	148	351
8	..	6098	1050	170	398
9	..	5159	914	173	331
10	..	5856	976	205	378
Mean	..	5846	971	180	376
S.E.%	..	16.76	18.4	34.94	23.53
C.D. at 5% for testing the differences of the means of Harrison Special early and late	..	N.S.	N.S.	37.95	50.36

between flowering time and other characters in which the trade is interested (Lorner, 1954). The third is ruled out because gross yield differences which form the basis of any selection by the farmers were not met with. And the differences in bright grades which were observed in this study can be detected only at a very late stage of the crop and therefore could not have been utilised by the farmers for selecting seed plants. The vigour of the heterozygotes is obviously responsible for maintaining the gene frequencies for this character. The extent of natural out-crossing through which the heterozygotes have arisen originally must be higher than the 4% value postulated by Bhat and Krishnamoorthi (1956) so as to account for the high frequency of the heterozygotes. Variation in the relative positions of the stigma and the anthers which influence the breeding structure of the population are known even within the same plant during different parts of the same season.

As regards the homeostatic properties, the high variances in the late lines without significant differences among the lines, suggest that different genetic combinations are maintained which exhibit more or less the same phenotype. Moreover, the fact that further advance could not be made for lateness suggests that the high degree of variance was more due to non-adaptive variation than to the release of cryptic genetic variability (Clausen and Hiesay, 1958). The differences in the variances among the early lines were obviously due to fixation at different stages of homozygosity. This indicates that some success could be obtained in the early lines for advancing the flowering time, whereas a threshold had already been reached for the late lines. Such a situation is expected as the genotypes which flower very late are not likely to be included in the seed collected for the next season. This explains the absence of differences among the late lines in spite of the higher variances.

The high degree of non-adaptive variation in the late lines and any linkage of the genes for earliness with those for curing behaviour which would automatically reduce the variance would limit the fixable portion of genetic variability. Presumably, therefore, the heritability was not as high as anticipated.

Based on this study the two distinct populations, early and late, are maintained by selecting individual plants and noting their dates of flowering. A total of two thousand such plants were selected during 1960-61. These individual plants will be used for selecting the earliest among the early strains, and the latest among the late strains. The early lines as a group fared better than Harrison Special in yield characters also. Among the early lines, one progeny, viz. E₂ appears to be outstanding. Its performance in comparison with Harrison Special grown in the same field is given in Table 3.

In view of its superior performance, the improved strain E₂ is being multiplied for field trials in the different districts. This strain is designated FCR 1. The letters FCR stand for the varieties of flue-cured tobacco evolved at the Central Tobacco Research Institute, Rajahmundry.

SUMMARY

The variability for flowering time encountered in populations of the flue-cured tobacco variety Harrison Special from different sources, the results of selection in two opposite directions, viz. early and late and the subsequent yield performance were examined.

Significant differences were found in the mean flowering time between the groups of ten early and ten late lines but, within each group the differences were not significant. Heterogeneity for variances was observed in the early group but not among the late lines. Based on parent-progeny regression on a standardized

TABLE 3. Yield performance of early isolates in comparison with Harrison Special. (In kg. per hectare)

	Green leaf	Cured leaf	Bright leaf
(i) Harrison Special ..	5,539	910	15.7
(ii) Mean of the 10 early isolates (Em) .	7,203	986	18.1
(iii) Increase of Em over Harrison Special ..	30.1%	8.4%	15.9%
(iv) Early strain E ₂ ..	8,263	1,181	34.2
(v) Increase of E ₂ over Harrison Special.	49.2%	29.9%	118.2%

normal scale, heritability for this character was found to be nearly 30%. Gross yield differences were not met with but, yield of bright leaf was significantly higher in the early group compared to the other group.

The performance of one of the early lines in the next generation was found to be superior to Harrison Special in green, cured and bright leaf respectively by 49.2, 29.2 and 118.2 per cent. This strain has been designated FCR 1.

The causes of the maintenance of several biotypes varying in flowering time in the populations of Harrison Special were discussed in relation to the selective advantage of heterozygotes over the homozygotes, the homeostatic properties of the populations, and other components of fitness.

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Effect of Some Cultural and Manurial Treatments on the Yield and Quality of Motihari Tobacco (*N. rustica*) in North Bengal*

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INTRODUCTION

Motihari tobacco since past many years has been a crop of prime importance to the tobacco growers in Cooch-Bihar and Jalpaiguri districts of North Bengal. Of the total acreage of about 40,000 under tobacco in the State of West Bengal, about 24,000 acres are planted with *Motihari* variety and the above-mentioned two districts together account for about 90% of the acreage under *Motihari* tobacco.

No studies are known to have been made on the cultural and manurial requirements of this tobacco. An experiment was therefore laid out at the Wrapper & Hookah Tobacco Research Station, Dinhata, during 1955-56 to broadly determine the optimum requirements of *Motihari* tobacco with regard to such important factors as time of planting, manuring, spacing and topping. The results obtained are presented in this paper.

MATERIAL AND METHODS

(i) SITE AND SOIL

The experiment was conducted at the farm of the Research Station during the 1955-56 and 1956-57 seasons. In each season a new site was selected. Most of the land was freshly brought under tobacco cultivation. For laying out the experiment, small plots were merged together and levelled up. The soil was a sandy loam type.

(ii) EXPERIMENTAL

The experiment was laid out in a split-plot design with 3 replications. Dates of planting, manures, and spacing-topping treatments were assigned to main plots, sub-plots and sub-sub-plots respectively. The ultimate net plot size was 8' × 12' = 0.22 cent.

Main plot treatments (Planting Dates)

D₁ — Last week of October.

D₂ — Second week of November.

D₃ — Last week of November.

The specific dates of planting during the two seasons were as follows :—

Dates	1955-56	1956-57
D ₁	23rd October	28th October
D ₂	8th November	13th November
D ₃	23rd November	28th November

Sub-plot treatments (Manures)

- M₁ — Farmers' practice — 25 cartloads of f.y.m./acre (1 cartload=1000 lbs.)
M₂ — 10 cartloads of f.y.m.+0 lbs. N/acre.
M₃ — 10 cartloads of f.y.m.+50 lbs. N/acre.
M₄ — 10 cartloads of f.y.m.+100 lbs. N/acre.
M₅ — 10 cartloads of f.y.m.+150 lbs. N/acre.
M₆ — Dhaincha green manure+0 lbs. N/acre.
M₇ — Dhaincha green manure+50 lbs. N/acre.
M₈ — Dhaincha green manure+100 lbs. N/acre.
M₉ — Dhaincha green manure+150 lbs. N/acre.

Single superphosphate at the rate of one maund (82 lbs.) per acre was applied at the time of sowing Dhaincha (*Sesbania aculeata*) and the same quantity was applied in the non-Dhaincha treatments except in M₁ — Farmers' practice.

Sub-sub-plot treatments (Spacing-topping combinations)

Spacings.	Toppings.
S ₁ — 2'×2'	T ₁ — 4 leaves per plant.
S ₂ — 2'×1½'	T ₂ — 6 leaves per plant.
	T ₃ — 8 leaves per plant.

Farmyard manure was applied about two weeks before planting and mixed by four ploughings each followed by planking. Dhaincha for green manuring was broadcast in the last week of May and ploughed in with light soil turning ploughs after about 7 weeks' growth. Bulk of the green matter remained at the surface only. Nitrogen in the form of

ammonium sulphate was applied in shallow rings around the plants three weeks after planting. The variety planted in the experiment was a late maturing type of Motihari tobacco locally known as 'Hemti'.

All the cultural operations done in the experimental crop conformed to the local practices. In 1955-56 season the crop received one irrigation. During 1956-57 only D₁ plots were irrigated while D₂ and D₃ plots were not irrigated, due to the rains received during the second week of January.

(iii) OBSERVATIONS

For observational purposes, three plants were randomly selected per plot after topping. The length and breadth of all the leaves of these three plants were measured at maturity. These plants were then separately harvested, their leaves cured as usual and their stems air-dried. The cured weight of the leaves and the air-dry weight of stems were recorded. In addition to the above, cured leaf yield and the quantity of first grade leaf per plot were recorded.

SEASON

Dinhata is situated in the sub-Himalayan region of West Bengal. The climate is warm and humid. Annual average rainfall is about 2,865 mm. The months of May, June, July and August are usually heavy rainfall months. Monsoon rains lose intensity in September and usually cease near about the end of October. However in abnormal years, there may be practically no rains in October or there may be heavy showers even at the end of October. November, December and January are practically rainless months. In February and March, cyclonic storms usually bring a few light showers. Pre-monsoon showers normally commence towards the end of April.

January is the coldest month with a mean monthly temperature of 62.7°F. The mini-

TABLE 1. Rainfall, temperature and relative humidity at Dinhata during tobacco growing season.

Meteorological weeks	Rainfall						Mean* temperature °F	Mean relative humidity %
	1955-56		1956-57		Mean 1942-43 to 1955-56			
	Rain-fall mms.	Rainy days	Rain-fall mms.	Rainy days	Rain-fall mms.	Rainy days		
Oct. 1-7	54.9	1	41.9	4	79.8	2.7	82.5	80.4
8-14	..	..	77.2	3	26.5	1.3	82.1	80.0
15-21	..	..	202.7	6	41.8	1.4	78.3	77.0
22-28	..	..	..	..	19.5	0.8	77.6	74.3
29-4th Nov.	..	..	33.3	4	13.5	0.4	74.8	75.0
Nov. 5-11	..	..	..	..	..	..	73.6	74.0
12-18	..	..	..	..	0.9	0.1	72.1	70.4
19-25	..	..	..	..	0.2	0.1	70.8	69.8
26-2nd Dec.	..	..	..	..	1.6	0.3	69.9	71.8
Dec. 3-9	..	..	..	..	1.0	0.1	67.3	71.0
10-16	..	..	..	..	..	..	69.7	71.4
17-23	..	..	..	..	..	..	64.9	73.1
24-31	..	..	..	..	..	..	63.8	72.3
Jan. 1-7	..	..	..	..	4.1	0.4	62.4	72.6
8-14	..	..	91.2	4	0.5	0.4	62.9	76.8
15-21	..	..	..	..	0.9	0.3	62.9	71.1
22-28	1.8	1	..	..	3.3	0.3	62.8	73.8
29-4th Feb.	8.6	2	6.6	1	5.3	0.6	63.2	71.8
Feb. 5-11	10.2	1	..	..	2.9	0.4	64.4	67.9
12-18	..	..	..	..	0.1	0.1	65.9	63.1
19-25	..	..	..	..	5.1	0.4	68.1	62.8
26-4th Mar.	..	..	5.3	1	3.7	0.4	70.6	62.8
Mar. 5-11	10.2	1	8.9	1	2.3	0.3	70.3	62.2
12-18	13.7	2	1.0	1	7.7	0.9	76.1	56.4
19-25	24.1	1	..	..	9.2	1.1	78.3	56.8
26-1st Apr.	19.1	1	1.0	1	12.2	1.2	78.0	61.5
Total	142.6	10	469.1	26	242.1	14.0		
Total for the year	3,710.7	125	3,073.1	107	2,865.5	113.5		

*Average of five years (1953-54 to 1957-58)

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imum temperature seldom drops below 50°F. March. The principal growing season for Motihari tobacco covers the months of November, December and January. The weather data for 1955-56 and 1956-57 according to meteorological weeks for the principal growing season are given in Table 1.

TABLE 2. Final length and breadth of leaves in inches under various treatments*
(Average of measurements made on all leaves of 3 plants per plot and 3 replications)

Treatments	1955-56		1956-57		Mean	
	Length	Breadth	Length	Breadth	Length	Breadth
<i>Planting dates :</i>						
D ₁	11.46	8.25	13.05	9.91	12.26	9.08
D ₂	12.14	8.99	12.23	8.99	12.19	8.99
D ₃	11.17	8.39	12.18	9.11	11.68	8.75
<i>Manures :</i>						
M ₁	11.04	7.97	12.13	8.78	11.59	8.38
M ₂	10.84	7.84	11.43	8.18	11.14	8.01
M ₃	12.12	8.97	13.02	9.99	12.57	9.48
M ₄	12.57	9.49	13.43	10.29	13.00	9.90
M ₅	12.60	9.59	13.60	10.52	13.10	10.06
M ₆	10.35	7.25	11.38	8.13	10.87	7.69
M ₇	10.95	7.99	12.19	9.16	11.57	8.58
M ₈	11.96	8.84	12.68	9.55	12.32	9.20
M ₉	11.89	8.94	12.51	9.45	12.20	9.20
<i>Spacings :</i>						
S ₁	11.76	8.74	12.66	9.56	12.21	9.15
S ₂	11.42	8.34	12.31	9.12	11.87	8.73
<i>Toppings :</i>						
T ₁	11.91	8.98	12.90	9.87	12.41	9.43
T ₂	11.58	8.50	12.54	9.33	12.06	8.92
T ₃	11.28	8.14	12.02	8.83	11.65	8.49
Mean	11.59	8.54	12.49	9.34	12.04	8.94

* Leaf length was measured along the mid-rib and includes the length of petiole also. Breadth of the leaf was measured across the mid-rib and corresponds to the maximum width of the lamina.

It would be seen that both the seasons differed from each other as well as from the normal in respect of amount and distribution of rainfall. In 1955-56 the rains ceased unusually early in October and hence the crop, particularly the late planted one, experienced moisture shortage. During 1956-57 there were heavy rains throughout October and hence the soil moisture status remained quite high especially during early plantings. Again in the second week of January, there were unexpected rains which caused considerable damage and killed the plants in low-lying patches. The crop in the second week of November (D₂ treatment) suffered the most.

Considering the rainfall and its distribution during both the seasons, the 1955-56 has been termed as 'dry' and 1956-57 as 'wet' season.

EXPERIMENTAL RESULTS

(i) LEAF SIZE

The data on the effect of various treatments on the leaf size are summarised in Table 2.

The leaf size tended to decrease in the crop that was planted late in November. In the earlier planted crop the effect of planting time on the size of the leaf was not consistent. In both seasons, however, the planting date producing the highest yield also produced the largest sized leaves.

Application of 50 lbs. nitrogen per acre markedly increased the size of the leaf. Higher levels though tended to further increase the leaf size, the relative increase was rather small. As compared to the Dhaincha green manure, the leaf was longer with farmyard manure. In general the treatments carrying inorganic nitrogen produced larger leaves than Farmers' practice (M₁).

Closer spacing and higher toppings tended to decrease the length and breadth of the leaves.

(ii) WEIGHT OF CURED LEAF

The data on the effect of various treatments on the weight of cured leaf are presented in Table 3.

TABLE 3. Total weight of cured leaf in gms. from 3 sample plants under various treatments.

(Average of 3 replications)

Treatments	1956-57	1957-58	Mean
<i>Planting dates :</i>			
D ₁	109.3	130.2	119.7
D ₂	137.5	131.2	134.4
D ₃	115.3	126.2	120.7
C.D. at 5%	N.S.	N.S.	
<i>Manures :</i>			
M ₁	95.3	107.4	101.4
M ₂	96.5	97.6	97.0
M ₃	129.9	147.0	138.4
M ₄	145.0	153.4	149.2
M ₅	155.0	167.9	161.5
M ₆	88.4	100.9	94.6
M ₇	107.3	126.7	117.0
M ₈	127.6	135.1	131.3
M ₉	141.2	141.9	141.5
C.D. at 5%	23.31	19.69	
<i>Spacings :</i>			
S ₁	129.8	138.8	134.3
S ₂	111.5	122.9	117.2
C.D. at 5%	3.82	4.77	
<i>Toppings :</i>			
T ₁	100.8	108.7	104.8
T ₂	124.3	133.6	128.9
T ₃	137.0	150.3	143.6
C.D. at 5%	4.68	5.84	
Mean	120.7	130.9	125.8
Mean per plant	40.2	43.6	41.9

Effect of time of planting:—Tobacco planted during the second week of November tended to give higher yield than earlier or later plantings. But the yield differences were not significant and varied with the season. Thus during the 1955-56 season, the yield was considerably higher in mid-season planting whereas in 1956-57 there was practically no difference in yield between the three treatments.

Effect of nitrogen: Nitrogen markedly increased the yield of cured leaf in both the seasons. With the basal manuring of farmyard manure, the first dose of 50 lbs. N consistently produced significant increase in yield. Further doses of nitrogen though tended to yield higher, the additional yields obtained were smaller and only 150 lbs. N proved significantly better than 50 lbs. N. As compared to the farmers' practice, all the treatments (M_3 , M_4 & M_5) having inorganic nitrogen, gave significantly higher yields.

With dhaincha green manure as basal, the response due to nitrogen varied with the season. In the dry season of 1955-56, the increase in yield due to the first dose of 50 lbs. N failed to reach the level of significance by a small margin, whereas during the wet season of 1956-57, it was found to be significant. Higher doses of nitrogen during 1955-56 produced similar effects as with farmyard manure. While during 1956-57 even 150 lbs. N failed to show significant increase over 50 lbs. N. As compared to the farmer's practice only 100 lbs. N and 150 lbs. N (M_8 and M_9) treatments proved significantly better.

Effect of spacing: Closer spacing significantly decreased the yield of individual plants in both the seasons. The decrease, however, was not proportional to the reduction in the area per plant. Thus when the area per plant was reduced by 25% from 4 sq. ft to 3 sq. ft. the yield per plant decreased by 13% only.

Effect of topping:—An increase in the height of topping from 4 to 6 and from 6 to 8 leaves per plant significantly increased the yield of cured leaf per plant in both the seasons. But here again, the increase in yield was not proportional to the increase in the number of leaves. With the increase of 50% (T_2 over T_1) and 100% (T_3 over T_1) in the number of leaves per plant, the corresponding increase in yield was only 23% and 37% respectively.

Interactions between factors studied were not consistent during both the seasons.

(iii) AIR-DRY WEIGHT OF STEMS

The data on the effect of various treatments on the air-dry weight of stems are presented in Table 4.

TABLE 4. Total air-dry weight of stems of 3 sample plants in gms. under various treatments. (Average of 3 replications)

Treatments	1955-56*	1956-57	Mean
Planting dates :			
D ₁	21.79	44.1	32.95
D ₂	30.36	41.8	36.08
D ₃	23.35	41.0	32.18
C.D. at 5%	..	N.S.	
Manures :			
M ₁	24.88	42.9	33.89
M ₂	22.37	38.4	30.39
M ₃	25.50	46.7	36.10
M ₄	30.38	48.9	39.64
M ₅	31.79	46.6	39.20
M ₆	20.27	36.7	28.49
M ₇	21.98	41.4	31.69
M ₈	26.82	40.1	33.46
M ₉	24.49	39.0	31.75
C.D. at 5%	..	7.96	

Treatments	1955-56*	1956-57	Mean
Spacings :			
S ₁	25.78	43.6	34.69
S ₂	24.15	41.0	32.58
C.D. at 5%	..	1.70	
Toppings :			
T ₁	18.27	30.9	24.59
T ₂	24.77	42.8	33.79
T ₃	31.86	53.3	42.58
C.D. at 5%	..	2.08	
Mean	24.97	42.3	33.64

* Data for 1955-56 season were not analysed statistically because few values were missing.

The effect of various treatments on the stem development (as judged by its air-dry weight) in general was similar to that on the leaf size.

In both the seasons the planting date which gave the highest yield of cured leaf also produced the heaviest stems. The first dose of 50 lbs. N produced an increase of about 19% in stem weight with farmyard manure and about 11% with dhaincha green manuring. Further application of nitrogen did not seem to materially affect the stem weight.

Closer spacing tended to reduce the weight per stem. However, the reduction was not proportional to the decrease in the area per plant. Thus a reduction of 25% in the area per plant decreased the stem weight by 6% only.

Stem weight increased with the increase in the height of topping. The increase in weight was equal when topping height was increased from 4 to 6 leaves and from 6 to 8 leaves.

(iv) YIELD OF CURED LEAF PER ACRE

The data on cured leaf yield per acre under various treatments during individual seasons and their means are presented in Table 5.

TABLE 5. Yield of cured leaf under various treatments in lbs. per acre. (Average of 3 replications)

Treatments	1955-56	1956-57	Mean
Planting dates :			
D ₁	1022	1026	1024
D ₂	1215	838	1027
D ₃	978	919	949
S. Em. ±	163.82	31.28	83.39
C.D. at 5%	N.S.	122.83	N.S.
Manures :			
M ₁	932	812	872
M ₂	879	693	786
M ₃	1113	1070	1091
M ₄	1271	1070	1170
M ₅	1369	1177	1273
M ₆	806	698	752
M ₇	944	933	939
M ₈	1107	969	1038
M ₉	1226	928	1077
S. Em. ±	67.05	66.22	47.14
C.D. at 5%	185.85	188.17	133.32
Spacings :			
S ₁	1002	864	933
S ₂	1141	991	1067
S. Em. ±	16.17	11.65	9.45
C.D. at 5%	44.82	23.05	26.19
Toppings :			
T ₁	897	756	826
T ₂	1096	985	1040
T ₃	1223	1044	1133
S. Em. ±	19.80	14.32	11.58
C.D. at 5%	54.87	28.37	32.09
Seasonal means	1072	928	1000
S. Em. ±	..	163.73	
C.D. at 5%	..	N.S.	

Effect of seasons : The overall effect of seasons on the yield of tobacco was not significant. The yield during the wet season of 1956-57 was however depressed by 13.5% as compared to the dry season of 1955-56.

Effect of time of planting : During the dry season of 1955-56 the yields were highest from the crop planted during the 2nd week of November (D_2) although the yield differences were not significant. Similar trends were also observed when cured leaf weight of 3 sampled plants was considered (Table 3). In the wet season of 1956-57 the yields were however significantly lower from the above treatment as compared to the earlier planting (D_1). This was due to the damage caused to the crop by the untimely heavy rains received during the second week of January. Yields of late planted crop were consistently lower than early planted crop.

Effect of nitrogen : With the basal manuring of farmyard manure, the application of first 50 lbs. N consistently produced significant increase in yield. Further application of nitrogen though generally tended to increase the yield, the marginal yields were smaller. Hence the yield difference between 150 lbs. N (M_5) and 50 lbs. N (M_3) only proved to be significant during 1955-56. The experimental crop of 1956-57 season suffered from the unusually heavy rains in January and hence the yield data were disturbed. The performance of the three sample plants for both the seasons, however, is in complete conformity with that of 1955-56 results.

With dhaincha green manure the first dose of 50 lbs. nitrogen significantly increased the yield over no-nitrogen during 1956-57 season and subsequent increase in levels of nitrogen failed to produce any significant effects. During 1955-56, only 100 lbs. N (M_4) and 150 lbs. N (M_5) proved to be significant over no-nitrogen (M_0). The above results were

found to be largely in agreement with those of the sample plants.

Between the two basal manures tried in the experiment, the overall effect of farmyard manure was found to be significantly better than dhaincha green manure. There was however no significant difference between the two basal manures in the absence of nitrogen.

As compared to the farmers' practice, application of 50 lbs. or more nitrogen with farmyard manure as basal dose in general proved to be significantly better. Similar trends were also observed with sample plants data.

Effect of spacing : Closer spacing significantly increased the yield of cured leaf over wider spacing ($2' \times 2'$) in both the seasons. The increase in yield however was not proportional to the increase in the plant population. On an average 33% increase in plant population increased the cured leaf yield by about 14%.

Effect of topping : Higher toppings consistently and significantly increased the yield. With the increase in number of leaves per plant by 50% and 100% the corresponding increase in yield was only 25.7% and 37.2% respectively.

Interactions between factors studied were not consistent during both the seasons.

(v) LEAF QUALITY

Quality in Motihari tobacco depends upon texture, physical feel and colour of the leaf. Best grade leaf should be thick and heavy bodied with oily appearance and dark brown colour. In order to study the effect of various treatments on the leaf quality, the produce was got graded through professional graders according to the local market standards. The data are given in Table 6.

TABLE 6. Yield of 1st grade leaf under various treatments.
(Average of 3 replications)

Treatments	1955-56		1956-57		Mean	
	Yield in lbs. per acre	% of the total produce	Yield in lbs. per acre	% of the total produce	Yield in lbs. per acre	% of the total produce
Planting dates :						
D_1	437	42.8	573	55.9	505	49.3
D_2	368	30.3	540	64.4	454	44.2
D_3	337	34.5	584	63.5	461	48.6
Manures :						
M_1	243	26.1	359	44.2	302	34.6
M_2	187	21.3	320	46.2	254	32.3
M_3	399	35.9	679	63.5	538	49.3
M_4	534	42.0	730	68.2	631	53.9
M_5	571	41.7	853	72.5	712	55.9
M_6	225	27.9	333	47.7	278	37.0
M_7	317	33.6	567	60.8	443	47.2
M_8	421	38.0	659	68.0	540	52.0
M_9	529	43.2	595	64.1	562	52.2
Spacings :						
S_1	373	37.2	547	63.3	461	49.4
S_2	388	34.0	586	59.1	487	45.6
Toppings :						
T_1	419	46.7	529	70.0	474	57.4
T_2	412	37.6	624	63.4	518	49.8
T_3	309	25.3	545	52.2	428	37.8
Means	381	35.5	567	61.2	474	47.4

In general the yield of first grade leaf was higher during the wet season of 1956-57 as compared to the dry season of 1955-56. The effect of time of planting on the quality of the leaf was not quite clear. Application of inorganic nitrogen markedly improved the quality of the leaf and all the manurial treatments carrying inorganic nitrogen produced better quality leaf than the farmers' practice. There was no appreciable reduction in the yield of better quality leaf due to closer spacing but topping higher than 6 leaves tended to reduce the yield of first grade leaf.

RESPONSE CURVE FOR NITROGEN

(i) GENERAL

The yield data in general showed that the response due to nitrogen was consistently higher with the basal manuring of farmyard manure than with dhaincha green manure. Between the two seasons also 1956-57 data was disturbed due to rain damages. The res-

ponse curve was therefore fitted to the yield data (Table 5) of 1955-56 season considering 0, 50, 100 and 150 lbs. N levels (M_2 , M_3 , M_4 and M_5 treatments). Similarly response curves were also fitted to sampled plant data (Table 3) of both the seasons. The quadratic function ($Y = a + b_1x + b_2x^2$) was used in each case and the predicted as well as the observed values are given in Table 7.

TABLE 7. Observed and predicted yields based on sample plants and whole plot populations.

Treatments N. lbs./acre	Sample plant data Yield in gms./3 plants				Plot yield data (yield in lbs./acre)		
	1955-56		1956-57		Observed	Pre- dicted	
	Observed	Pre- dicted	Observed	Pre- dicted			
0	..	96.50	97.15	97.65	100.20	876.68	879.57
25	..	..	113.97	..	121.93	..	1003.50
50	..	129.87	127.88	146.96	139.32	1113.12	1110.43
75	..	..	138.87	..	152.35	..	1200.38
100	..	144.96	146.94	153.39	161.04	1270.67	1273.35
125	..	..	152.10	..	165.37	..	1329.33
150	..	155.02	154.35	167.91	165.36	1369.23	1368.33
Coefficient of determination. (R^2)	..	0.9955		0.9534		0.9999	
Mathematical function.		$Y=97.15$		$Y=100.20$		$Y=879.57$	
		$+36.55x$		$+47.82x$		$+264.83x$	
		$-5.83x^2$		$-8.70x^2$		$-33.97x^2$	

It is obvious from the comparison of the observed and the predicted values that the fit is good in each of the cases presented above.

(ii) PROFITABLE LEVEL OF NITROGEN

In the cases where input-output relationships are expressed in the form of a mathematical function, the most accurate and profitable rates for inputs can be determined by equating the marginal product to the factor-product price

ratio. The first derivative of the mathematical function given in Table 7 gives the marginal product. Taking the price of nitrogen at 87 nP. per lb. and price of tobacco at 55 nP. per lb. the relevant factor product price ratio was equated to the marginal product for each mathematical function. The profitable rate of inputs (nitrogen) thus obtained are given in Table 8.

TABLE 8. Profitable rate of Nitrogen.

Particulars	Units of nitrogen	Nitrogen in lbs./acre
Plant data 1955-56	2.40	120.00
Plant data 1956-57	2.25	112.50
Plot data 1955-56	2.72	136.00

Thus the most profitable rate of nitrogen under the conditions in which the experiment was conducted lies between the 2nd and the 3rd unit of inputs i.e., around 125 lbs. nitrogen per acre.

MOST PROFITABLE MANURIAL TREATMENT

Since dhaincha green manuring practice itself costs more than the cost of 10 cartloads of farmyard manure and as yields tend to be higher with farmyard manure as basal, the set of dhaincha treatments (M_6 , M_7 , M_8 , and M_9) do not deserve any consideration. Thus the only treatments that need to be considered in the economic analysis are M_3 , M_4 and M_5 in comparison with the farmers' practice (M_1). Ignoring the cost of extra labour involved in applying the inorganic nitrogen and in handling the additional yields, the relevant cost and return particulars are given in Table 9.

TABLE 9. Economics of the prospective improved manurial practices as compared to the farmers' practice.

Treatments	Cured leaf lbs./acre	Cost of manure Rs./acre	Added yield over farmers' practice lbs./acre	Added revenue over farmers' practice Rs./acre	Added cost over farmers' practice Rs./acre	Net profits over farmers' practice Rs./acre
M_1 — Farmers' practice (25 cartloads FYM/acre)	932	100	..	..	..	..
M_3 — 10 cartloads FYM+50 lbs. N/acre	1,113	84	181	99.55	-16	115.55
M_4 — 10 cartloads FYM+100 lbs. N/acre	1,271	128	339	186.45	28	158.45
M_5 — 10 cartloads FYM+150 lbs. N/acre	1,369	172	437	240.35	72	168.35

The economic implications presented above indicate that all the three treatments were profitable manurial practices for the farmers to adopt in place of the present manurial practice. It would however be rational for a farmer to apply first 50 lbs. N per acre to his tobacco crop. If his cash resources permitted then he could earn larger profits by applying

another dose of 50 lbs. nitrogen per acre. Though the application of third dose of 50 lbs. N also had shown some profit, the magnitude of profit earned was rather small as compared to the risks involved. It would therefore be safe to apply upto 100 lbs. Nitrogen per acre to motihari tobacco with 10 cartloads of farmyard manure as a basal manure.

DISCUSSION

Time of planting:—Because of varying seasons, it is not possible to fix any specific date as the only optimum date for transplanting of this tobacco. It is however possible to broadly fix a certain span of time as the most congenial time of planting for harvesting a bigger and better crop of tobacco under the prevailing agricultural and climatic conditions in the tract.

Motihari tobacco is very susceptible to water logging. The crop therefore needs to be planted only when there is no possibility of receiving heavy post-planting rains. Under North Bengal conditions the rains normally cease in late October and thus the earliest planting is possible in the last week of October if land is ready and seedlings are available.

At the other end of the season, the temperature usually begins to rise in the beginning of

February and the relative humidity starts falling. Atmospheric conditions therefore become progressively hot and desiccative. Such environment obviously is not conducive to good growth and ripening of leaves. Normally a motihari crop requires about 90 days from planting for the primings to begin. Thus if the crop is to mature by the beginning of February, it needs to be planted in the beginning of November. Crops planted late in November are likely to suffer from moisture shortage and may be slow in growth due to low temperatures. Furthermore, such crops would suffer due to dry and desiccative weather prevailing at the harvesting time late in February. Crops planted earlier in late October would normally have high incidence of gaps due to the high moisture status prevalent in the soil. The observations recorded in the experiment also support the above reasoning. The data are given in Table 10.

TABLE 10. Incidence of gaps, time taken from planting to topping, harvesting etc., under different dates of planting.

Treatments	Incidence of gaps, %	No. of days taken from planting to first round of topping	No. of days taken from planting to 1st priming	No. of days taken to complete the harvest
<i>Planting dates :</i>				
D ₁ 1955-56	11.9	45	84	39
1956-57	26.8	35	92	42
Mean	19.4	40	88	41
D ₂ 1955-56	7.3	30	97	15
1956-57	25.5	37	90	28
Mean	16.4	34	94	22
D ₃ 1955-56	7.6	60	100	13
1956-57	6.3	56	98	16
Mean	7.0	58	99	15

The cured leaf yield data presented in Table 3 and Table 6 broadly suggest that planting during the second week of November (D₂) is preferable to earlier or later plantings. The poor performance of D₂ treatment during 1956-57 season (Table 6) was mainly due to the abnormal rains received in January and hence may be disregarded.

Effect of nitrogen:—In the present practice of manuring the Motihari tobacco in the tract, usually farmyard manure is the sole material used. The rate of its application varies with the availability of manure from 20-30 cart-loads per acre.

Inorganic nitrogen tried in the experiment markedly increased the yield and quality of the leaf. Application of the first 50 lbs. Nitrogen with basal manuring of farmyard manure resulted in the highest increase of both yield and quality over no-nitrogen. Additional doses also improved the yield and the quality but the marginal yields were progressively smaller. 50 lbs. N + 10 cartloads of farmyard manure also proved to be better than the farmers' practice increasing the yield by 25% and improving the percentage of first grade leaf from 34 to 49%.

Nitrogen application was more effective with 10 cart-loads of farmyard manure than with dhaincha green manuring. It may be that the organic matter in the form of farmyard manure added to the soil created more favourable soil conditions for the nutrition and growth of the tobacco plants. Dhaincha green manuring as practised in this experiment apparently did not produce similar effects.

The manurial treatments tried in this experiment clearly indicate that the use of inorganic nitrogen in combination with 10 cart-loads of farmyard manure is beneficial both from quality and quantity point of view than applying 25 cart-loads of farmyard manure alone.

In view of the limited supply of farmyard manure, this finding assumes special importance. It would pay the farmers more if the available farmyard manure is spread over a larger area of cropped land and supplemented with inorganic nitrogen rather than dumping the farmyard manure alone in a relatively smaller area.

Effect of topping:—The topping practice adopted by the tobacco growers is 2½' × 2½'. Looking to the spread and growth of the Motihari plant, this spacing appeared to be too wide. The experimental data also clearly suggest that closer spacing of 2' × 1½' is preferable to a wider spacing of 2' × 2'. The closer spacing gave about 14% more yield than the wider spacing without any appreciable loss in quality.

Effect of topping:—The topping practice usually followed in the tract is to retain as many leaves as possible (after removing the sand leaves) depending upon the vigour of the plant. Normally this ranges from 5 to 7 leaves per plant. The experimental results tend to show that higher toppings consistently and significantly increased the yield of cured leaf. However topping higher than 6 leaves per plant tends to depress the leaf quality. Thus the practice of topping currently in vogue in the tract appears to be quite sound.

SUMMARY AND CONCLUSIONS

Results of an experiment on the planting time, manuring, spacing and topping of Motihari tobacco (*N. rustica*) are presented.

1. Planting during the second week of November appeared to be advantageous over planting 15 days earlier or later.

2. Application of inorganic nitrogen at 50 lbs. N per acre increased the yield and improved leaf quality over no-nitrogen. Higher doses upto 150 lbs. N per acre also tended to

further increase the yield and improve quality but at diminishing rates.

3. Ten cart-loads of farmyard manure per acre proved to be better as basal manure than dhaincha green manuring. With the former, 50 lbs. or more N per acre was superior to the farmers' practice. Response to nitrogen with green manuring was considerably poorer than with farmyard manure.

4. With 10 cart-loads farmyard manure as basal manure the optimum dose of nitrogen for Motihari tobacco appeared to be somewhat more than 100 lb. N per acre.

5. Economics of manuring showed that application of 50 lbs. or 100 lbs. of inorganic N per acre with 10 cart-loads of farmyard manure was more profitable than farmers' practice.

6. Closer spacing of $2' \times 1\frac{1}{2}'$ proved to be decidedly better than wider spacing of $2' \times 2'$.

7. Higher toppings increased the yield progressively but retaining 8 leaves per plant tended to impair the leaf quality.

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Effect of Nitrogenous and Phosphatic Manuring on the Yield and Quality of Motihari (*N. rustica*) Tobacco in North Bengal*

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INTRODUCTION

Motihari tobacco is a major cash crop in the state of West Bengal. Its cultivation is concentrated mainly in the northern districts of Cooch Behar and Jalpaiguri. During 1957-58 about 24,000 acres were planted to this crop in the State and the total production was about 15.68 million lbs. The average yield per acre thus works out to about 653 lbs. which is obviously quite low.

The chief cause of such a low yield seems to be the inadequate supply of nitrogen that the crop receives under the prevalent practice of manuring. Usually all motihari lands are double cropped. Year after year tobacco is planted on the same piece of land in rabi and a crop of jute or aus paddy is taken in kharif. In this rotation only tobacco is manured with about 25 cart-loads farmyard manure per acre. Apparently, this does not adequately meet the nitrogen requirements of Motihari tobacco for high yields and good quality. Quality of the leaf is an important consideration in the production of Motihari tobacco because all good grade leaf is used for chewing purposes and fetches a much higher price than the low grade leaf that is mostly consumed in hookah smoking. Among other things a good quality Motihari leaf should have heavy body and oily appearance, and for the production of these characters a liberal supply of nitrogen to the crop is an essential pre-requisite.

Experimental work for the improvement of yield and quality of this tobacco has been in progress at the Wrapper & Hookah Tobacco Research Station, Dinhat, since 1955-56. The results presented in this paper were obtained from an experiment conducted under this programme during 1957-58 and 1958-59.

RESUME OF PREVIOUS WORK

Results of an earlier experiment conducted at the research station (Patel, *et al.*) showed that the yields of Motihari tobacco could be substantially increased by application of inorganic nitrogen, high topping and close spacing. Application of nitrogen, however, proved to be most effective in increasing the yields and improving the leaf quality. 50 lbs. or more inorganic nitrogen in combination with 10 cart-loads of farmyard manure per acre significantly increased the yield and improved the leaf quality over the farmers' practice of applying only 25 cart-loads farmyard manure per acre.

The beneficial effect of N was discernible upto 150 lbs. N per acre (the highest dose tried) and the optimum dose was estimated to be somewhat more than 100 lbs. N per acre.

In the present investigations, therefore, it was considered desirable to concentrate on the nitrogenous manuring of this tobacco with the object of finding the most economic dose. The lowest dose of 50 lbs. N was dropped and the ceiling dose raised to 200 lbs. N per acre. P_2O_5 treatments were included to see the effect of this nutrient on the yield and quality of Motihari tobacco.

MATERIAL AND METHODS

(i) SITE AND SOIL

The experiment was conducted at the Wrapper & Hookah Tobacco Research Station, Din-hata, West Bengal, during 1957-58 and 1958-59 crop seasons. The soil was alluvial sandy loam and the site of the experiment was changed every year.

(ii) CULTURAL PRACTICES

Seedlings were planted at a spacing of 2'x2' and topped at 6 leaves per plant during 1957-58 and 7 leaves during 1958-59 excluding the sand leaves that were removed at the time of

topping as per local practice. The crop received one light irrigation in the middle of December. All other cultural, curing and grading practices followed in the experiment conformed to the prevalent local practices. A late maturing type of Motihari locally known as 'Hemti' was planted in the experiment.

(iii) EXPERIMENTAL

The experiment was laid out in a split-plot design with 5 replications. Nitrogen levels were assigned to main plots and P_2O_5 to sub-plots. The size of the net sub-plot was 12'x36'=0.992 cent.

Treatments :

Main plot treatments

- M_1 — 25 cart-loads farmyard manure per acre. Farmers' practice (1 cart-load = 1,000 lbs.)
- M_2 — 10 cart-loads farmyard manure plus 100 lbs. N per acre.
- M_3 — 10 cart-loads farmyard manure plus 150 lbs. N per acre.
- M_4 — 10 cart-loads farmyard manure plus 200 lbs. N per acre.

Sub-plot treatments

- P_0 — Nil.
- P_1 — 50 lbs. P_2O_5 per acre.
- P_2 — 100 lbs. P_2O_5 per acre.

Farmyard manure was applied about 15 days before planting and ploughed in. Nitrogen was applied in the form of ammonium sulphate. The calculated total quantities of the fertilizer to be applied per plot according to treatments were divided into two equal parts. Half the quantity was applied broadcast at the time of final field preparation and ploughed in. The remaining half was applied in shallow rings around the plants 3 weeks after planting. P_2O_5 in the form of single super-phosphate was

applied broadcast along with the first dose of nitrogen about 10 days before planting.

(iv) OBSERVATIONS

Observations included (a) length and breadth of all leaves from 5 random sample plants selected per plot at maturity, (b) yield of cured leaf, and (c) yield of 1st grade leaf per plot. All the data were statistically analysed. The results obtained are presented as follows :

Seasonal weather :

The monsoon rains during both the seasons

ceased near about the middle of October. During 1958-59, however, good showers were received at the end of January. During both years the crop grew well without any serious incidence of diseases and pests.

RESULTS

(i) SIZE OF LEAF

The length and breadth of all leaves at maturity on five sample plants in each treatment were recorded. The data are given in Table 1.

TABLE 1. Mean length and breadth of leaves in cms. at maturity under various treatments.* (Average of 5 replications)

Treatments		1957-58		1958-59		Mean	
		Length	Breadth	Length	Breadth	Length	Breadth
N. Levels	M_1	27.7	27.4	21.8	21.3	24.8	24.4
	M_2	29.7	29.7	24.6	24.4	27.2	27.0
	M_3	30.2	30.0	25.9	25.7	28.1	27.8
	M_4	29.5	30.2	26.2	25.9	27.8	28.1
	C.D. at 5%	1.89	1.85	0.95	1.77		
P_2O_5 Levels	P_0	29.5	29.0	25.1	24.4	27.3	26.7
	P_1	29.7	29.2	24.5	24.1	27.0	24.3
	P_2	28.7	29.2	24.6	24.6	26.6	24.6
	C.D. at 5%	N.S.	N.S.	N.S.	N.S.		
Mean		29.3	29.1	24.7	24.4	27.0	25.2

* Leaf length was measured along the mid-rib and does not include the length of the petiole. Leaf breadth corresponds to the maximum width of lamina across the mid-rib. In general, leaves were considerably larger in 1957-58 than in 1958-59.

In both the seasons all treatments carrying inorganic N produced significantly larger leaves

than the control. However, between the three levels of N the size of leaf did not vary materially. During both years the leaves in the control plots started yellowing quite early in the season. This symptom of N deficiency was more intense during 1958-59.

P_2O_5 did not affect the size of leaf.

(ii) YIELD OF CURED LEAF

The data on cured leaf yield per acre are summarised in Table 2.

TABLE 2. Yield of cured leaf in kilos per acre under various treatments.

Treatments	1957-58	1958-59	Mean
N. levels			
M ₁	504.1	454.4	479.3
M ₂	604.2	667.1	635.7
M ₃	597.8	697.1	647.4
M ₄	636.4	712.0	674.2
S. Em.	± 20.71	± 20.36	
C.D. at 5%	63.8	62.73	
P ₂ O ₅ levels			
P ₀	573.9	627.5	600.7
P ₁	593.3	629.9	611.7
P ₂	589.7	640.5	615.1
S. Em.	± 16.34	± 17.07	
C.D. at 5%	N.S.	N.S.	
Mean	585.6	632.6	609.2

The yield of cured leaf per acre was about 8% higher in 1958-59 than in 1957-58.

In both the seasons all treatments carrying inorganic nitrogen produced significantly higher yields than the farmers' practice. Doses of N higher than 100 lbs. N per acre (M₂), however, did not significantly increase the yield further. The average yield from M₂ treatment was about 33% higher than that of the farmers' practice.

P₂O₅ did not affect the yield of cured leaf.

(iii) YIELD OF 1ST GRADE LEAF

After curing and final bulking the produce from the experimental plots was got graded by professional graders according to local market standards, to see the effect of treat-

ments on the apparent quality of the leaf. The quantity falling in the first grade was recorded separately and the data are presented in Table 3.

In general, the yield of first grade leaf was greater by about 46% in 1957-58 than in 1958-59. The proportion of 1st grade leaf to the total produce was also considerably higher in 1957-58 than in 1958-59. The yield of first grade leaf was particularly low in the control plots during the latter season.

In both the seasons, however, all treatments carrying inorganic nitrogen produced significantly higher yields of first grade leaf than the control. More than 100 lbs. N per acre did not bring about further significant increase in the yield of first grade leaf during 1957-58. In 1958-59 150 lbs. N was superior to 100 lbs. N.

P₂O₅ apparently did not affect the quality of the leaf.

DISCUSSION

All treatments carrying inorganic nitrogen produced larger leaves, higher yields and better quality than the control. The superior performance of the crop under the N treatments was obviously due to the much larger quantities of nitrogen available to the plants under these treatments as compared to the control plots carrying only 25 cartloads farmyard manure per acre. These results are in complete agreement with earlier findings. (Patel, *et al.* 1959)

More than 100 lbs. N per acre hardly showed any material improvement either in the yield, quality, or size of leaves though a slight increasing trend was, however, discernible in these characters. In the previous experiment this trend was somewhat more marked. It might have been due to the lower inherent fertility of soil in the previous experimental

TABLE 3. Yield of first grade leaf in kilos per acre under various treatments.

Treatments	1957-58		1958-59		Mean	
	Yield	% of the total yield	Yield	% of the total yield	Yield	% of the total yield
N levels.						
M ₁	346.8	68.8	34.1	7.5	190.4	39.7
M ₂	485.8	80.4	340.1	51.0	413.0	65.0
M ₃	497.3	83.2	440.4	63.2	468.9	72.4
M ₄	501.9	78.9	440.4	61.9	471.1	69.9
S. Em.	± 28.58		± 33.43			
C.D. at 5%	81.10		100.01			
P ₂ O ₅ levels.						
P ₀	448.0	78.1	329.6	52.5	388.8	64.7
P ₁	455.1	76.7	296.3	47.0	375.7	61.4
P ₂	470.7	79.8	315.3	49.2	393.0	63.9
S. Em.	± 21.04		± 22.61			
C.D. at 5%	N.S.		N.S.			
Mean	457.9		313.7		385.8	63.3

sites. Such a view is substantiated by higher average yield of the control plots in the present experiment than in the previous one. It may, therefore, be concluded that under the conditions approximating to the present experiment, best results could be obtained if the crop is given a basal manuring of 10 cartloads of farmyard manure and 100 lbs. N per acre. This practice of manuring would substantially increase the net returns for the farmer. It also holds the promise of relieving about 8,000 acres of good land for the production of other crops without reducing the current production of Motihari tobacco.

Application of P₂O₅ did not influence the size, yield and quality of the leaf. Probably the soil was inherently in a position to adequately meet the P₂O₅ requirements of the crop.

The size of leaves was considerably larger during 1957-58 than in 1958-59. But the yield of cured leaf in the treatments carrying inorganic nitrogen was higher during 1958-59. The larger size of leaves during 1957-58 was apparently due to the higher fertility of soil in the site. Such a view is supported by higher yields of cured leaf and first grade leaf in the control plots during 1957-58. The crop in these plots also showed marked symptoms of N deficiency during 1958-59.

The larger yields of cured leaf in N carrying treatments during 1958-59 may be ascribed to the larger number of leaves retained per plant during this season. In 1957-58 the crop was topped at 6 leaves per plant, and during 1958-59 at 7 leaves per plant.

The low yield of first grade leaf in 1958-59 even in N carrying plots may be due to the

untimely rains at the end of January that washed down the resinous deposits of the leaves when the crop was approaching maturity.

PROFITABLENESS OF THE RECOMMENDED MANURIAL PRACTICE

Results showed that 100 lbs. N in combination with 10 cartloads farmyard manure per

acre produced significantly higher yields and better quality than the farmers' practice. Higher doses of N were not found to be useful. For an economic evaluation of nitrogenous manuring of Motihari tobacco, therefore, only 100 lbs. N with 10 cartloads farmyard manure per acre is compared with the farmers' practice of applying 25 cartloads farmyard manure per acre. The data are presented in Table 4.

TABLE 4. Cash returns from the recommended manurial practice for Motihari tobacco.

Treatments	Yield of cured leaf kilos/acre	Increase in yield over control kilos/acre	@ Cash value of increased produce Rs./acre	*Cost of manuring Rs./acre	Increase in the cost of manuring Rs./acre	Profit over control Rs./acre
(1) Farmers' practice. (25 cartloads farmyard manure per acre)	479.3	..	..	100	..	..
(2) Recommended practice. (10 cartloads farmyard manure + 100 lbs. N/acre)	635.7	156.4	375.36	127	27	348.36 (about Rs. 350/-)

@ Based on the average price realised for the farm grown Motihari tobacco during 1957-58 and 1958-59.

* Farmyard manure at Rs. 4/- per cartload (local rate). N at Rs. 0.87 per lb. as ammonium sulphate. Cost of application is not included.

It is clear that the Motihari growers can substantially increase their cash returns from the crop by reducing the quantity of farmyard manure from 25 cartloads per acre to 10 cartloads and applying 100 lbs. inorganic N per acre instead. The money spent on the purchase of inorganic nitrogen is not only returned in full but brings in a very handsome profit of Rs. 350/- per acre. The additional returns from the recommended practice should be still larger because the produce would fetch a considerably higher price due to its superior quality.

lity. This advantage in price would more than compensate the extra expenditure that the grower would undergo in handling the extra produce due to higher yields.

(5) The findings of this experiment clearly suggest that there is scope of relieving about 8,000 acres of good land from Motihari for the production of some other crops without reducing the current production of this tobacco.

CONCLUSIONS

(1) 100 lbs. inorganic nitrogen in combination with 10 cartloads farmyard manure produced significantly larger leaves and higher yields of total cured leaf as well as first grade leaf of Motihari tobacco than the farmers' practice of applying 25 cartloads farmyard manure per acre. The increase in yield observed was about 33%. This treatment is recommended for adoption by Motihari growers.

(2) More than 100 lbs. N per acre did not materially improve the yield or quality.

(3) P₂O₅ at 50 and 100 lbs. per acre did not affect the leaf size, yield or apparent quality of the produce.

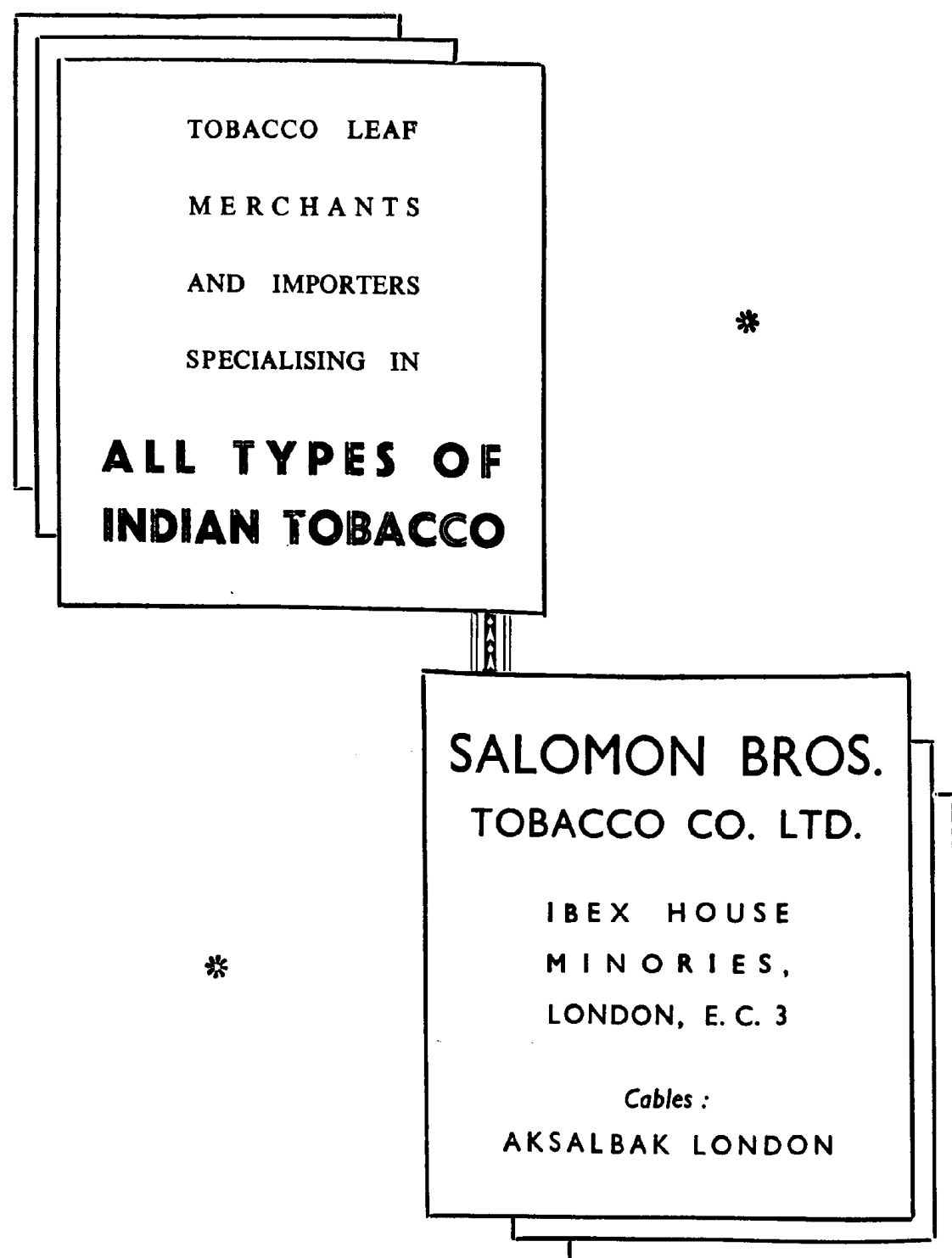
(4) The recommended practice of manuring would bring an additional return of about Rs. 350/- per acre after meeting the cost of manures.

ACKNOWLEDGMENT

The authors wish to express their thanks to Dr. N. R. Bhat, formerly Director, Tobacco Research, for his constant interest and encouragement. Thanks are also due to Dr. G. S. Murty, Director, Tobacco Research for going through the manuscript and suggesting suitable modifications in the text.

REFERENCE

- Patel, G. C., Singh, M. and Das, R. (1959). Effect of some cultural and manurial treatments on the yield and quality of Motihari tobacco (*N. rustica*) in N. Bengal. Paper read at the 2nd Conference of Tobacco Research Workers, held at Anand, Dec. 1959.



Effect of Nitrogen and Phosphorus Manuring on the Yield of Hookah Tobacco (*N. rustica* L.)

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JULY-SEPTEMBER 1961

From the point of view of Hookah tobacco (*N. rustica* L.) cultivation, U.P. easily takes the first place in the Indian Union, both from the point of view of acreage and production. The acreage varies annually from 35,000 to 40,000 including the winter and summer crops. Nearly 1/3 of this acreage is concentrated in Farrukhabad district which grows some of the finest trade varieties, e.g. Kampila. In fact tobacco together with potato and cauliflower plays a very important role in the agricultural economy of the tract. In spite of the great economic importance of the tobacco crop no reliable information on the manurial requirements of the tobacco crop is available at present. The Department of Agriculture, U.P. has only recently turned its attention to the improvements of the tobacco crop in collaboration with Indian Central Tobacco Committee by establishing a tobacco research station at Saraimiran (Kannauj) in District Farrukhabad.

The tobacco cultivator in this district applies heavy doses of organic manures to the tobacco crop and practises suitable rotations with other crops in order to build up fertility in the soil, Gupta, *et. al.* (3). He also applies plenty of 'Lona mitti' to the crop. 'Lona mitti' is supposed to supply the nitrogen requirements of the crop and is available in plenty from the ruins of ancient buildings of old historical city of Kannauj. They also make a liberal use of brackish water for tobacco cultivation. Brackish water and the 'Lona mitti' are supposed to give the required pungency and flavour to the tobacco so much in demand by connoisseurs of Hookah tobacco. In view of the acute shortage of fertilizers and manures in the country, it is important to work out a proper schedule of manuring of cash crops without adversely affecting their yield per acre or quality and avoiding wasteful use of manure and diverting it to food crops.

In order to assess the manurial requirements of the Hookah tobacco an experiment was conducted for four years, i.e. 1955-56 to

1958-59 at the Govt. Tobacco Research Station, Saraimiran.

MATERIAL AND METHOD

Nitrogen at 0, 50, 100 lbs. per acre in the form of Ammonium sulphate and phosphorus at 0, 25, 50 lbs. per acre in the form of super phosphate singly and in different combinations were applied to NPS 219 (*N. rustica* L.) except in 1955-56 when Farukhabad local was used. The treatments were properly randomised and replicated. The spacing given was 14' each way. In the first two years the trial was conducted with the summer crop while in the latter two years it was on winter crop. Superphosphate was applied by the placement method at the time of transplanting

while Ammonium sulphate was top dressed one month after transplanting. Topping and suckering was done, keeping the number of leaves equal in all treatments except in Rassa in 1955-56 when no topping was done.

EXPERIMENTAL FINDINGS

The 1956-57 crop was severely attacked by the tobacco stem rot disease caused by *Rhizoctonia* Sp. As the number of plants was markedly different in different treatments the yields for different treatments showed erratic trends, hence the results of the experiment during 1956-57 are not given here. In Table 1, given below, yield of entire plants (known as Rassa) is given for different treatments for 1955-56.

TABLE 1. Average yield of cured product (Rassa) in Kilograms per acre during 1955-56 (Summer crop).

Nitrogen	P ₂ O ₅			Mean	S. E.	C. D. at 5%
	0	25	50			
0	212.1	227.9	288.3	242.8	22.8	115.4
50	501.0	670.5	540.6	570.7		
100	814.7	774.4	852.7	814.0		
Mean	509.3	557.6	560.5	542.5		

S.E. for the mean in the body of the table — 199.9.

The analysis of variance revealed that only nitrogen differences were statistically significant, phosphorus giving no response. The yield of Rassa increased as the dose of nitrogen applied was increased.

In Table 2 average yields of cured leaves under different treatments for the years 1957-58 and 1958-59 are given.

In both the years only nitrogen differences were significant, higher doses giving higher yields, phosphorus giving no responses.

These results are confirmed by Ferozepur (2) and Pusa (1) results. In Ferozepur 0, 50, 100 and 200 lbs. N/acre gave significantly higher yield than control (1954-55) on *N. rustica* and *N. tabacum*, superphosphate did not excite any response.

At Pusa 0, 50 and 100 lbs. nitrogen in the form of Ammonium sulphate and groundnut cake 0, 30 and 60 lbs., P₂O₅ in the form of superphosphate and 0, 50 and 100 lbs., K₂O in the form of potassium sulphate per acre

TABLE 2. Average yield of cured leaves in Kilograms per acre for the years 1957-58 and 1958-59 (Winter crop).

1957-58						
Nitrogen Levels	P 205 Levels			Mean	S. E.	C. D. at 5%
	0	25	50			
0	305.5	260.3	271.5	279.1	19.2	56.0
50	424.4	347.0	419.4	396.9		
100	547.9	405.2	454.3	469.1		
Mean	425.9	337.5	381.7	381.7		
S.E. for means in the body of the table — 56.0						
1958-59						
Nitrogen Levels	P ₂ O ₅ Levels			Mean	S. E.	C. D. at 5%
	0	25	50			
0	668.8	439.4	535.4	547.9	44.5	129.8
50	727.7	683.0	767.7	726.1		
100	1016.8	943.0	935.1	965.0		
Mean	804.4	688.5	746.1	746.3		
S.E. for means in the body of the table — 77.0						

were tried in all possible combinations during 1953-54, 50 and 100 lbs. N/acre increased the yield of cured tobacco significantly over control. Superphosphate and potassium did not have appreciable effect.

In addition to the yield length and breadth of leaf were also determined in relation to the manurial treatment (Table 3).

It is evident from the above that length and breadth of leaf also increase with the increasing doses of nitrogen. So under Saraimiran conditions nitrogen manuring of both the sum-

mer and winter crops of hookah tobacco is advantageous from the point of view of increasing the yield as reflected by increase in the size of the leaf, phosphorus playing no part.

Since the number of leaves was practically kept constant in different treatments by topping, the effect of the application of nitrogen is reflected in the size of the leaves, which increases as the dose of nitrogen is increased. In tobacco leaf is of prime economic importance. Hence any manuring schedule which has to be worked out for tobacco must take

TABLE 3. Mean length and breadth of leaf in inches for the years 1957-58 and 1958-59 under different treatments.

Length					Breadth				
N	P ₂ O ₅ Levels				N	P ₂ O ₅ Levels			
Levels	5	25	50	Mean	Levels	0	25	50	Mean
0	12.05	12.30	11.3	11.88	0	8.9	9.3	9.1	9.1
50	13.80	13.90	14.70	14.13	50	10.4	10.6	12.3	11.10
100	15.15	15.35	15.80	15.43	100	12.05	12.6	13.1	12.58
Mean	13.67	13.85	13.93	13.81	Mean	10.45	10.83	11.50	10.93

into account its effect on the size and quality of leaf. In the absence of any facilities for determining the quality of leaf on scientific basis only the relationship between the size of the leaf and the nitrogen applied could be determined.

SUMMARY

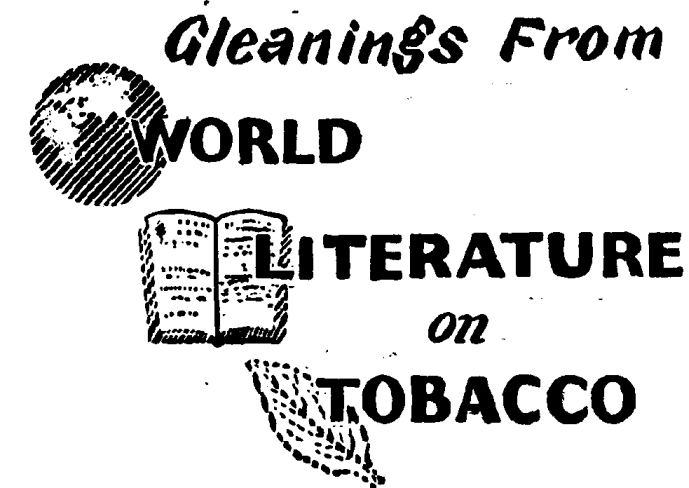
Effects of different doses of nitrogen and phosphorus were studied for 4 years at Sarai-miran on winter and summer crops of hookah tobacco. Increasing doses of nitrogen gave increasing yield of tobacco leaf as reflected in large size of leaf. Phosphorus did not elicit any response. These results are confirmed by the Ferozepur and Pusa results.

This work was carried out under a scheme of tobacco research being financed by the Indian Central Tobacco Committee, Madras.

Thanks are due to Sri R. C. Pandey, Senior Statistical Assistant for carrying out the statistical analysis of the data.

REFERENCE

- (1) The Annual report of the Hookah and Chewing Tobacco Research Station, Pusa (Bihar), 1953-54.
- (2) The Annual Progress Report of the Tobacco Research Sub-Station, Ferozepur (East Punjab), 1954-55.
- (3) Gupta, P. S., Shukla, T. N. and Singh, I. 1956. *Indian Tobacco*, Vol. No. 2.



CHEMICAL AND PHYSICAL PROPERTIES

COLLINS, W. K. ; JONES, G. L. : Comparison of six flue-cured tobacco varieties for certain chemical, physical and agronomic characters over years and locations. Tob. Chem. Res. Conf. 14th, Winston-Salem, N.C., Oct. 13-14, 1960. Papers No. 28. (Abs.)

Six flue-cured tobacco varieties were investigated for 49 chemical and physical properties and 3 agronomic characters. Leaf tobacco was produced in a randomized block field design with 4 replications at each of 5 locations representative of the flue-cured tobacco growing area of North Carolina during 1956-58. The data were statistically treated to determine the variation associated with years, locations, varieties and interactions. Varietal differences were found for 40 of the characters studied, including all the nitrogenous compounds, carbohydrates, organic acids and miscellaneous chemical and physical properties, 10 of the mineral characters, 2 of the 6 structural carbohydrates and all the agronomic characters. Generally, the varieties performed relatively the same from year to year and location to location. The objective of this investigation was to provide analytical information which might serve as a guide to more thorough chemical evaluation of varieties and breeding lines of flue-cured tobacco.

NYSTROM, C. W. : Some indexes of quality of flue-cured tobacco. Tob. Chem. Res. Conf. 14th. Winston-Salem, N.C., Oct. 13-14, 1960. Papers No. 8 (Abs.)

Flue-cured leaf grades representative of a high quality leaf, intermediate quality leaf, and low quality leaf were selected from 3 different tobacco markets and for 4 crop years. The tobacco samples were stemmed and processed for aging according to standard commercial practices. The basic samples were sub-sampled by coring, the cores were blended and then ground to pass a 40 mesh. Duplicate analyses were performed on each sample. Scopoletin was extracted from the ground tobacco with chloroform, separated from interfering substances by paper chromatography, and was determined in eluates from chromatograms by the intensity of its fluorescence in carbonate buffer at pH 9.5 Chlorogenic acid and rutin were extracted from the tobacco with 60% methanol and were separated from interfering substances and each other by paper chromatographic techniques. Chlorogenic acid was determined in the eluates from the chromatograms by the optical density of the rutin AIC 13 complex at 41 Omu. The results show that within a given market there is a direct correlation between the leaf quality and the chlorogenic acid content with the high quality leaf having approx. 1.5 times the chlorogenic acid content of the low quality leaf. The rutin content showed, in general, a similar relationship although the differences between grades were not as great. The scopoletin content showed an inverse relationship with the leaf quality. Although the relationship between tobacco quality and the individual compounds was consistent within a given market and crop year, large differences were observed between

markets and from one crop year to the next. Therefore, a low quality leaf from one market area might have a higher chlorogenic acid content than an intermediate quality leaf from another market area.

RUNECKLES, V. C.: Determination of rutin and chlorogenic acid in tobacco. Tob. Chem. Res. Conf. 14th. Winston-Salem, N.C., Oct. 13-14, 1960. Papers No. 25 (Abs.).

A technique has been developed for the assay of rutin and chlorogenic acid by direct photometry of paper chromatograms. Extracts and mixtures of standards are separated on paper under standardized conditions. A ferric ferricyanide reagent is used to develop the phenol bands. Excess reagent is removed by washing the chromatograms which are then air-dried, impregnated with oil and scanned in a direct-reading photometer. Minimum Transmittance readings are taken. Mixtures of standards separated simultaneously with extracts provide reference points which, when used in conjunction with calibration curves, allow ready estimation of the concentrations of the constituents of the extracts. Four replicates of each unknown mixture are employed, allowing rutin and chlorogenic acid to be estimated with a standard error of less than 5% in the concentration range 40-1000 ug of extract.

SADLER, W. W.; CHESSON, R. R.; SCHOENBAUM, A. W.: Automated procedure for determining the nicotine content of steam distillates. Tobacco 151(19): 23-8 (Tob. Sci. 4: 208-12), Nov. 4, 1960. graph, tables. TS2220 FT6.

A procedure for the continuous and automatic determination of nicotine in the distillate of a steam distilled tobacco sample is given. The procedure utilizes Technicon Instruments Corporation's Auto-Analyzer and is based upon the reaction of nicotine, cyanogen bromide, and aniline. Samples are monitored at 480mu through a 6mm light path. 442 tobacco samples were analyzed with the given procedure and by the gravimetric silicotungstic acid technique. The agreement between the 2 methods was excellent for all types of commercial tobaccos investigated. (Abstract).

VAN VUUREN, P. J. J.: Polyphenols in tobacco seed. So. African J. of Agr. Sci. 3(1): 15-21. Mar. 1960. tables. (NCS).

Three different extracts were made from tobacco seed of Jamaica Wrapper variety. The extracts were fractionated by means of band paper chromatography on Whatman No. 3 MM paper, using 10%

acetic acid as solvent. Rutin, scopoletin, scopolin and chlorogenic acid were identified. Some fluorescent compounds were present which gave no color reactions specific to phenolics. The ratios of the amounts of rutin and chlorogenic acid to scopoletin are much smaller in the seed than in the leaf. (From summary).

CULTURAL PRACTICES

BRELAND, H. L.; PRITCHETT, W. L.: Effect of fertilizer sources and levels on cigar-wrapper tobacco as related to soil and plant analyses. Fla. Agr. Expt. Sta. Ann. Rpt.: 158, 1957-58. (NCS).

On a soil high in exchangeable nutrients with an initial pH of 5.8 the average yield of tobacco was slightly higher in plots that received additional Mg and slightly lower in plots that received Ca and K. Yields increased progressively with N rates up to 250 lb/ac. The highest yield but lowest grade index were obtained with a split application of N at 250 lb. An organic source of N produced higher yields than an equivalent rate of N from ammonium nitrate. A moderate rate of P (165 lb. of P₂O₅) from concentrated superphosphate produced a higher yield and grade index than higher or lower rates from the same source or from steamed bone meal. Burn decreased with increasing N and Mg but was little

HtA 30(3): No. 3980, Sept. 1960.

DISEASES

MITSKOVSKI, J.: Application of Vapam for disinfection of the soil in tobacco seedbeds. Duvan 10(1): 1-13, Jan. 1960. illus., tables. (Serbo-Croatian) SB273 A2D83

Treatment of tobacco seedbeds with 1% Vapam (10 l/m²) 20 days before seeding gave the following positive results: seedling development is accelerated, plant width and height is significantly greater, number of healthy plants increases by 2.5 times, total weight of transplantable seedlings is 2.7 times greater, weeds decrease by 6.3 times, plant pulling time is decreased more than 3.4 times, black root rot fungi are completely destroyed, as are *Amaranthus* sp. and *Heliotropium europaeum*; number of *Portulaca Oleracea* is decreased 7.5 times and *Trifolium* sp. somewhat less. Application of Vapam is simple, since it requires no seed-bed cover. It would be especially useful in tobacco seedling producing co-operatives and in tobacco growers' co-operatives. (From English summary).

BOLSUNOV, I.: Seminar on *Peronospora tabacina* A. and the possibilities of controlling it. CORESTA B. of Inform. (1): 9-11, 1960 (NCS).

To obtain resistant hybrids starting from interspecies crossings, the following is recommended: (a) The processes used by breeders of the Experimental Station at Beltsville, Maryland. (b) Those used by Mr. Ternovskii at the Tobacco Institute at Krasnodar (USSR). (c) Those used by the Tobacco Breeding Station of the Austrian State Monopoly at Furstenfeld, Austria. The following peculiarities must be taken into account: (1) Resistance to *Peronospora tabacina* is governed by several hereditary factors; it is, therefore, polygenic dependence, which is the source of some of the difficulties for the combination of the characteristics required. (2) Resistance to *P. tabacina* often varies in the course of the vegetative cycle of the plant; it can be somewhat slight with seedlings, whereas after transplantation in the open field the plant may be adequately resistant.

MADAMBA, C. P.: Practical method of collecting soil nematodes for population surveys. Philippine Agr. 44(2/3): 146-8, July/Aug. 1960. illus. S17 P5.

The modified technique employs the fundamental principle of Cobb's sieving along with Baerman's funnel technique. Only 1 sieve which will trap adults of the known nematode parasites of field crops and vegetables may be used. This method eliminates the possibility of large scale nematode escape. Moreover, it minimizes the interference from organic debris frequently encountered in Cobb's decanting method. When done on a routine basis, the method is also reasonably fast.

GENETICS AND VARIETIES

(see also 6, 16, 54, 139)

BOLSUNOV, I.: Semperante une variete "Superburley". Recemment introduite dans la culture de tabac autrивienne. (Semperante, a giant variety of burley, recently introduced in Austrian tobacco culture.) Rev. Internatl. D. Tab. 35(330/331): 162, Aug./Sept. 1960. SB273 A2R4.

The giant burley variety Semperante contains less leaf chlorophyll 11 than standard burley varieties and the leaves yellow during maturation and cure readily to a very pure color. This characteristic is retained even when heavily fertilized with nitrogen and grown on heavy soils. The variety is preferable to other

burley varieties grown in Austria both because of its leaf characteristics and because of its high yields.

SMITH, H. H.; ROBSON, D. S.: Quantitative inheritance study of dimensions of flower parts in tobacco. Biometrics 15: 147, 1959. (Abs.)

Measurements of corolla tube length and lobe length were made on 2 inbred species of *Nicotiana*, *N. sanderae* and *N. langsdorffii*, and their derived generations through the F₄ and the second backcrosses. On the logarithmic scale environmental variances as measured in the nonsegregating generations were essentially constant through time and independent of genotype, though the effect of years (confounded with locations) was substantial and there was some indication of a genotype-year interaction. First degree genetic parameters including epistatic effects of triplets of non-allelic genes were estimated by a regression.

HARVESTING AND CURING

JOHNSON, W. H.: Bright-leaf can be cured in bulk. Agric. Res. Wash. 8(6): 6, 1959. illus.

Whole leaves are stacked evenly in frames, which are clamped in racks in special barns that are much smaller than conventional barns, air from the furnace being forced through the tobacco at 30 ft/min. During yellowing the temperature is held at 90-100°F; it is then raised gradually to 140-150°F to set the color and dry the leaf, and is finally advanced to 170°F for stem drying. Quality is not adversely affected and labor requirements are reduced by 75%. Figures are given for the composition and quality of bulk-cured and conventionally-cured tobacco. Bulk-curing was less satisfactory for green shredded tobacco.

HtA 30(3): No. 4021, Sept. 1960.

MYERS, J. M.; CLARK, F.; HARRIS, H. C.: Curing bright leaf tobacco grown under different levels of nitrogen. Fla. Agr. Expt. Sta. Ann. Rpt.: 35-7, 52-3, 1957-58. (NCS).

Tobacco fertilized with 24 lb N/ac showed the highest quality when yellowed at 105°F that fertilized with 48 lb. N/ac when yellowed at 100°F and that fertilized with 96 lb. N/ac when yellowed at 95°F. Tobacco harvested at optimum maturity gave a better quality produce than that harvested 7 days before or 7 days after optimum maturity for all 3 levels of N and for 3 levels of curing humidity and temperature tested. The value of cured tobacco

fertilized with 48 lb. N/ac ranged from \$49-60/cwt. for that harvested green to \$60-60/cwt. for that harvested mature when cured at 100°F and 85% relative humidity. Tobacco harvested when overmature averaged \$58-50/cwt.

HtA 30(3) : No. 4020, Sept. 1960.

INSECTS

BLAGOJEVICH, M. ; KRSTOVICH, R. : Application d'insecticides de synthèse dans la lutte contre le ver jaune et le ver gris chez le tabac. (Use of synthetic insecticides in the control of cutworms and wireworms in tobacco.) Duvar 10(2) : 33-41. Feb. 1960. tables. (Serbo-Croatian) SB273 A2D83.

Cutworms (Noctuidae) and wireworms (Elateridae) were best controlled (91. 3-94. 5%) by single-plant watering with 20% aldrin, 10% dieldrin, 10% lindane and pantakan (253 DDT). Dry spreading of 2-5% aldrin, 2% dieldrin, 1-3% geoline and pantakan (5% DD) gave a kill of 76. 6-88. 1%. Plant dusting with the last-named materials was still less effective, giving 67. 9-80. 7% control. Wetting stalks and roots with an insecticidal solution gave the poorest results, 43. 4-64. 7%, except for lindane, which gave 83.9% control. Disting roots and stalks of transplants gave no satisfactory results, but the method is of interest because of the lower quantities of insecticides required. (From French summary).

TAPPAN, W. B. : Control of insects attacking cigar-wrapper tobacco. Fla. Agr. Expt. Sta. Ann. Rpt. : 334-5, 1957-58. (NCS).

Parathion at 1% gave effective control of green peach aphid, Thiodan at 3-5% alone or with zineb at 6-5% also showed good control but was somewhat slower acting; it was much better than parathion against budworm, hornworm and cabbage looper. Parathion at 1% + TDE at 10% + zineb at 6-5% was less effective than thiodan against the hornworm and looper, but as good as it for budworm control. Parathion at 1% + DDT at 10% + zineb at 6-5% was almost equal to the parathion + TDE + zineb mixture for hornworm and looper control but was less effective against budworm.

HtA 30(3) : No. 4015, Sept. 1960.

PHYSIOLOGY AND BIOCHEMISTRY

CHAILAKHIAN, M. H. ; AKSENOVA, N. P. : Relationship between photoperiodism and respiration in plants. Fisiol. Rast. 6 : 699-708, 1959. (Russian).

Long-day plants, including *Rudbeckia bicolor* and *Nicotiana sylvestris*, and short-day plants including *Perilla nankinensis* and tobacco var. Mammoth, were grown for 1-3 months at unfavourable day lengths and then for 3-17 days at favourable day lengths. The change rapidly affected the diurnal variation in both the respiration rate and oxidase activity. Photoperiodic induction of flowering led to an increase in the activity of the oxidases containing heavy metals in the long-day plants, whereas in short-day plants it increased the rate of residual respiration.

HtA 30(3) : No. 3139, Sept. 1960.

PEARSE, H. L. : Growth conditions and the characteristic of cured tobacco leaves. I. Influence of modified nutrition at different growth stages on the growth of plants and leaves. So. African J. of Agr. Sci. 3(2) : 197-207, June 1960. graphs, tables.

Flue-cured tobacco plants were grown in a mixture of sand and vermiculite in pots, under glass-house conditions, by means of a constant drip nutrient solution technique. Feeding was stopped at different physiological stages of growth and the subsequent growth behaviour of plants and leaves was recorded. Early cessation of feeding (18 in. growth stage) did not significantly affect growth in height, but had a major effect on leaf development, the leaves being both narrower and shorter than where feeding was continued to later growth stages. Even when feeding was continued up to 1 week after the topping stage, the leaves, although taking longer to ripen still cured to an acceptable color. Late onset of starvation improved the size and weight of all the leaves although the increase was greatest in the middle and top leaves. There was an increase in weight/unit leaf area from the bottom to the top of the plants in all series. Early cessation of feeding produced bottom leaves with a slightly greater weight/unit area. (From abstract)

Tso, T. C. ; McMURTREY, J. E., Jr. ; SOROKIN, T. : Mineral deficiency and organic constituents in tobacco plants. I. Alkaloids, sugars, and organic acids. Plant Physiol. 35(6) : 860-4, Nov. 1960. graphs. QK1 P6.

Reports the relative differences in alkaloid, sugar, and organic acid contents in tobacco plants (*Nicotiana tabacum* var. Connecticut Broadleaf) due to the deficiency of 1 of the following elements; N, P, K, Ca, Mg., S, and B. The data indicate the drastic changes in the plant metabolic system due to such deficiencies. Manually and physiologically

(—B, —Ca) topped plants showed a higher alkaloid content than plants given any of the other treatments mentioned. Alkaloid formation is considered not simply as a function of total nitrogen available or of total nitrogen content in a plant. Amounts of various sugars and organic acids in the ethanol extracts and hydrolyzate fractions of plants given different treatments were reported. Untopped control plants appeared to have a higher total sugar content than others. Glucose seemed to indicate some relation to alkaloid formation, but not a consistent one. Boron-deficient plants had a higher total organic acid content than untopped control plants, which are the next highest group among all treatments. The high glutamic acid content in —B plants and its possible role in alkaloid formation are discussed. (From summary).

Tso, T. C. ; McMURTREY, J. E., Jr. : Mineral deficiency and organic constituents in tobacco plants. II. Amino acids. Plant Physiol. 35(6) : 865-70, Nov. 1960. graphs. QK1 P6.

An earlier withdrawal of certain elements during the plant growth period resulted in more severe symptoms and more prominent effects on amino acid composition than later withdrawal. In general, deficiency of B, Ca, P, K, Mg. and S caused an increase in free amino acid content in the plants, but not so in N-deficient ones. Less difference was observed in the amino acid content of the hydrolyzate fraction among mineral-deficient and control plants when deficiencies occurred at earlier stages of growth. Ca and B deficiency appeared to have more effect than others. Mg also had a prominent effect on free amino acid content, but not in the hydrolyzate fraction. The content of asparagine in the plants of each deficiency treatment appeared to show a positive relation to the alkaloid content in that treatment. A similar, but not so prominent, relationship between proline and alkaloid content was also indicated. Regarding glutamic acid, since the larger

portion of it is included in organic acid fraction through ion-exchange process, the small amount left in the amino acid fraction showed no significant relationship with alkaloid content, although such relationship was indicated in the organic acid fraction in —B plants. (From summary).

SEEDLING PRODUCTION

CLARK, F. ; SAUNDERS, E. S. : Supplementary heat and light for the production of tobacco seedlings. Fla. Agr. Expt. Sta.

The effects of 2 soil heating treatments, 6 types of seed-bed cover and 2 sowing dates were compared. Both the heat treatments, vinyl, polythene and fiber-glass covers and later sowing advanced growth. The most rapid seedling production, amounting to 64 days, resulted from sowing on Jan. 20 in soil continuously heated to 60°F. and using either polythene or vinyl covers.

HtA 30(3) : No. 3973, Sept. 1960.

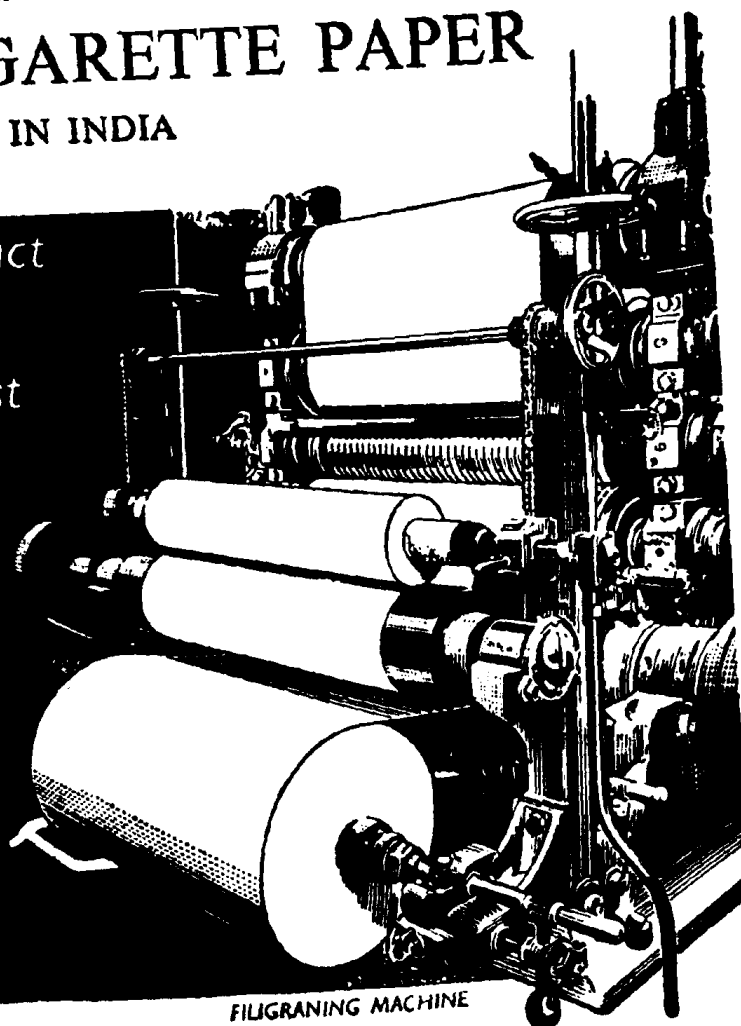
STEINBERG, R. A. : Production and germination of *Nicotiana* seed grown under various greenhouse conditions. Tobacco 151(21) : 19-22 (Tob. Sci. 4 : 216-8) ; Nov. 18, 1960. Tables. (TS2220 ft6.)

Ability to produce seeds was tested with 57 species of *Nicotiana* under various greenhouse conditions of season, temperature and day length. Poor and erratic germination of *Nicotiana* species seed when harvested is caused by dormancy, not by lack of viability. Dormancy decreased and percentage germination increased greatly for at least 3-4 years in seed stored at about 50°F. Species seed viability is estimated to have about the same duration as tobacco seed. Environmental conditions during growth influenced dormancy of fresh seed, the differences disappearing with storage. Propagation of species (duplicate fertile plants) at about 5 year intervals should be adequate to maintain seed stocks. (Abstract)

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INDIAN TOBACCO

SEMINAR NOTES

CHEMISTRY OF FLUE-CURING PROCESS

The Seminar group of the Central Tobacco Research Institute, Rajahmundry met on 24th January, 1961. Shri B. V. Ramakrishnayya gave a talk on the above subject.

The speaker in the beginning discussed the flue-curing process and pointed out that in this process the mature tobacco leaf is transformed into yellow aromatic product. In biochemical terms this process involves essentially the catabolism of detached leaf under modified conditions of temperature and humidity. Thus the chemical changes in the tobacco leaf during this process may be reckoned as similar to those in detached leaves of other plant species except that these changes in the tobacco leaf are either hastened or abruptly stopped depending upon the quality requirements of the trade.

Reviewing the early work done on the chemical changes in harvested tobacco leaves it was pointed out that this has been admirably summarised by the late Dr. Frankenburg in his two reviews in the *Advances in Enzymology*. Among the later work, studies of Bacon in United States of America, Askew in New Zealand and Sastry in India were mentioned.

Discussing the influence of each of the factors on the chemical composition of the leaf, it was pointed out that mainly in the flue-curing process (a) temperature, (b) humidity, and (c) air flow were controlled. Increase in temperature increased the rate of chemical reactions. But further increase over a certain optimum inactivates the enzymes, and chemical reaction ceased to take place and the leaf merely dried. This is exactly what happens during the fixing and the drying stages of curing while in the first stage, viz. 'yellowing', the temperature is at an optimum level. The relative humidity controls the rate of drying and therefore regulates the water content in the leaf. The water in the leaf serves three functions, viz. (1) The reaction medium, (2) One of the reactants in hydrolytic reaction, and (3) Agent for translocating the mobile chemical constituents. Any change in the water content is therefore, reflected in the set up of chemical components in the leaf. The interplay of temperature and humidity on the tobacco leaf is reported by Roberts. When the humidity is high and the temperature is raised beyond 120°F. there is destruction of cell structure and extensive disorganisation of the cellular components, leading to formation of brown oxidation products which participate in further condensation reactions. The air-flow supplies oxygen required for oxidation reactions in addition to its role in driving off the moisture in the leaf.

The major chemical reactions taking place during the starvation of leaf are hydrolysis and oxidation, while the respiratory processes which involve loss of dry matter complicate the quantitative estimation of chemical constituents, translocation from leaf web to ribs and *vice versa* introduces to some extent new complication. The proteins, carbohydrates, organic acids, pigments, resins and waxes and the polyphenols etc. and their transformations and inter-actions form the core of the chemistry of flue-curing process.

SOME OBSERVATIONS ON THE DETERIORATION OF COLOUR OF FLUE-CURED VIRGINIA TOBACCO

The Seminar group of the Central Tobacco Research Institute, Rajahmundry met on 18th February, 1961. Shri T. G. Sastry gave a talk on the above subject.

In his introductory remarks the speaker pointed out that the colour of the leaf is of primary importance for flue-cured Virginia tobacco. Of late it is reported that the tobacco produced on certain types of lands, viz. inundated, low lying, tank bed, wet paddy and saline is not keeping colour during storage. The deterioration of colour not only affects the farmer but also the trader and the manufacturer. This is a very serious problem we are now facing and hence the work on this problem has been commenced at the Institute since 1957-58.

The speaker then gave some idea about the work thus far done in this direction. Leaf produced from different varieties, viz. Harrison Special, Putcha and Karedu were collected for the last two

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years and tested for their fading of colour after subjecting the leaf to varying temperature and humidity. The physical characteristics like colour, thickness, weight per unit area, leaf burn and chemical composition have been determined on these various samples. The speaker pointed out that colour of the leaf samples were compared with the Dictionary of colour and the colour squares were assigned some numerical values for evaluation purpose. He then presented in detail the method of colour reading and the procedure adopted in sampling the leaf material.

Summing up the discussion, it was brought out that the work done thus far has given the following indications :

- (1) Leaf produced on high level areas retained colour better than the other types of land.
- (2) Leaf kept at higher humidities faded more rapidly than at lower humidities.
- (3) Under vacuum and at lower temperature the fading occurred at a very low rate irrespective of the leaf thickness or the type of land on which the leaf is produced.
- (4) Leaf produced on high land areas contained less chlorine and was better in burn than that produced on other types of lands. There was no relationship between the colour and the chemical composition (Inorganic).
- (5) The fading of colour is to some extent associated with the destruction of the yellow pigments like Carotene and Xanthophyll but they are not quantitatively related.

The deterioration of colour is mostly due to the oxidation of polyphenols and some enzymatic reactions. The problem is being studied further.

MONOSOMICS IN TOBACCO

The Seminar group of the Central Tobacco Research Institute, Rajahmundry met on 24th March, 1961. Shri K. V. Satyanarayana, Cytological Assistant gave a talk on 'Monosomics in Tobacco'.

A brief review of the methods used in securing and maintaining the monosomics in tobacco and their possible utilization in the improvement of the tobacco crop was presented.

Shri Satyanarayana explained how monosomics provide a convenient and time-saving method for localizing mutant genetic loci on specific chromosomes and for the substitution of chromosomes. In *N. tabacum* the first two monosomics for chromosomes 'C' and 'F' were reported by Clausen and Goodspeed in 1926. A complete set of monosomics was established in *N. tabacum* utilising 'pale sterile', a partly asynaptic race. All the 24 monosomics differ from one another and from the standard *purpurea* in a specific assemblage of morphological and reproductive features of sufficient degree to permit easy recognition. They are maintained by recurrent backcrossing of each monosomic to the standard *tabacum* type, *purpurea*. Since this method involves considerable labour and effort in the growth of stocks and the scoring of cultures each year, the monosomic stocks have been maintained, in recent years, by propagating selected plants from cuttings. This procedure enables us almost indefinitely to maintain the plants verified for chromosome number. It is well known that two species of *Nicotiana* were involved in the origin of *N. tabacum* and for the sake of convenience, monosomics involving chromosomes of the *tomentosa* subgenome have been given the letter designations A to L and those of the *glauca* subgenome M to Z. X and Y have been reserved for non-specific characterization of any monosomic or of an unknown type. Monosomics are useful for locating mutant genes, to determine linkage groups and to associate them with specific monosomics. Chromosomes carrying certain desirable genes like resistance to diseases and pests can be transferred from one variety to another by utilising monosomic stocks.

After dealing with the above practical aspects, the speaker explained how monosomics were of considerable theoretical interest in understanding the nature of varietal diversity, the changes that have occurred since the origin of genus *Nicotiana*, whether by evolution of modifier complexes and dominance mechanisms or by gross structural changes or both. He further pointed out how monosomics show differential sensitivity to irradiation treatment and how the monosomics could be used for the effect of irradiation on material hemizygous for certain sets of genes.

The talk was amply illustrated by photographs and tables projected on the screen and by live specimens.

INFLUENCE OF IRRIGATION, FERTILIZATION AND TOPPING OF FLUE-CURED TOBACCO.

(Seminar at the Central Tobacco Research Institute, Rajahmundry, May, 1961.)

The seminar group of the Central Tobacco Research Institute, Rajahmundry met on 29th May, 1961. Shri N. A. Awatramani, Technical Assistant gave a talk on the above subject.

Irrigation and fertilisation are two important aspects of agronomy which help in increasing the production of any crop. Irrigation is more beneficial to crops which are grown on conserved moisture. Previous experiments had shown that light irrigation increased yield without affecting quality. Application of balanced fertilizer (NPK) is usually more useful particularly where quality of the crop is equally important.

An experiment concerning these two aspects along with topping was conducted at the Central Tobacco Research Institute farm, Kateru during 1957-58 to 1959-60 with variety Harrison Special. The effect of treatments on the development of plant, yield and quality characters were presented and discussed in details. The data indicated that irrigation favourably increased the height and leaf area per plant. It produced appreciable beneficial effect on the yield of tobacco without affecting quality as given by Bright Grade Percentage and number of leaves per kilo.

Application of NPK did not show any beneficial effect over N alone even under irrigated conditions and when fertilisers were applied deep with deep placement implement. Topping tended to increase the yield of cured leaf though not always significantly. It increased the weight per unit area substantially.

INFLUENCE OF PHOSPHORUS AND NITROGEN IN TOBACCO NURSERIES ON THE STAND AND EARLY GROWTH OF SEEDLINGS AND THE NUMBER OF TRANSPLANTS.

(Seminar at the Central Tobacco Research Institute, Rajahmundry, June, 1961.)

The seminar group of the Central Tobacco Research Institute, Rajahmundry met on 21st June, 1961. Shri M. Bangarayya, Plant Physiological Assistant gave a talk on the above subject.

Commercial tobacco nurseries are generally raised on sandy soils. Attempts made to grow them in black cotton soils often met with failure due to large number of deaths of seedlings occurring in early stages from various causes.

From pot experiments it has been found that one of the causes for these deaths was insufficiency of phosphorus for the young seedlings and the situation getting much aggravated if nitrogen was present in high quantities.

Results of the experiments conducted during 1959-60 and 1960-61 in Kateru farm of the Institute on the influence of Nitrogen and Phosphorus in the nurseries were presented.

From the data it was pointed out that addition of phosphorus as a basal dose favourably influenced the stand and early growth of tobacco seedlings as recorded on the 18th day. On the contrary addition of nitrogen had a deleterious effect on the stand though it favourably influenced the growth of the seedlings at a later stage i.e. 30th day.

Taking final number of transplants into consideration it was found that addition of phosphorus as a basal dose had given maximum number of transplants; whereas addition of nitrogen alone as a basal dressing produced the least number of transplants which is probably due to depletion of seedlings in the early stages. But the necessity of the nitrogen in small quantities even from the very beginning is evident from the data of the transplants obtained from different pullings. It is seen that when nitrogen is supplied in a number of split doses over a basal application of phosphorus, more number of transplants are obtained from the earlier pullings as well as in aggregate from all the pullings taken together. From these experiments, it seems that the best method of manuring nurseries of black cotton soil will be to apply 56.3 kg./ha. of P and 11.25 kg./ha. of N as a basal dose, followed by two doses of 5.6 kg./ha. of nitrogen and 3 doses of 11.25 kg./ha. of N at two day intervals starting from the day of germination.

LANKA TOBACCOS — DISTRIBUTION, MORPHOLOGY AND VARIETAL TRIALS

(Seminar at the Central Tobacco Research Institute, Rajahmundry, July, 1961.)

The seminar group of the Central Tobacco Research Institute, Rajahmundry met on 28th July, 1961. Shri V. V. Ramana Rao, Botanical Assistant gave a talk on the above subject.

Seminar Notes

The speaker observed that the *lanka* tobaccos could broadly be classified into two major groups, namely the Krishna *lanka* types and the Godavari *lanka* types. The Krishna *lanka* types are more related to the 'natu' type of Guntur district while the Godavari *lanka* types are distinctly different from the 'natu' types. Presenting information on the morphological characters of the *lanka* tobaccos he observed that as a rule Krishna *lanka* types are sessile and Godavari *lanka* types are petiolate. In addition to this there are distinct differences between the two types and within the types in regard to plant height, phyllotaxy, panicle length, internodal length, maturity, flower shape, position of stigma in relation to anthers, capsule shape and size. D.R.1 and Inavalli-2 types were characterised as having unequal leaf base which could be taken as marker characteristics for these types.

Yield trial data for 4 Krishna selections and 15 Godavari selections with D.R.1 as control were presented and it was observed that Katavaram 1 and 2 had an over all superior performance in both the years.

After the discussions, winding up the seminar, Dr. G. S. Murty, Director, Tobacco Research observed that the *lanka* tobaccos constituted a fascinating material for study because of high genetic variability that was observed not only between the two groups of *lanka* tobaccos but also within each of these groups. The frequent inundation of the *lankas* and the unpredictable deposition of silt to different degrees in different years inevitably has an effect on the fitness of the *lanka* populations and this has led to the evolution of a genetic mechanism that would enable the *lanka* tobaccos to survive in nature. The studies so far made at the Institute have suggested that the *lanka* types need to retain a certain degree of heterozygosity for survival in the frequently changing conditions under which they are grown.

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Fig. 1. Mixed crop of Tobacco and Ragi.

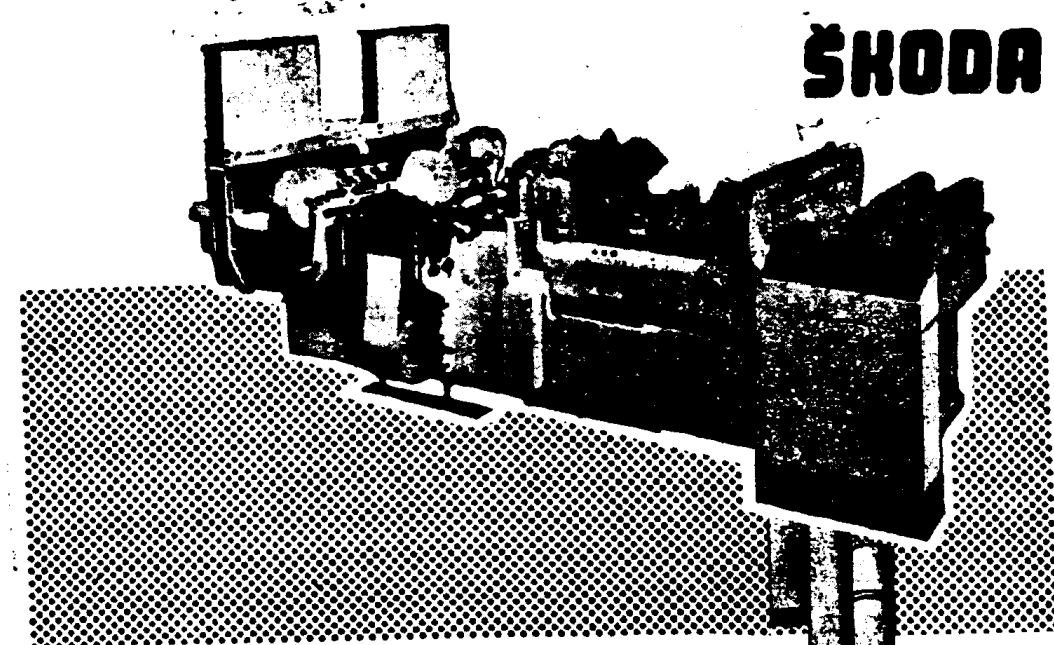


Fig. 2. Shri Raju, Progressive Tobacco Grower of Mysore State, looks with satisfaction at his well-grown mixed crops of Tobacco and Ragi.

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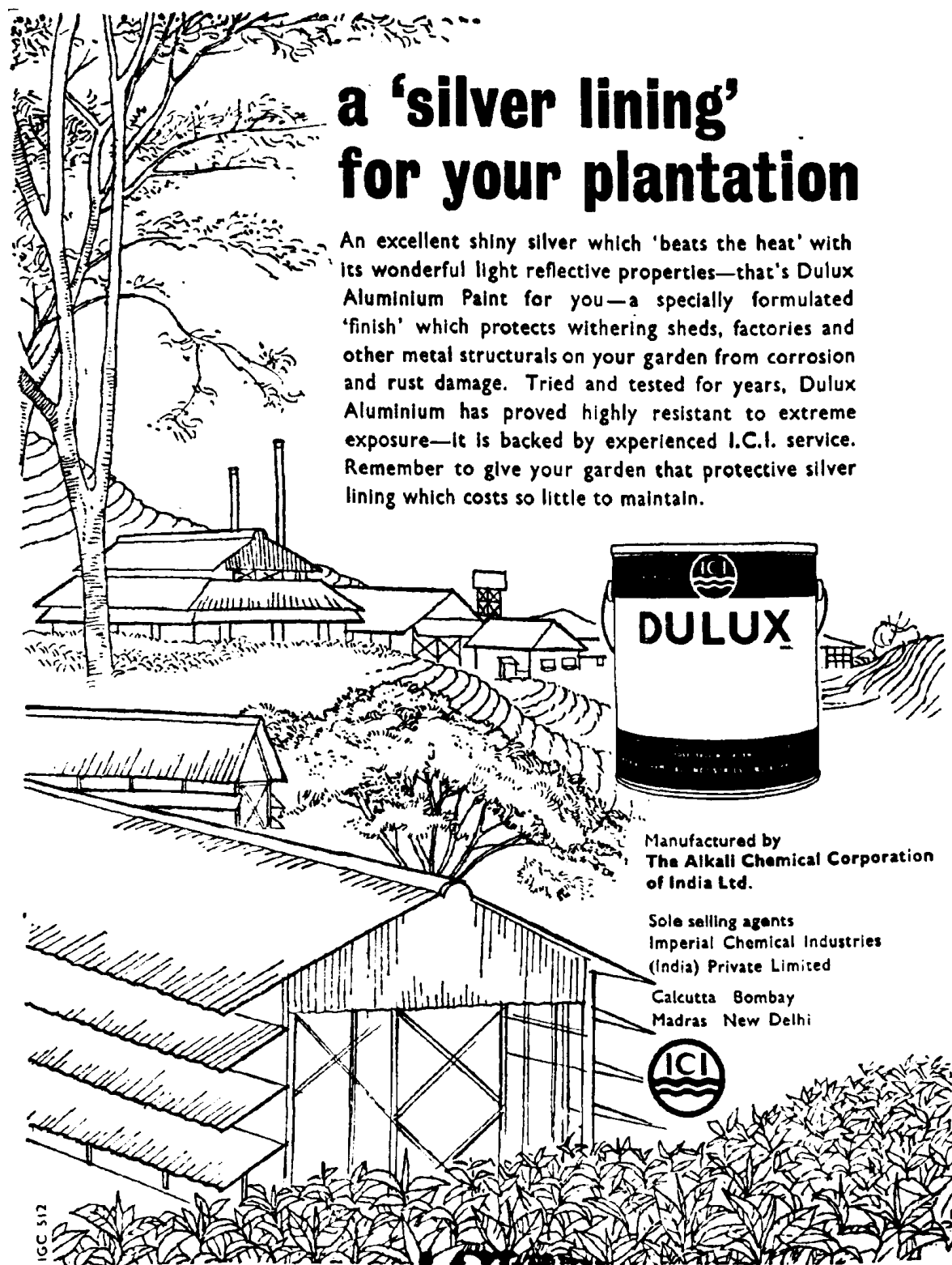
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