Planting by Marker-Method

Indian Tobacco

Quarterly

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INDIAN CENTRAL TOBACCO COMMITTEE

122, MOUNT ROAD

MADRAS-6

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FOR CONTRIBUTORS' GUIDANCE

Articles should be as concise as possible and generally with appeal to the lay public. Titles of the artieles should be short. Articles on scientific research need not contain the details of experiments conducted, and should avoid, as far as possible, scientific formulae and technical terms. Where technical terms are unavoidable, they should be explained in the text in simple language. Statistical tables should be restricted to the absolute minimum and should be typed on separate sheets with their positions marked in the text. Appropriate mention in the article of the economic value of the results of research and methodological studies will enhance its usefulness. Original articles should conclude with a short summary of the main facts and conclusions.

2. Reference to literature which must be restricted to the very few of importance, should be given in the text wherever possible in chronological order—only the names of authors and years of publication in brackets being given. They should be stated in full after the summary, authors' names following in alphabetical order, as under :—

(i) Name or names of author(s).

(ii) Name of journal (abbreviation), with a single underline, year of publication, number of volume, page number.

3. Information of a miscellaneous nature and of interest to the general public, facts, observations, etc.; relating to TOBACCO are also received for publication.

4. Manuscript should be neatly typed with double spacing on one side of the paper only and with wide margin. Three copies should be sent. Drawings, diagrams, etc. should be done in Indian ink. Coloured illustrations are not required.

5. All papers should be carefully revised by the authors and should be absolutely in final form for printing.

6. In addition to one copy of the Journal, in which their articles appear, 25 complimentary copies of the reprints of only the original articles will be supplied to their respective authors free of cost on request. If there are more than one author, these 25 copies will be distributed among them. Authors should intimate, while sending their articles for publication, whether they require their reprints. Additional copies of reprints can be supplied on payment at printer's cost price if intimation is given while sending the articles for publication.

7. The Editorial Board reserves the right to suitably change, rewrite or reject the whole or any portion of the matter received for publication.

8. All articles and other materials for publication in "INDIAN TOBACCO" should be addressed to the Secretary, Indian Central Tobacco Committee, 122, Mount Road, Madras-6.

INDIAN TOBACCO

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CONTENTS

THIS ISSUE

Contains the glowing tribute, paid to the former Vice-President, Indian Council of Agricultural Research, on his relinquishing the post, and a brief congratulatory note on the new Vice-President's taking over the post.

The article on the development and spread of the cultivation of F.C.V. tobacco in Vijapur with the significant help of Indian Leaf Tobacco Development Company Ltd. is a salient feature of this issue. It is followed by the article " the tobacco extension activities in Gujarat " which throws helpful light on convincing the growers of the utility of application of research findings in improving tobacco production.

The articles following them, as a whole, give us invaluable information about experiments on the nutritional response of cigarette beetle to different grades of flue-cured tobacco and enlighten us on the role of vegetable oils in the suppression of suckers in Hookah and Chewing tobacco and on that of the chemicals in the control of suckers in cigar tobacco. The precious results of the manurial trials on tobacco nurseries at Dinhata ought to be known by every farmer to be able to understand the economic benefits and commercial gains of the artificially produced hybrid vigour in tobacco. The gleanings from world literature on tobacco, seminar notes etc. feature in this issue as usual.

M. S. PATEL,
Secretary.

INDIAN TOBACCO

Dr. M. S. RANDHAWA — A TRIBUTE

(*Indian Farming*, Nov. 1960)

(Contributed)

Dr. M. S. RANDHAWA laid down office as Vice-President of the Indian Council of Agricultural Research on 17th November, 1960. As doyen of the organisation for over five years, he adorned a seat of learning with a vitality and grace, all his own. He is essentially a scientist by training, an administrator by profession, an artist by nature and a farmer at heart. He is one of those practical visionaries who has his feet firmly on the ground. It is by the rare combination of these qualities that he could thrill to the phenomenon of the reproduction of the algae which to most is nothing more than the slimy scum in the ponds, and yet could foresee in this low plant life the future food for the ever-growing hungry millions of the world.

DR. M. S. RANDHAWA

His interests are wide. He derives a child's innocent delight in viewing a picture or witnessing a dance while simultaneously exercising a connoisseur's discernment in every subtle shade of colour and every classical nuance. His persuasions in such directions as these have found expression in his books, *Kangra Valley Paintings, Basohli Paintings, Geet Govind Paintings* and *Punjab De Lok Geet.* Every village to him is the abode of the meek that are blest and every farm, the temple where every tread of the farmer means an extra grain in the granary. He shares these thoughts with you in his books, *Developing Village India* and that *magnum opus* of rural life, *The Farmers of India.* Every tree in flower to him is a poem in colour and every garden a riot of colours and he unfolds a bewitching story of these in his delightful books. *Flowering Trees of India* and *Beautifying India.* It is in the impulses of these variegated traits that have born so far as many as 32 books in English, Punjabi and Hindi.

VARIED INTERESTS

His interests are not only wide but they are sustained. Landscape development of Punjab's capital of Chandigarh was an activity that he took up while he was an official serving in that State but it continues to be one of his chief concerns even today. Work on the Community Development Blocks of the Punjab was once a duty cast on him but it is still a passion that grips him. The problem of refugees is yet another subject of which once being seized, he now finds hard to divorce himself from.

In the Indian Council of Agricultural Research, his advent presaged an era of rapid

progress in both agriculture and animal husbandry. To him an integrated and co-ordinated approach to most of the farmers' problems was the most rational way to cut through the maze of complexities that characterise each crop or commodity when taken singly and by itself. PIRRCOM Centres to work simultaneously on crops such as millets, oilseeds and cotton that go in association with one another in farmers' holdings all the country over, experimental stations for research on fruits, vegetables and flowers to promote crop welfare in a regional set up characterised by more or less agro-climatic similarities are the outcome of the new orientation that Dr. Randhawa spelt out after pregnant thought. It is he, again, who has been responsible for the constitution of a Council to co-ordinate and improve the standards of agricultural education in the country.

YEARNING FOR NEW CONCEPTS

His thirst is avid for new concepts and movements in progressive scientific thinking. Hybrid maize strongly attracted him as a possible solution for feeding the masses of our country and its production has now been launched in a big way. The Gamma garden for hustling nature to beget bigger and better progenies of crop plants that has been established at the Indian Agricultural Research Institute, New Delhi, is a radiating testimony to his yearning that India should not linger behind other countries in exploiting such harbingers of prosperity and abundance.

Dr. Randhawa is a recognised leader among men but withal he is astonishingly meek and retiring in disposition. Notwithstanding these characteristics, his humanity is massive and fundamental. Scientists and scientific talent are dear to his heart and among his many and varied achievements, the one, perhaps, which has singularly satisfied him is the provision which the governing body of the I.C.A.R. made at his behest towards the grant of honoraria to retired scientists for carrying on useful work after attaining superannuation age.

It has been a privilege for the Indian Council of Agricultural Research to have its destinies guided by so versatile a person and in paying this tribute, it indeed honours itself.

Shri V. SHANKAR TAKES OVER AS VICE-PRESIDENT, I. C. A. R.

(*Indian Farming*, Nov. 1960)

Shri V. SHANKAR, I.C.S., former Director General of Posts and Telegraphs, took over as Special Secretary in the Department of Agriculture, Ministry of Food and Agriculture, on the afternoon of November 17, 1960. He will also discharge the functions of Vice-President, Indian Council of Agricultural Research.

SHRI V. SHANKAR

An eminent administrator and a man of literary pursuits, Shri Shankar ranks high among the Civil Service men in the country. He is known for his strong determination and sees that his plans are got through.

Shri Shankar came to the limelight when he served as the Private Secretary to Sardar Vallabhbhai Patel and later as Joint Secretary in the States Ministry during the very critical times of the post-Independence period. Afterwards, in the Ministry of Defence, he solved many problems of defence, specially that of the Navy and Air Force. As Secretary of State, he put through important schemes of land reforms particularly tenancy laws. During his tenure as Director General of Posts and Telegraphs Department, the autonomous Posts and Telegraphs Board was constituted and there was extensive expansion of the postal, telegraph and telephone facilities in the country.

After 27 years of distinguished service in various capacities, Shri Shankar now comes to the Department of Agriculture, in the Ministry of Food and Agriculture, as its Special Secretary where many important problems await his early attention, the most important being the co-ordination of agricultural research, education and extension and stepping up the agricultural production programme. There is no doubt that under the effective guidance of Shri V. Shankar the agricultural production will go up.

EARLY LIFE

Shri Shankar hails from a respectable middle class family of Partapgarh (Oudh) in Uttar Pradesh. He graduated in the first division from the Allahabad University after a brilliant academic career at the local school and the D. A. V. College, Kanpur. He took his Master of Arts degree in History in 1931, the same year in which he passed his I.C.S. competitive examination at Delhi. After two years' probation at St. John's College, Oxford, he joined the Bombay cadre of the I.C.S. at the young age of 24 as Assistant Collector, Dharwar, now part of Mysore.

He served in this capacity for several years in the District of Dharwar, West Khandesh and Poona. In January 1939, he joined the Bombay Secretariat as Under Secretary in the Revenue Department. Later he became Deputy Secretary of the Finance Department in April 1940, from which post he was transferred to the Government of India as Under Secretary, Home Department, in September 1941. He became Deputy Secretary in that Department in October 1943 and was later selected by Sardar Vallabhbhai Patel as his Private Secretary in September 1946. He served the late Sardar in that capacity until his death in December 1950. He was appointed Joint Secretary in the Ministry of States in addition in March 1948. After the death of Sardar Patel, he continued in the Ministry of States as Joint Secretary till August 1952 when he was appointed Joint Secretary in the Ministry of Defence. He returned to his cadre State of Bombay in January 1954 and after a year as Collector of Palanpur, he assumed charge of his office as Secretary, Revenue Department, Government of Bombay, in January 1955. In October 1958 Shri Shankar joined the Ministry of Communications as Director General, Posts and Telegraphs, from which post he now comes to the Department of Agriculture.

CORRIGENDUM

TO

'INDIAN TOBACCO'

JANUARY - MARCH 1961

Pages 3 & 53

The name of the second author of the article—'Effect of NPK manuring of Bidi Tobacco (Keliu K 49)' is C. C. Shah, and not C. C. Shaw.

Spread of Cultivation of F. C. V. Tobacco in Vijapur

M. S. PATEL, M. Sc., Ph. D. (U. S. A.) [1]

Z. M. KADRI, M. Sc., (Agri.) [2]

EARLY EFFORTS

In the year 1945, an exploratory centre for cigarette tobacco was set up at Vijapur in a chain of exploratory stations established throughout the country by the Indian Central Tobacco Committee with a view to examine the possibility of those regions growing the flue-cured tobacco. The results of the work done at this station indicated that F.C.V. tobacco of good quality could be grown in Vijapur area. The exploratory work at the Bidi Tobacco Research Scheme, Anand also indicated the possibility of growing F.C.V. on a commercial scale in the Gujarat area. The commercial cultivation of the F.C.V. tobacco in Vijapur was first started in the year 1949 by Indian Leaf Tobacco Development Co. Ltd., who are pioneers in the field of Virginia tobacco development in this area also as they were in Andhra Pradesh in the late twenties.

The cultivation of flue-cured Virginia tobacco in Northern Gujarat is concentrated mainly in Vijapur, Visnagar and Kalol talukas of Mehsana district. The yield of green leaf and of top grades is considerably higher than that obtained in Mysore State and Andhra Pradesh.

Soil in Vijapur area is alluvial and contains a large percentage of sand. Its percolation capacity is therefore good. Normally Flue-cured Virginia tobacco is cultivated on well-drained sandy soil.

SEASON

As usual, there are three seasons, Monsoon, Winter and Summer. The Monsoon starts generally in mid-June and continues till September. Sometimes late rains are also received in the month of November. Average rainfall is 63·5 cms.

Winter begins with the advent of October and continues till the end of February. Winter is cold. Frosts also occur during December

[1] Secretary, Indian Central Tobacco Committee and Member, Tobacco Export Promotion Council.
[2] Technical Assistant, Indian Central Tobacco Committee.

and early January. The temperature during winter ranges from 5°C to 37°C. Humidity during November to December, which is the curing season, is very low, i.e. 25% to 50%. The summer lasts from March to June and is dry and hot. Temperature during April and May goes up as high as 46·7°C. Average temperature during summer is 41°C.

Tobacco cultivation commences with the advent of the monsoon or kharif season.

The nursery work starts in June. Sometimes the nursery field is irrigated in January-February. It is ploughed thereafter and is kept fallow upto June. Nursery field is generally given the Farm-Yard Manure. This helps to raise nursery beds. The seeds are sown in June and are protected from hot sun. The seedlings are ready in 5 to 6 weeks after sowing.

VARIETIES

The farmers are advised to grow the Delcrest variety as it gives good yield and quality leaf. Other varieties grown are Harrison Special and Hicks and F.C.V. Special strain. Seeds of all varieties are supplied by Messrs. Indian Leaf Tobacco Development Co. Ltd., to curers at approximately Rs. 2 per lb. Seeds are produced at the Company's Research farm at Rajahmundry.

MANURES AND FERTILISERS

Besides the basic dose of 25 cartloads of farm-yard manure per hectare, 830 kgs. of the Fertiliser Mixtures, which can enrich the soil with 22·5 kgs., Nitrogen 91 kgs., Potash 68 kgs., Phosphates 11 kgs., Magnesium Oxide are recommended. Indian Leaf Tobacco Development Co. Ltd., provides varieties of mixtures with varying proportion of N.P. & K.

PREPARATORY TILLAGE

The land is ploughed in the month of May after the harvest of hot weather crop. Tobacco land is manured with farm-yard manure at the rate of 25 to 30 cartloads per hectare and the land is ploughed 4 to 5 times.

TRANSPLANTING

Land is then marked with wooden markers to sow seedlings in rows. Transplanting commences from August for early crop and it is done in the evenings. In some cases it is continued upto mid-September. Planting of late crop is done during October. The spacing generally adopted is 0·76 mtrs. × 0·76 mtrs. or 0·91 mtrs. × 0·91 mtrs. It has been found that spacing of 1·22 mtrs. × 0·61 mtrs. is advantageous.

Crop is irrigated 6 to 8 times at an interval of 10 to 15 days as may be required, after September or October. In case of scanty rains, the crop may have to be irrigated about 12 to 14 times.

HARVESTING

Harvesting by priming begins in December. The harvested leaves are graded. The damaged and diseased leaves are not taken into account in the total green weight. Only the good quality leaf is accounted for.

CURING

The barns are usually 6·10 mtrs (long) × 4·27 or 4·88 mtrs. (broad) in size and are single furnaced. The curing of the leaves is done by barn-owners who enter into contracts with the growers. There are at present 502 flue-curing barns in Vijapur.

GRADING

During the curing season, the humidity is generally about 25% to 50% which is considered low for handling the cured leaf. This difficulty is overcome by grading the leaf in underground cellars which is a unique feature of this tract. The cured leaf is graded by the

Fig. 1. Tobacco Grading

Fig. 2. A barn owner inspecting the field

curers or the farmers with the willing guidance of the trade. The cured leaf is graded according to the grades prescribed by Indian Leaf Tobacco Development Co. Ltd (Fig. 1).

F.C.V. TOBACCO CROP

The Gujarat Leaf Tobacco Redrying Co. (Pvt.) Ltd., composed of growers-cum-curers has also been set up with the acknowledged help of Indian Leaf Tobacco Development Co. Ltd. It has a plant with a capacity of redrying about 2,200 kgs. of tobacco leaf per hour.

It is reported that during 1959-60 the average yield of the flue-cured Virginia tobacco in the area was 1,075 kgs. per hectare i.e. higher than that obtained in other F.C.V. tobacco growing areas in India. Some farmers achieved yields as high as 3,362 kgs. per hectare. The yield of top-grade leaf was also comparatively higher. The farmers being progressive, pay good attention to all cultural practices of the crop under the guidance of Indian Leaf Tobacco Development Co.'s staff. This helps to maintain quality production of the flue-cured Virginia tobacco which has made its cultivation paying to the cultivators.

The unique feature of this area again lies in its progress gained through the willing and unremitting co-ordination and co-operation between the keen and enthusiastic growers and the expert staff of Indian Leaf Tobacco Development Co. Ltd. This helps the farmers to solve their difficult problems in the various stages of tobacco production viz. (i) lack of body and burning quality, (ii) difficulty in handling leaf under the dry conditions of Vijapur and (iii) diseases like leaf-curl, etc.

GENERAL

Method of cultivation of Virginia tobacco is similar to that of Mysore State. The farmers grow tobacco under an agreement with barn owners. Unlike in Guntur, the curers and growers are different persons. Normally the farmers enter into contract for supply of green leaf to the barn-owners. Their fields are periodically inspected by the staff of Indian Leaf Tobacco Development Co. Ltd., of the area or the barn owners who advise the farmers to carry out different cultivational operations such as earthing, weeding, irrigation and priming at proper times. The picking of the leaf is arranged only after inspection. Similarly, the barn owners inspect the fields before transplanting (Fig. 2). The curer, sometimes, advances loan to the farmers. The farmer is helped by the curer in meeting the cost of the fertilisers, their application, etc. Of late, even the picking is done at the expense of the curer. In all, an aid of Rs. 100 per acre mostly in kind, is received by the farmers from the curers. The picked leaves are carted to the barn by the farmer. In his presence green leaves are weighed and graded. The weight of good quality leaf only is entered in the book and a receipt for it is issued.

PRICES

The price of the green leaf is fixed by the Barn Owners' Association. Generally the rate ranges from Rs. 2 to Rs. 2.50 per kutcha maund (18·60 kgs.).

PRESENT DEVELOPMENT

Under the patronage of Indian Leaf Tobacco Development Co. Ltd., most striking progress has been achieved within the last ten years both as regards the crop production and the quality improvement of Virginia tobacco as will be evidenced by the following table showing acreage, production and number of barns from 1949-50 to 1960-61.

Spread of Cultivation of F.C.V. Tobacco in Vijapur

TABLE 1 : Statement showing acreage, number of barns, production and percentage of grade out-turn from the year 1949-50 to 1960-61.

Years	F. C. V. Acreage (in hectares)	No. of Barns	F. C. V. production in kgs.	Grade out-turn percentage		Yield in kgs. per hectare.
				Top grade	Low grade	
1949-50 ..	16.0	11	15,000	55	45	1,000
1950-51 ..	33.0	22	18,000	68	32	545
1951-52 ..	86.0	28	57,000	62	38	663
1952-53 ..	199.0	37	127,000	67	33	638
1953-54 ..	214.0	70	259,000	62	38	1,210
1954-55 ..	330.0	120	286,000	48	52	867
1955-56 ..	342.0	140	416,000	59	41	1,216
1956-57 ..	520.0	160	618,000	64	36	1,188
1957-58 ..	720.0	234	794,000	56	44	1,103
1958-59 ..	788.0	263	636,000	64	36	807
1959-60 ..	732.0	291	787,000	68	32	1,075
1960-61 ..	1,858.0	502	2,107,000	55	45	1,134

FUTURE DEVELOPMENT

Visualising the potentiality of this area for growing good quality of Flue-cured Virginia tobacco combined with high yield, the establishment of a cigarette tobacco research substation at Vijapur, Gujarat, is planned by the State Government in collaboration with the Indian Central Tobacco Committee during the Third Five Year Plan.

ACKNOWLEDGMENT

The authors wish to acknowledge their gratitude to Shri A. N. Srivastava, M.Sc., Superintendent, Indian Central Tobacco Committee, for his going through the manuscript critically and to Shri S. M. Desai, Officer, Indian Leaf Tobacco Development Co. Ltd., Vijapur, for furnishing all the factual information in time.

Tobacco Extension Activities in Gujarat [1]

Dr. G. J. PATEL [2]

All round improvement in the production of various tobacco types in India has been the responsibility of Indian Central Tobacco Committee, under the Ministry of Food and Agriculture, Government of India. To achieve the objectives, the Committee on its inception in 1945 established Research Stations and also started Schemes in conjunction with State Governments in different regions for undertaking comprehensive scientific investigations on all types of tobacco.

Of the many tobacco types grown in India, *Bidi* tobacco has been the speciality of Kaira and Baroda Districts of Gujarat, Kolhapur and Satara Districts of Maharashtra and Belgaum District of Mysore State. Hence, in 1947, the Committee established Bidi Tobacco Research Station, Anand, for research work on bidi tobacco grown in Gujarat, and in 1948 started bearing full recurring expenditure of the Bidi Tobacco Research Sub-Station, Nipani, of the then Bombay Government, for agricultural improvement of the crop.

In 1951, the Committee transferred the research work on bidi tobacco at Anand to the Institute of Agriculture, Anand as a fully financed Scheme of the Committee, the land for research work being provided by the Institute free of cost. This research unit during the eleven years' period has made valuable contributions in the quantitative and qualitative production of bidi tobacco.

As the basic purpose of the research work is fulfilled only when the results of research reach to the growers, the Bidi Tobacco Research Unit at Anand, besides its normal research activities, endeavours to take the results of research to the growers. This is being tackled in the following ways since last five years.

[1] An attempt is made here to give an account, in brief, of the extension work done by the Bidi Tobacco Research Scheme. The Scheme is fully financed by the Indian Central Tobacco Committee, Madras, and administered by the Institute of Agriculture, Anand.

[2] Research Officer, Bidi Tobacco Research Scheme, Institute of Agriculture, Anand.

I. PROPAGATION OF THE IMPROVED METHODS OF BIDI TOBACCO CULTIVATION

The study of Farm *vs.* Farmers' method of bidi tobacco cultivation was concluded by the Station in favour of the Farm method in 1953-54. The Farm method was formulated from the research findings of the Station on spacing, topping and manuring and comprises manuring with 160 lb. N as groundnut or castor cake, 3′×3′ spacing and topping plants at 11 leaves after removing 3-4 bottom leaves, against the Farmers' method of manuring with 5 tons of farmyard manure and 40 lb. N per acre as oil cakes (groundnut or castor cake), 2½′×2½′ spacing and topping at 14-15 leaves. District trials were then conducted in 1954-55 and 1955-56 under the supervision of the research staff of the Station and in collaboration of the Agriculture Department of Bombay State.

The Farm method having been found to be superior to the Farmers' method (Fig. 1), both on the Farm and in the district trial of 1954-55, the Station in absence of any organisation for tobacco extension work, decided to take these results to the growers of Gujarat in 1955-56. As stated in Table 1, ten villages, known for growing quality tobacco and otherwise also, were selected by the Station.

The farmers were explained the direct advantages they will get by way of improvement in quality and the side advantages that will accrue, viz. (1) early maturity by about a month minimises the damage due to *orobanche* infestation and makes it possible to harvest the crop completely before the late frost in January or February, if it occurs, (2) save on the cost of suckering the crop (3 or 4 times), and (3) the tobacco so produced can be sold early, if found advantageous. Besides this, the growers were assured of the seed and seedling supply to plant the area registered under the improved method, in case of emergency and failure of their nurseries.

This served as a great impetus to the growers to try the improved method of tobacco cultivation and of the 900 acres registered initially, the village-wise details of the recommendations adopted is given in Table 1.

Though the area covered during 1955-56 was small, it served the basic purpose of making more and more farmers improved-method-minded because the growers who had adopted all recommendations of the method were convinced about its superiority over the local method. Moreover, the fields served as good demonstration plots in their own villages.

To cite only an example of the progress made by the advanced growers by adopting improved method of tobacco cultivation, Shri Raojibhai Motibhai Patel, a farmer of Sarsa village of Anand Taluka was mainly interested in cotton growing before 1955-56 and was producing only 46,000 lb. of tobacco from an area of 46 acres.

In 1955-56, when the research staff of the Tobacco Scheme had been to Sarsa to visit the fields of the growers who had intimated their desire to adopt the improved method, his name was not in the list because he was thinking that not much advantage will accrue from it. But when he learnt that the research staff had come to see the type of soil, etc. of the area registered under the improved method, he visited the Bidi Tobacco Research Station at the Institute, with lot of questions and with the prejudice commonly prevalent among the growers that they know more about tobacco and whatever the research workers say is not practical or is not advantageous. Hence, during the discussions, he was assured that if he undergoes any loss by adopting the improved method, it will be made good. This probably made him think that the improved method must be advantageous and later on he too

TABLE 1. *Particulars of the area under various factors of the Farm method.*

S. No.	Village	No. of growers in the Scheme: Initial Registration	No. of growers in the Scheme: Who carried out recommendations in part or full	Area in acres under various factors of recommendations * : M. S&T A gt	M. S&T S & T A gt	M & S M A gt	M & S S A gt	T A gt	Total A gt
1.	Anand	8	3	2—00	..	..	..	9—29	12—17
2.	Bedva	2	2	..	..	9—00	..	9—17	24—09
3.	Gamdi	5	5	22—30	..	1—00	..	2—00	37—25
4.	Lambhvel	4	4	11—27	17—15	5—25	3—38	60—08	110—31
5.	Napad	18	13	11—39	..	..	..	0—21	12—20
6.	Navli	10	4	3—24	..	..	1—05	6—37	52—37
7.	Ode	17	17	..	..	1—28	..	21—12	35—19
8.	Sarsa	8	7	143—13	45—25	9—17	7—12	36—22	279—29
9.	Vadod	33	25	..	..	..	..	..	44—36
10.	Vasad	6	6	66—36	..	..	..	5—13	89—38
	Total	109	86	267—09	82—12	26—30	12—15	151—39	700—21

* The factors are — M = Manuring with 160 lb. N per acre as groundnut or castor cake.
S = Spacing of 3′×3′.
T = Topping plants keeping 11 good leaves after removing 3-4 bottom leaves.

registered his area. Then he really became interested in it and requested the research staff to get him his groundnut cake requirements through them and ordered for a wagon-load of cake for him and some of his friends too (Fig. 2). Then everything got set to perfect gears and on his request for guidance and help for growing tobacco nursery also by improved method, needful was done by the Station. Thereafter, he purchased even the tools, etc. similar to those used on the Research Farm.

To put the progress made by him in nutshell, he has increased his per acre production of about 1,000 lb. in 1954-55 to 1,845 lb. in 1959-60 and is expecting an average of 2,000 lb. in 1960-61. Moreover, even though he grows his own tobacco nursery by improved method, he always registers with the Station half of his tobacco seedlings requirement on advance registration and guaranteed supply basis to safeguard his planting the crop in time. The matter does not end there but he is thinking of utilising the area available with the M. V. High School, Sarsa, to meet the seedlings requirement of the whole village and has requested the Station to supply a trained person to look after that.

To gauge his interest in the research work to-day, as soon as he came to know that the Second Tobacco Research Workers' Conference was to be held at Anand, in December 1959, he came up with a proposal before the Director, Institute of Agriculture, Anand, that he would very much like the research workers to see his crop and be his guest. On his insistence, a short visit to Sarsa was agreed upon by the President of the Indian Central Tobacco Committee in order to give a chance to the delegates to see the country side and their contribution in the country's increased production (Fig. 3).

On the success of this preliminary work, the Station made proposals for a Tobacco Extension Scheme to the Indian Central Tobacco Committee in 1956-57 which were favourably considered by the Committee and the Tobacco Extension Scheme started functioning effectively since 1959-60, under the administrative control of the then Department of Agriculture, Bombay State.

II. PRODUCTION AND DISTRIBUTION OF PURE TOBACCO SEEDS AND SEEDLINGS

In the production of quality tobacco, the supply of seeds and seedlings of improved varieties plays a unique role (Fig. 4). This was rightly realised by the Indian Central Tobacco Committee in 1951 at the time of the transfer of the research work to the Institute, and hence along with the research work, it also transferred its 47 acres of land to the Institute for production and distribution of pure seeds and seedlings of the improved tobacco types, of course, on a self-sufficiency basis.

This Farm is not only fulfilling the improved seed requirement of Gujarat tobacco growers but also has started a Scheme of supply tobacco seedlings on an advance registration and guaranteed supply basis (Fig. 5).

This has become very popular among the growers as it is an unfailing source of seedlings even under the most adverse conditions — even when the nurseries in the district get wiped out either due to excessive rains or the damping-off disease. Because of this, there is a constant flow of growers to the Farm. This gives them a good opportunity to see how the nurseries should be grown and what precautions should be taken to protect their own seedlings from diseases and other insect pests. The growers become more impressed about the improved method of raising tobacco seedlings when they find the seedlings at the Farm intact and their own destroyed. The result has been that many individual growers have started raising nurseries as recommended and are able to sell the seedlings after meeting their own requirements. It must be noted here that a

Farm method

Fig. 1. Farmer's method

Fig. 3. The President (third from the right) visiting Shri R. M. Patel's crop

Fig. 2. Shri Raojibhai M. Patel (right) and his crop

Fig. 4. An ideal tobacco nursery—a result of researches

Fig. 6. Farmers' Day at the centre.

Fig. 5. The result of advance registration and

beginning has also been made in Ode village of Anand Taluka to grow seedlings by the improved method in the area available with the village High School to meet the requirements of all the growers of the village. It has been quite successful and many more villages are expected to follow the same.

In addition, the Farm has two pumping sets and supplies water to the area around the Farm and helps the growers in raising food crops and also cash crops. The extension statistics of the Farm are given in Table 2.

These statistics do show that the plan of supplying pure seeds and seedlings had been very effective in propagation of the improved strains of bidi tobacco and our recent experience in respect of the demand of seeds of the improved strain K.20 which has been released by the Station only two years back confirms the same as the demand for K.20 and K.49 (previous improved strain) seed in 1959-60 was in the proportion of 3 : 1. Hence, in 1960-61 it was decided to produce only K.20 seed to cope up with the growing demand for K.20.

III. DEMONSTRATIONS (FARMERS' DAY), TRAINING AND EXPERT ADVICE

Beginning with 1957-58, Farmers' Day is held every year to acquaint the farmers with the improved method already put out and the research activities of the Farm. As aimed, this also provides an opportunity to the farmers and the research workers to understand each other's problems better and to work out what is wanted and what ought to be supplied or developed (Fig. 6).

The Institute also arranges to send out the team consisting of the Research Officer (To-

TABLE 2. *Extension Statistics of the Seed Multiplication Farm Scheme.*

Year		Tobacco seed Produced in lb.	Tobacco seed Supplied in lb.	Tobacco seedlings Supplied in number	Irrigation water in hours
1951-52	..	574	..	..	552-30
1952-53	..	1,967	574	26,200	1,092-45
1953-54	..	2,011	1,915	5,26,750	377-00
1954-55	..	3,138	2,845	13,97,875	147-00
1955-56	..	4,890	2,351	35,00,000	292-40
1956-57	..	10,411	4,890	64,40,500	798-00
1957-58	..	5,350	7,690	66,13,450	1,540-00
1958-59	..	3,187	3,310	62,76,000	673-00
1959-60	..	10,639	9,087	64,98,000	1,216-00
1960-61	..	15,000*	10,556	69,65,000	1,500-00*

* Estimates for 1960-61, as the crop is standing and irrigation water is being supplied to the crops grown outside the Farm.

** Besides this, the Institute also distributes the seeds and seedlings produced by its Farm Sections.

bacco), Plant Pathologist and Entomologist on receiving intimation of the trouble from any part of the area and needful done in the matter by recommending appropriate remedial measures.

With a view to further encourage the production of uniform quality bidi tobacco, which otherwise is classified as a non-descript type, the Committee has been financing a Scheme for Training in the Improved Methods of Cultivation, Handling, Curing and Marketing, etc. of Bidi Tobacco since 1957-58. The target of the Scheme is to train 35 sons of tobacco growers every year paying Rs. 20/- per month as stipend. During three years' period, 16 farmers' sons have undergone complete training for nine months at the Centre. Besides this, 60 Central Excise Officials were also given a short course for a week in the improved method of tobacco cultivation, curing, handling and marketing of bidi tobacco.

The response from the farmers' sons was quite encouraging in the first year but has been on decline thereafter, probably because of no scope of getting employed anywhere after training.

The basic purpose of the Scheme being to train the farmers' sons in improved methods of cultivation and help thereby in the production of bidi tobacco of uniform quality, the service-inclination of the trainees is not encouraged at all. From 1960-61, the stipend has been increased from Rs. 20/- to Rs. 40/- P.M. to provide enough financial assistance to meet the expenses when under training and take only good trainees who would be really interested in going back to their lands and take up the tobacco cultivation by improved method.

There are 18 trainees undergoing training at present.

Preliminary Studies on the Nutritional Response of the Cigarette Beetle *(Lasioderma Serricorne F.)* to Different Grades of Flue-cured Tobacco*

ANNAMMA R. KURUP [1]

Though the cigarette beetle (*Lasioderma serricorne* F.) has been known to cause serious damage to stored tobacco, especially of the flue-cured type, very little attention has so far been paid to a study of its feeding habits and nutritional physiology. No wonder then, that considerable difference of opinion prevails among the trades about the susceptibility of different grades of flue-cured tobacco to this pest. Some maintain that the beetle prefers the brighter grades while some others hold the opposite view that the lower grades are more easily infested.

A knowledge of the food preference of the beetle would be of great help to the trade in taking appropriate prophylactic and control measures. The results presented in this paper, are from a preliminary study conducted at the Central Tobacco Research Institute, Rajahmundry ; with a view to find out the feeding response of the beetle to different grades of flue-cured tobacco as the first step towards a detailed study of its nutritional physiology.

MATERIALS AND METHODS

The seven grades of flue-cured tobacco, viz., Y_1, Y_2, LBY_1, LBY_2, LMG, DG and PL used for these studies were graded according to the simplified grading procedure adopted at the Central Tobacco Research Institute, Rajahmundry. Y_1 is a mixture of grades 1 and 2 of Agmark and Y_2 of grades 3 and 4 of Agmark. LBY_1, LBY_2 and DG are the same as the Agmark grades. LMG is a mixture of LG and LMG of Agmark (Sastry, 1959). PL consists mostly of damaged leaves and broken bits.

In all, three tests were conducted with lots of 10 to 12 larvae for each grade and control. The tobacco was powdered and sifted through a 72 mesh sieve of 6 gms. of tobacco from each of the 7 grades were taken for each test. The tobacco was weighed into beakers which were covered with muslin cloth, and tighten-

* Article read at the Second Tobacco Research Workers Conference held at Anand during December 1959.

[1] Entomologist, Central Tobacco Research Institute. Rajahmundry, India.

TABLE I. *Growth of* Lasioderma Serricorne F. *in different grades of flue-cured tobacco.*

Grades														Total No. of Larvae tested	Total No. becoming adults	Percentage becoming adults (n)	Average development period (av)	Growth index (n/av)
Y_1	No. of days for emergence	27	28	31	32	33	34	35	37	38	39	40	41	34	23	67.65	35.96	1.8813
	No. of adults emerged	1	1	1	3	1	1	2	1	6	1	1	4					
Y_2	No. of days for emergence	32	33	35	38	45								34	10	29.41	35.60	0.8261
	No. of adults emerged	3	2	1	3	1												
LBY_1	No. of days for emergence	30	36	39	40	41	42	44	48	55				34	12	35.29	41.08	0.8591
	No. of adults emerged	2	1	1	2	1	1	1	2	1								
LBY_2	No. of days for emergence	33	34	35	39	42	44	45	46	48	51			34	11	32.35	41.73	0.7752
	No. of adults emerged	1	1	1	1	2	1	1	1	1	1							
LMG	No. of days for emergence	29	31	32	36	38	47							34	12	35.29	33.17	1.0639
	No. of adults emerged	2	5	2	1	1	1											
DG	No. of days for emergence	28	29	32	35	40								34	11	32.35	31.73	1.0195
	No. of adults emerged	2	2	5	1	1												
PL	No. of days for emergence	46	53	54	55									34	4	11.76	52.00	0.2262
	No. of adults emerged	1	1	1	1													
Wheat flour + yeast	No. of days for emergence	20	21	22	23	24	25	26	27	30				29	23	79.31	23.74	3.3408
	No. of adults emerged	1	2	5	1	7	4	1	1	1								

ed by rubber bands, after the introduction of larvae. The larvae were bred in the laboratory under identical conditions of temperature and humidity. 2 to 4 day old larvae were pre-treated in an incubator at a temperature of 35°C. for 48 hours before introducing them to the food medium. Wheat flour supplemented with yeast proved to be the most ideal medium and was therefore kept as control.

The average minimum and maximum temperature and relative humidity during the tests were 84·1°F., 88·0°F. and 70·25% respectively.

The number of larvae reaching adult stage and the time taken for it, were the criteria for evaluating food preference. Observation on the duration of development periods and survival response were therefore taken with each grade. In all 267 larvae were studied.

RESULTS AND DISCUSSIONS

From the development period and survival response, the growth index for each grade was calculated using the formula of Pant (1956). The results are presented in Table I.

It will be seen from the table that among the grades tested Y_1 gave the best growing index. This indicated that the grade Y_1 offered a good dietary medium for the insect and that the beetle showed a definite preference for that grade. The magnitude of the growth index showed a general tendency to decrease with the quality of the grade from Y_2 to LBY_2. But with LMG and DG the growth index again showed an increase. This meant that they were better food media for the insect than Y_2, LBY_1 and LBY_2. Perished leaf gave the lowest index showing that its nutritive value was the lowest.

Though the high value of growth index obtained with Y_1, and the very low value obtained with PL clearly indicated that the insect had a definite preference for the first grade leaf and that the lowest grade was nutritionally quite unsuitable, too much reliance cannot be placed on the differences in growth indices obtained with successive grades. This is because the grading system in vogue is based solely on the differences in colour of the leaf and it may not be possible to draw a sharp line of demarkation between successive grades. Therefore it was thought safer to combine the seven grades for the purpose of comparison into 3 groups, viz. (1) bright grades consisting of Y_1, Y_2 and LBY_1, (2) medium grades consisting of LBY_2 and LMG, and (3) low grades consisting of DG and PL. The growth indices calculated on this basis are given in Table II.

The results clearly show that the beetle preferred the brighter grades to the medium and lower grades. The lower grades were the least preferred.

In his classical studies on the ecology of the cigarette beetle, Powel (1931) also found that the beetle showed a food preference, as exemplified by the length of life cycle for certain 'qualities of tobacco'. "Excellent, well aged, good smoking tobacco" of better grades were preferred to "leafy and heavy bodied inferior grades".

The basic food requirements of all insects seem to be very much like those of higher animals. Apart from sources of energy like carbohydrates (preferably sugars) they include according to Fraenkel (1959) the essential aminoacids, most of vitamins of B complex, a sterol and the physiologically important minerals. So far as tobacco is concerned nicotine and its degradation products may also influence its dietary efficiency. Pant and Fraenkel (1954) have shown that nicotinic acid is essential for the tobacco beetle. The content of nicotine assumes special significance in the light of the theory put forward by Fraenkel (1959) that the purpose of secondary plant substances like glucosides, tannins, alkaloids and essential oils is to function as a means of attracting or repelling insects.

TABLE II. *Growth of* Lasioderma *in bright, medium and low grades of flue-cured tobacco.*

S. No.	Treatments	Total No. of larvae tested	Total No. becoming adults	Percentage becoming adults	Average No. of days	Growth index
1.	Bright grades (Y_1, Y_2, LBY_1)	102	45	44.12	37.24	1.1847
2.	Medium grades (LBY_2, LMG)	68	23	33.82	37.26	0.9077
3.	Low grades (DG, PL)	68	15	22.06	37.13	0.5941
4.	Control (Wheat flour +Yeast in 4 : 1)	29	23	79.31	23.74	3.3408

The differences in the feeding responses, shown by the beetle with different grades of tobacco indicated that they may be differing in their content of one or more of these factors. That the different grades show some differences of chemical composition has been observed by Sastry (1959). He found that the bright grades were characterised by high ash (minerals), low total nitrogen and high total sugars. The content of these constituents in the lower grades were lower for ash and total sugars and higher for total nitrogen. The present study being preliminary in nature no attempt was made at a chemical examination of the grades. However, the above trends indicated that it would be interesting to study in detail the chemical constituents of the leaf that are responsible for its dietary qualities and their correlation with the growth index.

In such a study apart from the nutritional factors and alkaloidal concentration, attention has to be bestowed on the aromatic constituents of the leaf also. Powel (1931) has shown that the beetle shows preferences to tobacco odours. The aroma of the better grades of tobacco was more acceptable to the beetle than that from poorer grades. In the aromatic Turkish types of tobacco he observed highest percentages of positive reactions. These observations indicated that the number of beetles attracted would be influenced by the aroma of the leaf and that the brighter grades would attract more.

Preliminary tests have shown that the number of eggs laid also might differ with the quality of the leaf. The results obtained on the oviposition of 5 pairs are summarised below :

Grade	Average No. of eggs laid by a pair
Bright grades	24.17
Medium grades	10.00
Low grades	12.88
Wheat flour+yeast	20.33

These data indicate that the tendency of the beetle was to lay more eggs on the bright

grades than on the medium and lower grades.

The results of the present study thus indicate that the brighter and costlier grades are more in danger of being attacked by the tobacco beetle than the medium and lower grades. The brighter grades might attract more beetles. The beetles lay more eggs on them and the emerging larvae also destroy the brighter grades more than the medium and lower ones.

These results should not be taken as conclusive evidence for the above observations. But they indicate clearly that the characteristics that control the quality of the leaf probably are responsible for the pest infestation and consequent destruction also. Further work in the direction indicated above would not only be of theoretic interest in so far as it would throw light on the inter-relationship between nutritional physiology of the pest and the chemical constituents of the leaf, but also tremendous practical importance to the trade. If the selective susceptibility of the brighter grades to this pest is established they could be isolated and taken better care of.

SUMMARY

A preliminary study was conducted at the Central Tobacco Research Institute, Rajahmundry on the feeding response of the tobacco beetle (*Lasioderma serricorne* F.) to seven grades of flue-cured tobacco. From observations on the development period and survival response of 267 larvae, the growth index for each grade was calculated. The best grade (Y_1) gave the highest growth index and the poorest grade (PL) gave the lowest. The results of the study seemed to indicate that the beetle preferred the higher grades to the medium and lower grades. The lower grades were the least preferred. This seems to show that the costlier grades are more in danger of infestation. The importance of continuing the work on more detailed lines is discussed.

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Suppression of Suckers in Hookah and Chewing Tobacco (N. tabacum) by Common Vegetable Oils

SAJNANI B. T. [1], **DHYANI K. C.** [2]
&
SINGH A. N. [3]

Some work has been done in recent years both in India and abroad on the suppression of suckers in different types of tobacco by various growth regulators e.g. mineral and vegetable oils, fats, emulsions, hormones etc. with a view to find simple and inexpensive method of controlling suckers which otherwise is a costly, tedious and time consuming process. In India, works of Pal and Kadam (1949, 51, 54) on flue-cured tobacco at Rajahmundry, A. S. Sastry *et al* (1957) on cigar and cheroot tobacco at Vedasandur and Ramakrishna Kurup *et al* (1957) on cigar and cheroot tobacco at Vedasandur have shown that the suckers could be controlled by various growth inhibitors. Abroad, Calvert (1948, 53) in Australia, Patterson (1952) in U.S.A. on Havana seed tobacco have also reported suppression of suckers by various chemical substances.

In north Bihar since the tobacco crop is heavily manured and topped at 8-14 leaves, large number of side shoots begin to grow vigorously after topping necessitating removal of these 7-8 times at the interval of 8-10 days. The operation, apart from being expensive and laborious in process, sometimes causes damage to luxuriously growing leaves unless the cultivator is extremely careful in going round the field for the removal of suckers at frequent intervals. It is therefore obvious that any cheap device which would eliminate the necessity of such frequent suckering would be welcome to the farmer.

Pal *et al* (1954) found some of the common vegetable oils e.g. coconut, groundnut and sesamum oils quite effective in influencing sucker growth of flue-cured cigarette tobacco and of these coconut oil was found to be most effective. Ramakrishna Kurup *et al* (1957) while working on cigar tobacco found these oils effective in controlling suckers from the treated leaf bases but they were not found effective when all the leaf bases were taken into consideration. In order, therefore, to try

[1, 2 & 3] Agronomist, Agronomical Assistant and Farm Manager respectively, Hookah and Chewing Tobacco Research Station, Pusa (Bihar).

some of the oils on hookah and chewing tobacco on field scale under Bihar conditions, three common vegetable oils namely mustard oil, coconut oil and groundnut oil were selected for the trial. Mustard oil was selected because it is the most commonly used vegetable oil in these parts.

MATERIAL AND METHODS

Variety used was Bori Bharao-10 of hookah and chewing tobacco (*N. tabacum*). Usual field operations of green manuring with sann-hemp and application of 50 lbs. N per acre in the form of ammonium sulphate and mustard cake in equal doses was done. Mustard cake was applied as basal dressing about a week before planting and ammonium sulphate as top dressing a month after transplanting. The seedlings were planted at a distance of 2′ × 3′. The crop was irrigated 2-3 times and weeding, interculturing and other operations were done at felt needs.

Topping was done about 6 weeks after planting tobacco retaining 14 leaves per plant excluding 2 to 3 sand leaves which were removed at the time of topping. As usual plants were pierced with a needle 9-10″ long immediately after topping. The oils were applied to young buds in the axils of the leaves with a brush soon after the topping operation.

The experiment was laid out in a split plot design with three kinds of oils relegated to main plots and the different number of buds treated with oil relegated to sub-plots. Following were the treatments :—

Main treatments :

1. Mustard oil.
2. Groundnut oil.
3. Coconut oil.

Sub-treatments :

1. No application (control).
2. Application of oil to 4 top buds.
3. Application of oil to 6 top buds.
4. Application of oil to 8 top buds.

There were six replications with a net plot size of 1·3 cents during the first year of the trial and 0·537 cents during the last two years of the trial. Suckering was done at the interval of 8-10 days in all the treatments including the no application of oil treatment and from all the leaf axils both treated and untreated and total green weight of suckers recorded. The suckers from the various treatments were also dried in the open in the sun due to the absence of any oven available at the research station and their dry weight recorded. Since the drying of suckers was done in the open which was subjected to various atmospheric factors beyond control, green weight of suckers should be considered as more accurate. The harvesting was done as usual and the cured weight of leaves and the weight of first grade leaves were noted with a view to see the effect of oils on the yield and quality of tobacco.

The yield of cured leaves, green weight of suckers and dry weight of suckers obtained from the net plots were subjected to statistical analysis in the individual years while the combined analysis of the data was done for green weight of suckers and dry weight of suckers only. Since the size of the plot was different during the first year of the trial from that of subsequent years, the green weight of suckers and dry weight of suckers obtained in the first year of the trial were first adjusted according to equal plot size for combined analysis. The combined analysis of the cured leaf data was not done as the yield and quality of tobacco produced were not affected by the different types of oils and their application in any year.

RESULTS

The experiment was started in 1955-56 and concluded in 1958-59 out of which the results during 1956-57 were vitiated due to severe hail storm which badly damaged the crop hence the data for 1956-57 have been excluded from the results presented in Table I.

TABLE I. *Green and dry weight of suckers and cured leaf and first grade leaf in kg. per acre.*

Treatments	1955–56				1956–57				1957–58				Average			
	Green wt.	Dry wt.	Cured leaf	First grade	Green wt.	Dry wt.	Cured leaf	First grade	Green wt.	Dry wt.	Cured leaf	First grade	Green wt.	Dry wt.	Cured leaf	First grade
Main plots :—																
Mustard oil ..	573	56	806	260	740	101	930	128	1.297	107	1.020	287	870	88	919	225
Groundnut oil ..	623	61	821	249	867	112	914	142	1.328	109	1.005	263	939	94	913	218
Coconut oil ..	617	59	837	221	880	117	865	129	1.305	110	1.035	306	934	95	912	219
Sub-plots :—																
No application (control) ..	764	71	826	233	965	129	919	135	1.478	118	1.017	291	1.069	106	921	220
Application to 4 top buds ..	587	59	875	260	829	112	936	125	1.321	110	1.011	258	912	94	941	214
Application to 6 top buds ..	573	56	845	243	790	104	916	150	1.279	106	1.109	283	880	88	923	225
Application to 8 top buds ..	494	49	821	238	731	94	841	122	1.161	100	1.042	308	795	81	901	223
Mean ..	604	59	833	243	829	110	903	133	1.307	109	1.034	281	914	92	918	220
S.E. % for Main plots ..	36.26	26.03	14.33		13.51	16.34	15.41		17.42	14.67	11.28		24.93	23.85	N.D.	N.D.
Sub-plots ..	20.19	18.81	9.22		11.38	14.64	16.07		17.00	14.07	7.46		23.08	20.18	N.D.	N.D.
C.D. at 5% for Main plots ..	N.S.	N.S.	N.S.		72	12	N.S.		N.S.	N.S.	N.S.		66(yr)	6(yr)	N.D.	N.D.
Sub-plots ..	81.8	7.4	N.S.		64	11	N.S.		198	N.S.	N.S.		58(app)	5(app)	N.D.	N.D.

It would be seen from the results that the effect due to the application of oil on green weight of suckers is significant in all the years and the application of oil to 8 buds is the most effective giving the least weight of suckers. The effect of oil on cured weight of suckers was also more or less similar to that of green weight except that the results were not significant in the final year. There appears to be no effect of oil on the yield and quality of tobacco.

Amongst the different types of oils, mustard oil was more effective in the suppression of suckers than the coconut and groundnut oil in all the years although the results were significant only during 1957-58. The yield and quality is however not affected by different types of oil.

The combined analysis of the three years data for green and dry weight of the suckers revealed that the differences due to years and applications were highly significant. Maximum suppression of the suckers was obtained in the first year of the trial followed by second and third year. Application of oil to 8 top buds was most effective in producing the least amount of suckers followed by the application to 6 and 4 top buds. None of the interactions showed any significant effect.

DISCUSSION

Although the application of oil to various number of buds has substantially reduced the weight of suckers as compared to no application (control) and hand suckered as is usually practised, it has not completely suppressed the growth of suckers. This is because the lower untreated buds start growing when the buds in the upper axils are treated and suppressed. The suppression is maximum when 8 buds are treated followed by 6 and 4 buds. Taking green weight of suckers from all the leaf bases into consideration, suppression of suckers to the extent of 34%, 21% and 17% has been achieved on average by the application of oil to 8, 6 and 4 buds respectively as compared to untreated and hand suckered control. Pal and Kadam (1954) while working with coconut oil on flue-cured tobacco found that the least amount of suckers was produced when 12 leaf bases were treated and the largest when 3 bases were treated.

From the combined analysis of the data of the experiment conducted at this research station, it was found that the effect due to seasons was highly significant indicating that the amount of suppression of suckers varied during different years due to seasonal factors. During the last year of the trial when the growth of the crop was comparatively more vigorous than during the 1st and 2nd years, the suppression of suckers was only 27% with the application of oil to 8 buds as compared to 32% and 55% suppression during 2nd and 1st years of the trial. It will be noted that during the 3rd year, the suppression was less than 2nd year and during the 2nd year it was less than that of the 1st year, as the growth of the crop was better during the 3rd year than the 2nd year which in turn was better than the first year, as seen from the cured leaf yield obtained during these years. The results are therefore in conformity with that of Pal and Kadam (1954) who did not find coconut oil effective in abnormal season when the growth of the crop was more vigorous than usual while working on flue-cured tobacco at Rajahmundry. The effect of oils on suppression of suckers varies inversely with the vigour of the crop as seen from the results obtained at this research station (vide Table I).

Ramakrishna Kurup *et al* (1957) working on cigar and cheroot tobacco found that coconut oil, groundnut oil, coconut oil emulsion and sesamum oil emulsion were effective in controlling suckers from the treated leaf bases only but they were not found superior to control suckered when all the bases were

taken into consideration. The results obtained with mustard, groundnut and coconut oils on hookah and chewing tobacco at this research station however indicate that the oils do suppress the suckers to a certain extent when compared to untreated and hand suckered control taking all the leaf bases into consideration. As already discussed 34% suppression was obtained with the application to 8 top buds and 17% with application to 4 buds taking all the leaf bases into consideration. But since complete suppression is not achieved even by application to 8 buds it is not of much practical value to the ordinary cultivator. It may not be economical for the cultivator to apply oil to all the buds in the leaf axils.

It may be noted that mustard oil is the most commonly used oil in these parts and it has been found to be most effective among the three oils in the suppression of suckers.

The application of oils has no effect on the yield and quality of tobacco as would be seen from the results given in Table I.

SUMMARY

An experiment on suppression of suckers with common vegetable oils conducted at the Hookah & Chewing Tobacco Research Station, Pusa, from 1955-56 to 1958-59 showed that on an average the application of oil to 8, 6 and 4 buds suppressed the sucker growth to the extent of 34%, 21% and 17% respectively taking all the leaf bases into consideration and among the oils mustard oil which is the most commonly used in Bihar appeared to be more effective than coconut and groundnut oils. It was also found that the amount of suppression of suckers varied inversely with the vigour of the crop. Since the application of oil to even 8 buds suppressed the suckers only to the extent of 34%, it will not be of much practical importance to the cultivators.

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APPENDIX I

Combined analysis of data for Green weight of suckers.
Analysis of variance.

Due to	d. f.	T. ss.	N. ss	Ratio	Theo	'F'
Blocks	15	198.8791	..	..	..	..
Year	2	2626.2560	1313.1280	249.45 *	3.32	5.39
Oil	2	30.2812	15.1406	2.88 N.S.	3.32	5.39
Oil × Year	4	7.5923	1.8981	< 1. N.S.	2.69	4.02
Error (a)	30	157.9207	5.2640	..	..	..
Application	3	296.5862	98.8621	28.83 *	2.67	8.93
Oil × application	6	15.4621	2.5771	< 1. N.S.	2.17	2.95
Year × application	6	6.1243	1.0207	< 1. N.S.	2.17	2.95
Oil × year × application	12	49.7422	4.1452	1.21 N.S.	1.83	2.33
Error (b)	135	462.9143	3.4290	..	..	..
Total	215	3851.7584	..	..	..	..

S.E. Oil (Mean)	0.27	S.E.%	24.93%
S.E. Year (Mean)	0.27		
C.D. at 5% year (Mean)	65.9 kg. per acre.		
1% ,,	88.7 kg. per acre.		
S.E. application (Mean)	0.25	S.E.%	23.08%
C.D. at 5% application (Mean)	58.26 kg. per acre.		
1% ,,	76.8 kg. per acre.		

Year × application, Green weight of sucker in kg. per acre.

Year / Application	Y1	Y2	Y3	Mean
1 ..	763	965	1478	1069
2 ..	587	829	1321	913
3 ..	663	790	1280	881
4 ..	494	731	1499	796
Mean ..	605	829	1310	914

APPENDIX II

Combined analysis of data for Dry weight of suckers.

Analysis of variance.

Due to	d. f	T. ss	m. ss	Ratio	Theo	'F'
					5%	1%
Block	15	1.5891	..	..		
Year	2	16.9564	8.4792	177.37 *	3.32	5.39
Oil	2	0.2794	0.1397	2.92 N.S.	3.32	5.39
Year × oil	4	0.2038	0.5010	1.07 N.S.	2.69	4.02
Error (a)	30	1.4338	0.0478	..	..	..
Application	3	2.4672	0.8224	30.69 *	2.67	3.93
Year × application	6	0.2376	0.0396	1.48 N.S.	2.17	2.95
Oil × application	6	0.758	0.0126	*L* 1. N.S.	2.17	2.95
Year × application × oil	12	0.4509	0.0376	1.40 N.S.	1.83	2.33
Error (b)	135	3.6175	0.0268	..	..	..
Total	215	27.3115	..	..	..	..

S.E. Oil (Mean	0.026		S.E. %	23.85
S.E. Year (Mean	0.026			
C.D. at 5% Year (Mean)		6.33 kg. per acre.		
1% ,,		8.44 kg. per acre.		
S.E. application (Mean)		0.022	S.E.%	20.18
C.D. at 5% application		5.15 kg. per acre.		
1% ,,		6.75 kg. per acre.		

Year × Application : Dry wt. of suckers in kg. per acre

Year / Application		Y1	Y2	Y3	Mean
1	..	72	129	117	106
2	..	58	112	109	93
3	..	56	106	107	88
4	..	49	94	101	81
Mean	..	59	110	108	92

Control of Suckers in Cigar Tobacco by the use of Chemicals

A. S. SASTRY [1]
&
C. K. RAMAKRISHNA KURUP [2]

It is the common practice to top the cigar tobacco plant at 8 to 14 leaves and to remove the suckers, that are formed, twice. This is believed to improve the yield and quality of the leaf. At present suckering is done by hand. This is expensive and tedious, as the fields have to be visited a number of times. Also, frequent visits to the field may cause physical damage to the leaf. A simple, inexpensive and effective method of control of suckers is much in demand by the farmers.

With this object in view, Kurup, *et al.* (1957) tried the use of vegetable oils and emulsions in the top four leaf axils. However, their studies did not offer any practical method of control as, though some of the oils and emulsions suppressed the growth of suckers in the treated axils, they activated the dormant buds in the lower leaf axils. In other studies, Sastry, *et al* (1957) showed that suckers in chewing tobacco could be largely controlled by the use of 20% naphthalene acetic acid (NAA) and indole butyric acid (IBA) in triethanol amine (TEA). However, this level of concentration of the chemicals is not economical under Indian conditions, where labour is cheap. Hence the present studies were undertaken at the Cigar and Cheroot Tobacco Research Station, Vedasandur, to see if sucker growth in cigar tobacco could be controlled by lower and more economic concentrations of the chemicals.

EXPERIMENTAL

The cigar tobacco variety used was *Vellai Vazhai* (*N. tabacum* L.). The experiments were conducted for three seasons, 1956-57, 1957-58 and 1958-59. In 1956-57 the crop was fertilised with 20 cart-loads of farmyard manure applied one month before transplanting and 100 lbs. of nitrogen, half as ammonium sulphate and half as groundnut cake at the time of transplanting. In the other two years,

[1 & 2] Biochemist and Chemist, respectively, at the Central Tobacco Research Institute, Rajahmundry, India.

the fields were penned with 1,500 sheep per acre for one night one month before transplanting. Eight-week old seedlings were planted on ridges 2½′ apart and at a spacing of 2′ between plants. The plants were always topped leaving 14 leaves on the plant.

During the first year, viz. 1956-57, the experiment was laid out in a simple randomised block design with the object of finding the most economic concentration of the chemicals. The treatments are indicated in column 2 of Table 1. Twelve plants were used for each treatment and replicated four times. The two chemicals, Naphthalene acetic acid (NAA) and Indole butyric acid (IBA) were dissolved in either triethanol amine (TEA) or neutralised with potassium hydroxide solution and made up to the required strength with water. Potassium salt solutions which were also used as preliminary observations, showed that epinasty of the leaves was much less with this treatment. The plants were transplanted on 6-11-56, and topped on 24-1-57 i.e. after 79 days. One drop of the solution was applied on the cut wound of each plant and spread uniformly. Soon after application the plants to which triethanol amine solutions of NAA and IBA were applied showed a characteristic backward curvature of the upper leaves. The intensity of the curvature as well as the number of plants affected increased with the concentration of the solution. Potassium salt solutions did not affect the plants much. The plants recovered completely in the course of about a week. Maleic hydrazide solution was sprayed on the cut portion of the stem and top five leaf axils.

Excepting control suckered, which was suckered twice at approximately 10 day intervals all other treatments were suckered only at the time of harvest. The weight of all the suckers and total number of suckers above 2″ in length were determined.

The plants were harvested 106 days after transplanting on 20-2-57 and sun-cured and fermented in bulks with leaves attached for about 25 days. The leaves were then stripped from the stalks and divided into wholesome (good grade) and damaged (*kruz* grade) leaves and their weights recorded. This gave the yield figures.

In the second year, i.e. 1957-58, the experiment was conducted with the object of studying the effect of repeated applications of 2% NAA in TEA (which on the basis of results of the first year was found to be the most economic concentration), on the control of suckers and yield of leaf. Two topping treatments, early and late, and combination of application of the chemical and suckering were also included. The experiment was laid out in a split plot design with applications of the chemical as the main treatments and the methods of topping as the sub-treatments. Transplanting was done on 21-10-57 and toppings on 2-1-58 and on 10-1-58 (i.e. 73 and 81 days respectively after transplanting) for early and late topping treatments. The plants were harvested on 22-1-58 for early and 31-1-58 for late toppings, i.e. 93 and 102 days respectively after transplanting. Other experimental details were the same as in the first year. There were 25 plants in each treatment which was replicated 4 times. The details of the treatments are given in column 2 of Table II. The solution of the chemical was applied at the rate of one drop per plant. Second and third applications were made after removing the dried portion of the stalk. From all treatments except 2, 7 and 8 the suckers were collected only at the time of harvest. From treatment 2, control suckered, the suckers were removed twice, about 10 days after topping and at the time of harvest. From treatments 7 and 8 the suckers were removed at the end of 15 and 20 days respectively.

Just before topping time, the crop was rather

severely infested with aphids and leaf eating caterpillars which could not be effectively controlled.

In the third year, 1958-59, the experiment was conducted to get further confirmation of the results of the second year. Some minor variations like not removing the dried portion of the stalk before the second application and using glycerine as a diluent were also included. The topping treatments were slightly different from the second year. Instead of early and late as in the second year, the plants were topped on the same day but the length of the topmost leaf was kept at 9″ in one method and at 18″ in the other method. The experiment was laid out in a split plot design with applications of the chemicals as the main treatments and methods of topping as the sub-treatments. The plants were transplanted on 27-10-58. Topping was done on 9-1-59 (i.e. 74 days after transplanting) and harvesting on 1-2-59 (i.e. 97 days after transplanting). Other experimental details were the same as in the first year. There were 20 plants in each treatment which was replicated 4 times. The treatment details are given in column 2 of Table III. In treatments 4, 5 and 8 the second application was made after cutting and removing the dried portion of the stalk. In treatment 6 the second application was made on the dried portion of the stalk. Except in the case of treatment 2 (control suckered) which was suckered after about 10 days and at the time of harvest, all the other treatments were suckered at the time of harvest only.

RESULTS

In all these experiments two controls have been used, the unsuckered control to measure what would have been the sucker growth if no chemicals had been used, and the control-suckered as a measure of yield and quality characteristics under normal farmers' practice. A treatment becomes desirable only if sufficient control of the suckers over the unsuckered control is achieved without detriment to the yield of cured and good grade leaf as compared with the control-suckered.

The data on the number and green weight of suckers and the yield of cured and good grade leaf in the first year, 1956-57 are presented in Table I. In this and the subsequent tables, percent suppression over control is obtained by deducting the weight of suckers in a treatment from the weight of suckers in the unsuckered control and expressing this as a percentage of the weight of suckers in the unsuckered control.

The number of suckers is a measure of the labour required to remove them. Viewed from this point, control suckered produced twice the number of suckers produced in the unsuckered control and thrice the number produced in some other treatments. There was a progressive decrease in the number of suckers with an increase in the concentration of the chemicals in the triethanol amine solutions. In the potassium salt solutions the trend was not so definite. 10% and 20% solutions of both NAA and IBA produced significantly less number of suckers than control unsuckered.

As regards the weight of suckers TEA solutions always produced less suckers than KOH solutions. There was not much difference between 2% and 20% levels when the chemicals were used as TEA solutions.

The yield differences were not significant. Except in the case of a few treatments (Treatments 4, 9 and 19) the yield of good grade leaf also was not significantly different from control suckered.

Maleic hydrazide was not effective in controlling the suckers. However, a little stimulation in yield over control-suckered was noticeable. A similar stimulation in yield due to application of maleic hydrazide has been reported by Rogers also (1957).

TABLE I. *Yield of cured and good grade leaves and number and weight of suckers* (1956-57).

Treatments	Suckers per plant			Yield of leaf kg. per acre	
	Number	Green wt. in grams.	% suppression over control	Cured leaf	Good grade leaf
1. Control—Unsuckered	3.94	340.40	..	899.04	590.13
2. Control—Suckered	8.85	156.85	53.92	1116.31	782.91
3. 1% NAA in triethanol amine	4.21	242.25	28.34	958.46	633.23
4. 2% -do-	2.98	113.15	66.76	954.83	545.68
5. 5% -do-	2.71	91.23	73.11	1045.55	769.76
6. 10% -do-	2.35	96.31	71.71	1024.23	747.53
7. 20% -do-	1.88	74.17	78.21	1089.09	643.66
8. 1% NAA in KOH	3.85	269.90	20.71	960.72	656.36
9. 2% -do-	3.15	203.77	40.14	972.97	600.11
10. 5% -do-	4.50	269.75	20.76	1149.42	788.81
11. 10% -do-	3.58	152.06	55.33	1024.23	728.48
12. 20% -do-	3.02	91.73	73.04	996.11	695.82
13. 5% IBA in triethanol amine	2.75	62.79	81.55	1011.07	653.64
14. 10% -do-	2.00	37.48	88.99	1045.55	696.28
15. 20% -do	1.23	25.73	92.44	1031.49	724.40
16. 2% IBA in KOH	4.13	227.90	33.05	1031.49	678.59
17. 5% -do-	3.38	153.17	55.03	1022.41	673.60
18. 10% -do-	4.23	204.50	39.94	1011.98	658.63
19. 20% -do-	2.40	61.23	82.01	962.54	618.26
20. 1% Maleic hydrazide	6.50	232.00	31.84	1192.97	839.61
S.E.%	25.68	49.55		10.68	16.03
C.D. at 5%	1.30	108.81		N.S.	155.53

From these results it is obvious that 67% of the suckers could be controlled by the application of 2% NAA in TEA (which was the cheaper of the two chemicals). Hence repeated application of this chemical has been tried in the second year, 1957-58 and the results are presented in Table II.

It should be pointed out, at the outset, that the crop of this year was severely infested with aphids and leaf-eating caterpillars and so too much reliance cannot be placed on the results of this experiment. They are however presented since they have clearly brought out the efficacy of the chemicals in the control of suckers.

Application of the chemical reduced the number of suckers significantly.

As regards green weight of suckers, two applications, one at topping and a second after 7 days (Treatment 4) produced the least

TABLE II. *Yield of cured and good grade leaves and number and weight of suckers* (1957-58).

Treatments	Suckers per plant			Yield of leaf in kg./acre	
	Number	Green wt. in gms.	% suppression over control	Cured leaf	Good grade leaf
1. Control—Unsuckered	3.45	126.71	..	717.91	573.12
2. Control—Suckered	4.13	31.54	75.11	776.59	657.41
3. 2% NAA in TEA at topping only	2.62	46.57	63.25	779.20	588.71
4. 2% NAA in TEA at topping and repeated after 7 days	1.04	9.37	92.61	770.84	557.26
5. 2% NAA in TEA at topping and repeated after 14 days	2.16	22.81	81.91	800.28	650.05
6. 2% NAA in TEA at topping and repeated after 7 and 14 days	0.71	10.37	91.82	762.82	621.78
7. 2% NAA in TEA at topping and suckering after 15 days	3.02	20.13	84.11	804.03	647.08
8. 2% NAA in TEA at topping and suckering after 20 days	2.63	45.40	64.17	760.95	556.22
C.D. at 5%	0.62	24.24		N.S.	N.S.
A. Early topping	2.43	46.11		727.17	596.28
B. Late topping	2.50	32.10		770.99	616.62
S.E.%	18.65	36.25		7.64	10.06
C.D. at 5%	N.S.	7.32		N.S.	N.S.

weight of suckers and achieved a control of 92.6% over control unsuckered. A third application after 14 days did not possess any additional advantage (Treatment 4 *vs.* Treatment 6). The second application after 7 days was slightly better than after 14 days.

The yield differences due to the treatments were not significant. In the chewing tobacco, on the other hand, Sastry, *et al.* (1960) found that late topping was significantly better than early topping.

Early topping produced significantly more weight of suckers compared with late topping. This is in contrast to what has been found in chewing tobacco (Sastry, *et al.* 1960).

In the third year the experiment was repeated introducing slight modifications. The results are presented in Table 3.

The number of suckers was doubled in control—suckered as compared with other treatments. This is due to two suckerings in this treatment.

TABLE III. *Yield of cured and good grade leaves and number and weight of suckers* (1958-59).

Treatments	Suckers per plant			Yield of leaf in kgs./acre	
	Number	Green wt. in grms.	% Suppression over control	Cured leaf	Good grade leaf
1. Control-Unsuckered	3.83	292.50	..	875.56	690.43
2. Control-Suckered	8.00	80.00	72.65	953.97	790.61
3. 2% NAA (in TEA) at topping only	3.39	98.50	66.32	858.13	657.76
4. 2% NAA at topping and after 7 days also	3.14	83.00	71.62	906.05	723.10
5. 2% NAA at topping and after 14 days also	2.99	71.50	75.56	823.29	668.64
6. 2% NAA at topping and after 7 days without removing the dried portion of the stalk	3.61	83.50	71.45	879.92	664.78
7. 2% NAA in triethanol amine and glycerine at topping only	3.43	125.50	57.09	873.38	675.18
8. 2% NAA in triethanol amine and glycerine at topping and after 7 days also	2.71	84.50	71.11	895.16	707.85
C.D. at 5%	0.80	40.5		65.34	74.05
A. Length of topmost leaf at topping—9″	3.62	102.5		875.56	692.60
B. Length of topmost leaf at topping—18″	4.16	127.0		888.62	705.67
S.E.%	15.77	18.55		7.41	7.30
C.D. at 5%	0.32	15.00		N.S.	N.S.

As regards the weight of suckers two applications of the chemical was as good as control suckered and achieved about 75% suppression of the suckers. Removing the dried portion of the stalk before the second application was not advantageous to not removing it (Treatment 4 *vs.* 6). Using glycerine as a diluent offered no additional advantage (Treatments 7 and 8 *vs.* 3 and 4).

The yields of cured and good grade leaf were significantly increased by manual suckering (Treatment 2 *vs.* 1). Also the manual suckering was superior in respect of total yield as well as good grade leaf to all treatments except Treatment 4, where the chemical was applied once at the time of topping and again after 7 days.

As between the two topping methods, topping when the topmost leaf was less developed produced less number and weight of suckers. This observation is in conformity with that made in chewing tobacco (Sastry, *et al.* 1960) The yield differences, however, were not significant.

The foregoing results show that in some of the treatments (Treatment 4) it is quite possible to control the suckers without detriment to yield. It is necessary to see whether the quality of the leaf is affected in these treatments or not. For this purpose the leaf burn and cigar burn in the promising treatments and controls in the 1958-59 season were determined as per the procedures suggested by Sastry, *et al.* (1958) and the results are presented in Table 4.

TABLE IV. *Burning quality of the leaf from promising treatments* (1958-59).

Treatments	Leaf burn	Cigar burn score
MAIN		
1. Control-Unsuckered ..	2.67	20.03
2. Control-Suckered ..	2.70	21.08
3. 2% NAA in TEA at the time of topping ..	2.99	22.08
4. 2% NAA in TEA at the time of topping and repeated after 7 days after removing the dried portion of the stalk ..	2.82	22.65
C.D. at 5% ..	N.S.	N.S.
A. Length of topmost leaf at topping—9″ ..	2.77	21.31
B. Length of topmost leaf at topping—18″ ..	2.82	21.60
S.E.% ..	14.92	10.33
C.D. at 5% ..	N.S.	N.S.

From the data in Table 4, it can be concluded that the quality of the leaf is not adversely affected by treating the plants with 2% NAA in TEA.

DISCUSSION

These experiments appear to suggest that minor variations in the time or method of topping do not cause material differences in the yield of cured or good grade leaf. However, the number of weight of suckers appears to be significantly influenced by these. This may probably be due to the differences in the positions of the leaves left on the plants in the various topping treatments. Thus in the 1957-58 season later topping produced less weight of suckers though the number of suckers or yield differences were not significant. As is the common practice, the dried and over ripe leaves at the bottom of the plants were removed at the time of topping and the plants topped leaving 14 leaves on the plant both in the early and late topping treatments. Though transplanting was done at the same time in all the treatments, there was a time lag of 8 days between early and late toppings. During this period about two of the lowermost leaves would have dried up and would have been removed at the time of topping. Hence the leaves that remained on the plants in the late topping would have come from higher morphological positions than in the early topping.

Though this did not cause any significant yield differences, the weight of suckers in the late topping was less than in the early toppings. This is in contrast with the findings in the chewing tobacco, where later topping produced more weight of suckers and greater yield of cured and good grade leaf (Sastry, *et al.* 1960). The explanation for this appears to lie in the differences in the number of leaves that were left on the plants at the time of topping in the two types of tobacco. In the cigar tobacco 14 leaves were left on the plants while in the chewing tobacco only 10 leaves were left on the plants. It is well known that young developing apical leaves produce auxin which inhibits the growth of the lateral buds (Avery, 1935 ; Avery, *et al.* 1937 ; Snow, 1929 ; and Thimann, *et al.* 1934). In the chewing tobacco where topping was done quite low, the leaves left on the plants are not likely to be apical leaves and later topping, where leaves from higher morphological positions are likely to be left on the plant has not depressed the sucker growth (it has actually increased it). In the cigar tobacco where higher topping was practised, on the other hand, later topping is likely to leave more of the apical leaves on the plant than the early topping and these could have reduced the suckers. This was actually the case.

Again in the 1958-59 season, topping was done at the same time in both the topping treatments, only the length or development of the topmost leaf was varied. Where the topmost leaf was better developed, the leaves remaining on the plants after topping probably included some of the over ripe leaves in the lowermost positions as contrasted with those in the topping treatment where the topmost leaf was less developed. In the latter treatment leaves from higher morphological positions would have been left on the plants than in the former treatment. This produced less number and weight of suckers, again an influence of the apical leaves.

Whatever be the method of topping, the data have clearly demonstrated the undoubted efficacy of the chemicals in the control of sucker growth. The extent of control, however, appears to depend on the seasonal variations. The complex nature of seasonal conditions like temperature, light and relative humidity in modifying the absorption, translocation and action at cellular level of the chemicals has been dealt with in great detail by Leopold (1955). Using the weight of suckers in the "unsuckered control" as a measure of the vigour of sucker growth, in certain seasons (1956-57 and 1958-59) the growth of suckers was quite vigorous while in others (1957-58) it was poor. Thimann (1957) attributed this as due to the necessity of some kind of balance between auxin and other factors necessary for the growth of buds. When either of them is in excess, the sucker growth is inhibited. Miller and Skoog (1953) demonstrated that the formation of buds in tobacco stem segments was augmented by the addition of adenine to the culture medium —the so-called "adenine effect"—while low concentrations of indole-3-acetic acid (IAA) inhibited the bud growth. They postulated the hypothesis that IAA and adenine acted through their influences on the nucleic acid metabolism. From these, it is conceivable that in those seasons where the sucker growth was vigorous more of adenine and similar substances were probably produced in the plant. In such seasons the control achieved by the chemicals was much less than in the others. The data of 1957-58 and 1958-59 illustrate this point. Taking treatment 4 which was about the best, the amount of suppression achieved was 92.60 per cent in 1957-58 as compared with 71.62 per cent in 1958-59.

As compared with the chewing type of tobacco (Sastry, *et al.*, 1960) sucker growth

in this type is much less vigorous. In the three years of study, 340.4, 126.7 and 292.5 grams of suckers per plant were respectively produced in the unsuckered control in 1956-57, 1957-58 and 1958-59 in this type as contrasted with 712.9, 251.63 and 837.0 grams in the chewing type for the same years. The higher level of topping adopted in this type (14 leaves as against 10 leaves in chewing tobacco) and the shorter duration for which the plants remained in the field after topping (the cigar tobacco crop takes about 20 days for ripening, while the chewing type takes about 30 days) are probably the factors responsible for this. The varietal variations also may have played a part. Due to these reasons the chemicals were more effective in this type than in the chewing type. Application of 2% NAA in TEA at the time of topping and again after one week (treatment 4) achieved 92.61 percent and 71.62 per cent control in 1957-58 and 1958-59 in this type as against 79.23 per cent and 67.68 per cent for the same years. Also, due to the poorer sucker growth in this type, the control of suckers could be achieved without depression of yield over manual suckering as in chewing tobacco. The quality also is not affected as may be seen from the results in Table 4.

From these results it can be concluded that in the cigar type of tobacco the suckers can be effectively controlled by the application of 2% NAA in TEA at the rate of one drop per plant at the time of topping and again after one week without detriment to yield or quality. At the present market price of the chemical this treatment will cost only about Rs. 8 per acre while manual suckering is estimated to cost Rs. 12 to Rs. 15 per acre.

SUMMARY

Experiments in the control of suckers in the cigar tobacco (variety : *Vellai Vazhai*) by the use of chemicals were conducted for three years from 1956-57 to 1958-59.

The results of the first year showed that the two chemicals, naphthalene acetic acid (NAA) and indole butyric acid (IBA) were more effective when applied as triethanol amine (TEA) solutions, than as potassium salt solutions.

Among the triethanol amine solutions the sucker control achieved by the chemicals at 2% and 20% levels was not much different.

In the second and third seasons, therefore, repeated applications of 2% NAA in TEA were tried as NAA was far cheaper than IBA.

It was found, that irrespective of the topping treatments, the best control of suckers, without detriment to yield or quality of the leaf, was obtained by applying one drop of the chemical at the time of topping and repeating it after one week after slicing off the dried portion of the stalk.

The control achieved by this treatment ranged from 72 to 93 per cent depending on the vigour of the growth of suckers.

This treatment is more economical than manual suckering and is estimated to cost Rs. 8 per acre, as compared with Rs. 12 to Rs. 15 for manual suckering.

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Manurial Trials on Tobacco Nurseries at Dinhata *

G. C. PATEL [1], M. SINGH [2]
&
R. DASS [3]

INTRODUCTION

Availability of good seedlings in sufficient numbers at the right time and place is an important requirement for successful raising of tobacco crops. In North Bengal tobacco growers raise their own nurseries and apply large quantities of farmyard manure to the nursery lands. Investigations were, therefore, initiated at the Wrapper and Hookah Tobacco Research Station, Dinhata (Dist. Cooch-Behar) to compare a few sources of organic manures for the tobacco nurseries. Identical trials were conducted on each of the three types of tobaccos, viz. *Jati* (*N. tabacum*), cigar wrapper (*N. tabacum*) and *Motihari* (*N. rustica*), on which research work is being carried on at the Station.

METHODS AND MATERIAL

(1) *Season and Soil* :—The experiment was conducted for three seasons, viz., 1955-56, 1956-57 and 1957-58, on alluvial sandy loam soil. Every year, new sites were selected.

(2) *Experimental design and treatments* :—The trials were laid out in a split-plot design with four replications. The treatments were as follows :—

Main plot treatments :—Types of seed beds.
R — Raised beds ; F — Flat beds.

Sub-plot treatments :—Manures.

M_1 — Farmyard manure @ 100 lbs. N/acre.
M_2 — Farmyard manure @ 50 lbs. N plus mustard cake @ 50 lbs. N/acre.
M_3 — Dhaincha green manuring plus mustard cake @ 50 lbs. N/acre.
M_4 — Dhaincha green manuring plus farmyard manure @ 50 lbs. N/acre.
M_5 — Mustard cake @ 100 lbs N/acre.

The net bed size was 9′ × 3′.

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[1 & 2] Agronomist and Agronomical Assistant, respectively, at the Central Tobacco Research Institute, Rajahmundry.
[3] Farm Manager, Wrapper and Hookah Tobacco Research Station, Dinhata.

Dhaincha (*Sesbania aculeata*) for green manuring was sown in the beds in late May. After about six weeks' growth it was cut at ground level and buried in the beds. At the time of sowing it was fertilised with single superphosphate at the rate of 82 lbs. per acre and the same quantity was applied to all the remaining plots also.

Farmyard manure and finely crushed mustard cake were applied broadcast 7-10 days before sowing and lightly worked into the top soil. During 1956-57 ammonium sulphate @ 20 lbs. N per acre was applied as top dressing since the growth of seedlings had been adversely affected by continuous rains during the third week of October.

(3) *Seed rate and sowing* :—Seeds of *Jati* (Deshi variety), cigar wrapper (Rangpur Sumatra), and *Motihari* (Hemti variety) were sown at the rate of 4, 4 and 5 lbs. per acre respectively. The actual dates of sowings were as below :

	1955-56	1956-57	1957-58
Jati	Sept. 25	Sept. 20	Sept. 19
Cigar Wrapper	Sept. 25	Sept. 22	Sept. 19
Motihari	Oct. 4	Oct. 4	Oct. 4

(4) *Pulling of seedlings* :—The first pulling of transplants was done 43-48 days after sowing for *Jati*, 46-48 days after for cigar wrapper, and 34-40 days after for *Motihari*. In 1955-56 only two pullings were done for transplants at 15 days interval. In the subsequent two seasons three pullings were done for transplants at 10 days' intervals.

(5) *Observations* :—The data reported in this paper include :

(i) germination count two weeks after sowing made in 4 random cuts (each measuring 1′ × 1′) per bed.

(ii) Total number of seedlings pulled per bed of 9′ × 3′.

(iii) Total number of transplants* pulled per bed of 9′ × 3′.

(iv) Fresh weight of transplants pulled from the 4 random counts per bed as in (i) above.

SEASONAL WEATHER

The rainfall data during the nursery period is given in Table 1.

It would be seen that during 1955-56 season good rains were received upto the first week of October and no rains thereafter. During 1956-57 the rainfall received was equal to the normal precipitation but unusually heavy rains occurred in the third week of October. 1957-58 was a season of very low rainfall with particularly low precipitation during the first three weeks of September.

EXPERIMENTAL RESULTS

1. Germination

The germination count was made two weeks after sowing in four random cuts (each measuring 1′×1′) per bed. The data are presented in Table 2.

In general germination was considerably higher in 1956-57 as compared to the remaining two seasons.

The type of seedbed did not affect the germination of *Jati* and *Motihari* tobaccos. In the case of *cigar wrapper*, raised beds appeared to reduce germination during 1955-56 and increase during 1956-57 while no significant difference was observed in 1957-58.

Germination was higher in farmyard manure alone or farmyard manure plus green manure beds than mustard cake alone or mustard cake plus green manure beds. The combination of farmyard manure and mustard cake tended to produce intermediate results.

* In this study the term 'Transplant' denotes aseedling that is suitable for transplanting.

TABLE 1. *Rainfall at Dinhata during the tobacco nursery season.*

Periods (ending in meteorological weeks)		1955—56		1956—57		1957—58		Normal	
		Rainfall mm.	Rainy days	Rainfall mm.	Rainy days	Rainfall mm.	Rainy days	Rainfall mm.	Rainy days
September	3-9 ..	80.3	3	100.6	4	10.4	2	103.3	4
	10-16 ..	117.9	5	76.7	6	6.4	2	92.7	4
	17-23 ..	19.3	2	14.5	1	0.5	1	88.0	3
	24-30 ..	43.7	3	..	..	55.9	3	82.9	2
October	1-7 ..	54.9	1	41.9	4	7.6	1	79.8	2
	8-14 ..	..	..	77.2	3	13.5	2	26.5	1
	15-21 ..	..	..	202.7	6	22.6	3	41.8	1
	22-28 ..	..	..	..	..	..	..	19.5	1
	29-4th Nov. ..	..	..	33.7	4	..	..	13.5	1
November	5-11 ..	..	..	..	..	..	..	..	..
	Total ..	316.1	14	547.3	28	116.9	14	547.8	19

2. Total Number of Seedlings

The total number of seedlings included the transplants pulled in various pullings as well as the useless seedlings pulled at the end of the season. The data are presented in Table 3.

In all the three types of tobaccos the number of seedlings was considerably more in the wet season of 1956-57 than the remaining two seasons.

The type of seedbed did not affect the number of seedlings in the case of early sown *Jati* and *cigar wrapper* in any of the three seasons. But in the case of late sown *Motihari*, raised beds consistently gave lower number of transplants as compared to the flat beds, though the difference between the two was found significant during 1955-56 only.

Farmyard manure alone or in combination with dhaincha produced more seedlings than mustard cake alone or in combination with dhaincha. The combination of farmyard manure and mustard cake tended to produce intermediate results.

It would thus be seen that the effect of treatments as well as seasons on the number of seedlings is in general identical with that on the germination of seeds.

3. Number of Transplants

The total number of transplants pulled per bed in all the pullings are given in Table 4.

TABLE 2. *Germination count per 4 sq. ft. area per bed.*

Treatments		1955—56	1956—57	1957—58	Mean
CIGAR WRAPPER :					
Seed beds :	Raised	375	1245	240	620
	Flat	657	1036	219	637
	C.D. at 5%	138	176	N.S.	
Manures :	M_1	743	1365	281	796
	M_2	528	1060	175	585
	M_3	425	1042	165	544
	M_4	555	1422	360	779
	M_5	330	815	166	437
	Mean	516	1141	229	629
	C.D. at 5%	190	284	121	
JATI :					
Seed beds :	Raised	367	898	447	571
	Flat	558	1051	343	651
	C.D. at 5%	N.S.	N.S.	N.S.	
Manures :	M_1	617	1253	527	799
	M_2	412	984	381	592
	M_3	338	862	334	511
	M_4	595	1008	461	688
	M_5	350	766	272	462
	Mean	462	975	395	611
	C.D. at 5%	93	239	93	
MOTIHARI :					
Seed beds :	Raised	112	195	85	131
	Flat	163	212	89	155
	C.D. at 5%	N.S.	N.S.	N.S.	
Manures :	M_1	202	242	109	184
	M_2	117	194	87	133
	M_3	112	175	75	121
	M_4	175	183	92	150
	M_5	80	224	72	125
	Mean	137	204	87	143
	C.D. at 5%	49	N.S.	N.S.	

TABLE 3. *Total number of seedlings pulled per net bed of 9′×3′.*

Treatments		1955—56	1956—57	1957—58	Mean
CIGAR WRAPPER :					
Seed beds :	Raised	1001	2695	1118	1605
	Flat	1101	2855	1052	1669
	C.D. at 5%	N.S.	N.S.	N.S.	
Manures :	M_1	1065	3140	1382	1862
	M_2	1084	2448	1001	1511
	M_3	935	2873	804	1537
	M_4	1260	2999	1459	1906
	M_5	912	2415	778	1368
	Mean	1051	2775	1085	1637
	C.D. at 5%	N.S.	339	333	
JATI :					
Seed beds :	Raised	999	2902	1533	1808
	Flat	1224	2919	1541	1895
	C.D. at 5%	N.S.	N.S.	N.S.	
Manures :	M_1	1289	3508	1707	2168
	M_2	1020	2641	1582	1747
	M_3	771	2764	1308	1614
	M_4	1568	3286	1865	2240
	M_5	910	2352	1222	1494
	Mean	1111	2910	1537	1853
	C.D. at 5%	299	633	266	
MOTIHARI :					
Seed beds :	Raised	567	918	481	655
	Flat	879	1014	492	795
	C.D. at 5%	217	N.S.	N.S.	
Manures :	M_1	938	1019	630	862
	M_2	653	892	482	675
	M_3	600	935	366	637
	M_4	967	1032	531	843
	M_5	457	952	423	611
	Mean	723	966	486	725
	C.D. at 5%	131	N.S.	140	

TABLE 4. *Total number of transplants pulled per net bed of 9′×3′.*

Treatments		1955–56	1956–57	1957–58	Mean
CIGAR WRAPPER :					
Seed beds :	Raised	526	1244	853	874
	Flat	525	1348	806	893
	C.D. at 5%	N.S.	103	N.S.	N.S.
Manures :	M_1	578	858	958	798
	M_2	558	1161	813	844
	M_3	352	1698	652	901
	M_4	601	1272	1106	993
	M_5	537	1491	617	882
	C.D. at 5%	N.S.	242	270	N.S.
	Seasonal means	525	1296	829	883
	C.D. at 5 % for seasonal means	159			
JATI :					
Seed beds :	Raised	306	435	1070	603
	Flat	330	341	1069	580
	C.D. at 5%	N.S.	N.S.	N.S.	N.S.
Manures :	M_1	403	135	938	492
	M_2	360	418	1183	654
	M_3	102	419	941	487
	M_4	390	449	1335	725
	M_5	333	518	951	601
	C.D. at 5%	105	187	301	119
	Seasonal means	318	388	1070	592
	C.D. at 5% for seasonal means	N.S.			
MOTIHARI :					
Seed beds :	Raised	436	757	395	529
	Flat	584	832	420	612
	C.D. at 5%	N.S.	N.S.	N.S.	71
Manures :	M_1	578	759	543	627
	M_2	514	770	406	563
	M_3	476	819	281	525
	M_4	604	798	453	618
	M_5	379	826	355	520
	C.D. at 5%	93	N.S.	114	75
	Seasonal means	510	794	407	570
	C.D. at 5% for seasonal means	76.30			

In the case of *cigar wrapper* and *Motihari* tobaccos, the number of transplants pulled per bed was the highest in the wet season of 1956-57, but in the case of *Jati* more transplants were pulled in 1957-58 than the remaining two seasons.

The type of seedbed did not influence the production of transplants in the case of early sown *Jati* and *cigar wrapper*. But in the case of late sown *Motihari* raised beds tended to produce less transplants than the normal flat beds.

The effect of manurial treatments on the production of transplants varied considerably from season to season according to the prevailing weather conditions. Under wet conditions (1956-57) mustard cake produced more transplants than farmyard manure, but under drier conditions (1955-56 and 1957-58) farmyard manure produced more transplants than mustard cake. The poor performance of farmyard manure during the wet season of 1956-57 was accentuated in the case of early sown *Jati* and *cigar wrapper*, and moderated in the case of late sown *Motihari*. The combination of farmyard manure and mustard cake, however, was free from the drawbacks of its components and generally produced consistently good results during all the three seasons.

In general, the combination of mustard cake and dhaincha green manure did not increase the number of transplants over mustard cake alone and appeared to be particularly disadvantageous under drier conditions. Combination of farmyard manure and dhaincha green manure generally produced the higher number of transplants and gave a consistently good performance during all the three seasons.

Thus the manurial treatments involving combination of farmyard manure either with mustard cake or with dhaincha green manure appeared to be most promising.

Examination of the number of transplants obtained in individual pullings showed that the effect of the treatments on the early availability of transplants (in the first pulling) was generally similar to that on the total of all pullings. Thus the treatments which produced the highest total number of transplants also tended to give higher number of transplants in the earliest pulling.

4. WEIGHT OF TRANSPLANTS

The transplants pulled from 1 sq. ft. cuts at 4 locations per bed were weighed after washing the roots with water. The average fresh weight in gm. per 100 transplants is given in Table 5.

The type of seedbeds did not affect the fresh weight of transplants.

Transplants obtained from farmyard manure beds were conspicuously light in weight. This reduction in the weight of transplants was more marked in the case of early sown *Jati* and *cigar wrapper* and less marked in the case of late sown *Motihari*. Mustard cake tended to produce heavier transplants than farmyard manure.

It was observed during the course of the experiment that germination and early growth were better in farmyard manure beds than mustard cake beds. But with the advance of the season, seedlings in the farmyard manure beds gradually turned pale and stunted whereas in mustard cake beds the colour of seedlings continued to be dark green till the end of the season. The yellowing and stunting in farmyard manure beds was conspicuously greater in the case of *Jati* and *cigar wrapper* than in *Motihari*.

DISCUSSION AND INTERPRETATION OF RESULTS

In general the germination and ultimate plant population in the seedbeds varied with the nature of the season. Thus germination and ultimate plant population during the wet season of 1956-57 were much higher compar-

TABLE 5. *Fresh weight of transplants (gm. per 100 transplants).*

Treatments			1956–57	1957–58	Mean
CIGAR WRAPPER :					
Seed beds :	Raised	..	349	286	318
	Flat	..	338	284	311
Manures :	M_1	..	303	264	284
	M_2	..	326	354	340
	M_3	..	351	293	322
	M_4	..	318	265	292
	M_5	..	395	281	338
	Mean	..	343	285	314
JATI :					
Seed beds :	Raised	..	364	314	339
	Flat	..	372	310	341
Manures :	M_1	..	336	203	270
	M_2	..	382	309	346
	M_3	..	366	352	359
	M_4	..	346	307	327
	M_5	..	386	390	388
	Mean	..	368	312	340
MOTIHARI :					
Seed beds :	Raised	..	502	585	544
	Flat	..	490	618	554
Manures :	M_1	..	450	562	506
	M_2	..	513	655	584
	M_3	..	510	579	545
	M_4	..	497	647	572
	M_5	..	502	567	535
	Mean	..	496	602	549

ed to 1955-56 and 1957-58 seasons which were comparatively dry.

Raising the level of seedbeds did not affect the germination, ultimate plant population and production of transplants in the early sown wrapper and *Jati*. But in the case of late sown *Motihari* raised beds seemed to reduce the total population and the production of transplants. It appeared that if adequate surface drainage existed, raising the level of seedbeds in the light textured soils did not serve any useful purpose even during wet weather. On the other hand under drier conditions it would accelerate the depletion of soil moisture and consequently reduce the germination, ultimate plant population and the production of transplants.

Farmyard manure induced greater germination and larger ultimate plant population than mustard cake. This beneficial effect of farmyard manure was probably due to the creation of favourable physical condition and better retention of moisture in the top soil of the beds. Mustard cake could not produce such an effect probably because the bulk of the material so added was comparatively very small and undecomposed. During the decomposition of the raw cake some of the decomposition products also might have inhibited the germination of seeds. Dhaincha green manuring did not appear to have exerted any decisive influence on the germination and ultimate plant population. The performance of the mixed treatments, therefore, was largely dependent upon the farmyard manure and/or mustard cake component of the mixtures.

Farmyard manure, however, failed to supply adequate nutrition for the continued growth of the seedlings. In all the three seasons of the experiment and in all the three types of tobaccos, seedlings in the farmyard manure beds alone turned pale after an initial period of good growth and ultimately became stunted. The paleness intensified as the age of seedlings advanced. The transplants from farmyard manure beds, therefore, were lighter in weight.

The paleness and stunting of seedlings was more marked in the case of cigar wrapper and *Jati* than *Motihari*. This might have been due to larger plant populations in the two former types. The extremely poor performance of farmyard manure beds in producing transplants of cigar wrapper and *Jati* in the wet season of 1956-57 might have been due to the leaching of nutrients by heavy rains.

Mustard cake on the other hand gave good results under wet conditions and poor results under dry conditions. This might have been chiefly due to the delayed decomposition of raw cake under drier conditions and *vice versa*. It was observed that seedlings in mustard cake beds always took a late start but continued good growth later on and maintained dark green colour till the end of the season. Mustard cake, therefore, seemed to provide enough nutrition to the seedlings throughout the season but the nutrients took some time to become available because the cake was applied raw.

The effect of dhaincha on the nutrition of seedlings was more like that of mustard cake rather than farmyard manure. Therefore, when dhaincha green manuring was combined with farmyard manure, it supplemented the supply of nutrients to the large number of seedlings that germinated under the influence of farmyard manure. Consequently, the production of transplants went up. But when dhaincha was combined with mustard cake the treatment suffered adversely from the same drawbacks as the mustard cake alone.

The combination of farmyard manure and mustard cake always gave consistently good results because each component of the mixture corrected the deficiency of the other, as was the case with the combination of farmyard manure and dhaincha.

It, therefore, appeared that a good basal dose of farmyard manure was essential for the

good germination and early start of tobacco seedlings in the light-textured soils of this area. In addition to farmyard manure, some supplemental manuring was, however, necessary for continued good growth and adequate nutrition of the seedlings in later stages. Dhaincha green manuring and mustard cake at the rate of 50 lbs. N/acre appeared to make up the deficiency of farmyard manure more or less satisfactorily. Both of these, however, needed to be applied in such a way that the active phase of decomposition was over before the seeds are sown.

Further work on these aspects with combinations of organic and inorganic manures is currently in progress.

SUMMARY AND CONCLUSIONS

1. Raised beds did not show any advantage over the normal flat beds in the case of early sown cigar wrapper and *Jati*, whereas in the case of late sown *Motihari* raised beds seemed to be disadvantageous.

2. Application of farmyard manure induced good germination and rapid growth of seedlings during the period immediately following germination. But later on, seedlings in the farmyard manure beds alone gradually turned pale and became stunted, and many of the seedlings were found to be unsuitable for transplanting. The yellowing and stunting of seedlings was more acute in the case of *cigar wrapper* and *Jati* particularly during the season of heavy rains, and less acute in the case of *Motihari*.

3. Inclusion of mustard cake at 50 lbs. N/acre or dhaincha green manuring in addition to farmyard manure prevented the yellowing of seedlings and consistently produced good number of transplants in all seasons.

4. Mustard cake alone or in combination with dhaincha green manuring produced highest number of transplants in the season of heavy rains and lowest number in the remaining seasons when germination was poor, and the initial growth slow. In all the seasons, however, seedlings in these treatments remained dark green than in other treatments.

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Studies on Commercial Feasibility of Artificially Produced Hybrid Vigour in Tobacco (N. Rustica)

(ii) Heterosis in Subsequent Generations

L. C. SIKKA [1]
&
B. M. BATRA [2]

It has been reported earlier that hybrids from intervarietal crosses in *Nicotiana rustica* exhibit marked heterosis to warrant their commercial exploitation (Sikka and Batra, 1958). Since tobacco crop offers a promise for intensive study of heterosis, the studies were further extended to the possibilities of retention of hybrid vigour in F_2 and F_3 generations. This fact, if revealed, will make the exploitation of hybrid vigour more practicable.

Observations on hybrid vigour in seven crosses made between unrelated *N. tabacum* varieties by Rave (1934) revealed that vigour exhibited by three crosses was maintained upto F_4. More recently heterotic hybrids of *N. rustica* are reported to maintain heterosis for yield and resistance to tip chlorosis and scald in the F_2 and F_3 (Stasevskaja, 1957). In few cases it has been demonstrated that the superiority of hetrozygotes manifested in F_1 generation in *N. tabacum* was restricted only to F_2 and different characters involved were differently affected (Jakovak, 1941 ; Kosmodemjjanskii, 1941 ; Tomaovskii, 1950). It is also held that varying degrees of heterosis was manifested in different hybrids of *N. rustica* and not all the hybrids displaying heterosis in F_1 were found to perpetuate this beneficial effect in advanced generations (Bolsunov, 1954).

Contrary to the above, it has been severally reported that vigour in the successive hybrid generations declines progressively after F_1 in tobacco (Selby and Houser, 1921 ; Hayes, 1912 ; East, 1916 ; Mather and Vines, 1952).

MATERIAL AND METHODS

Fifteen combinations of six types namely 22, 24, 16, 40, 60 and 80 of *N. rustica*, used for evaluating hybrid vigour in F_1 reported elsewhere (Sikka and Batra, 1958) were simultaneously studied in this investigation. In F_2 five plants at random were selfed in each of

[1] Assistant Botanist, Central Potato Research Institute, Simla, formerly Research Assistant, Botany, Millet Section, Ferozepur, Department of Agriculture (Punjab).
[2] Agronomist, Tobacco, Millet Section, Ferozepur, Department of Agriculture (Punjab).

the F_1 lines of the above mentioned crosses for getting F_2 seed. The above crosses were also repeated to get F_1 available for comparison with F_2 and thus F_1 and F_2 along with their six parents making in all 36 cultures were tested in a replicated progeny row trial.

In 1953, again five plants in each of the F_1 and F_2 lines were selfed and fresh crosses repeated. A trial of 51 cultures made up of F_1, F_2 and F_3 of the 15 crosses along with six parents was laid out in 1954. The heterosis effects, on yield and its main components as reported earlier were studied.

In the present studies the term heterosis or hybrid vigour has been used to denote the superiority of a hybrid over the average of its parents, i.e. $(F_1 - \frac{P_1+P_2}{2})$ whereas super-dominance is employed to indicate increase of a hybrid over the superior parent of the cross in different generations.

RESULTS

The data of all the characters observed during the two years of study were statistically analysed. Since F_2 and F_3 will not comprise environmental variation but genetic variations as well due to segregation, the residual sum of squares was, therefore, further split up into its components corresponding to the interaction of the parents, F_1s, F_3s and F_2s with blocks so as to examine the data more critically. The characters for total yield, leaf yield and stalk yield were analysed by the covariance technique and the remaining characters on the basis of average data per plant by randomised block method. Tables I and II represent the mean percentage values of *heterotic* and *super-dominance* effects for different characters under investigation. The results are discussed herein :

Height per Plant

In the year 1953, six out of 15 crosses (40%) showed significant heterosis as against 10 hybrids (80%) in F_1. Of these, four hybrids (26.6%) were found to excel their superior parents. The mean increase for different F_2 progenies in respect of this character varied from 14.57 to 17.17%. During 1954, the range of increase was −18.70% to 9.13%. The hybrids 22×24, 22×40 and 24×60 contributed the maximum increase during both the years of study. In F_3, which was studied in 1954 only, heterosis was conspicuous by its absence practically in all the hybrids.

Number of Leaves per Plant

Heterotic and super-dominance effects were significant in two crosses (13.5%) in F_2 in the first year. During the following year though the differences were not significant in F_2 yet the differences were substantial. The mean super-dominance effects registered were −22.64 to 8.07% in 1953 and −8.90 to 12.73% in 1954. In F_3 there was complete suppression of this character.

It will be observed that hybrids 22×24 and 22×40 showed an appreciable increase in F_2 and hybrid 22×80 continued to show transgression even upto F_3 consistently.

Length of Leaf

The magnitude of heterosis was comparatively smaller for this character. Only one cross-combination was found to display heterosis at significant level in F_2 during both the years of study. There was no indication of super-dominance in any of the hybrid generations.

Breadth of Leaf

In 1953, of the seven F_1 crosses (46.6%) displaying significant heterosis, only one cross

(6.66%) contributed better breadth in F_2. The vigour observed in F_1 on the whole was seemingly lost in F_2. During second year, the results followed the like pattern.

Super-dominance was practically absent in all the generations subsequent to F_1 during the two years of study.

Days Taken to Flower

During the first year of study 8 out of 15 F_2 crosses (53.33%) were significantly earlier than the mean of their parents. The data during 1954 on the other hand showed definite tendency towards lateness excepting the cross 22×24 which manifested heterosis in respect of this character in F_1 and F_2 in 1953 and F_1 and F_3 during 1954. This shows that season plays an important role in the expression of heterosis in this character.

Super-dominance with respect to this character was, however, not substantial in any of the hybrid generations during both the years.

Stalk Weight

Majority of the hybrids perpetuated the beneficial effect of F_1 in the F_2 generation during both the years. When compared to the top parents, the magnitude of advantage thus accrued ranged from −34.67 to 78.27% in 1953 and −28.46 to 20.48% in 1954. Combinations 22×24, 24×60 and 40×60 strikingly exceeded their best parents consistently and the maximum gain of 28% being in cross 22×24. In F_3, however, heterosis as well as super-dominance effects were expressed in some of the crosses but differences in none of them were tangible.

Leaf Yield

Heterosis regarding leaf yield was in general, parallel to that of the stalk yield. Heterotic values in the F_2 progenies were −31.83 to 60.61% and −15.85 to 16.0% during 1953 and 1954 respectively. Super-dominance values in some of the crosses also persisted to a greater extent and it was −36.71 to 27.05% in 1953 and −23.44 to 13.76% in 1954. Hybrid 22×24 as before gave commendable performance during both the years. In F_3 heterotic effects almost dwindled away and the super-dominance effects were practically extinct.

Total Yield

Conspicuous heterosis was found to persist in F_2 for this character. In 1953 there were 12 F_2 crosses (80.00%) which maintained their supremacy over the mean of their parents and the extent of heterotic values were 6.14 to 66.87%. During 1954 the results were confirmatory to the preceding year. Of the F_3 progenies, 5 out of 15 crosses (33%) possessed positive increase but none of them attained the level of significance. As compared to the best parents, all the F_2 hybrids displaying significant heterosis also indicated significant super-dominance in 1953. Mean comparable super-dominance values in F_2 hybrids displaying significant heterosis also indicated significant superdominance in 1953. Mean comparable superdominance values in F_2 progenies were −33.90 to 35.04%. In 1954 though the superdominance was observable in F_2, yet it was not appreciable. Superdominance effects ranged from −34.06 to 16.83%. In F_3 reduction in yield was noticed in almost all the hybrids. Hybrid 22 × 24 had consistently given better yields than its superior parent both in F_1 and F_2. The behaviour of this cross is according to the expectation as the marked heterosis had been shown in all the characters which add to total capital by this cross.

Nicotine Content

Among the 15 hybrids studied, 6 F_2 hybrids (40%) indicated heterosis during 1953 but

the magnitude of gain was not perceptible. During 1954, alkaloidal content was higher in 10 hybrids (66.6%) in F_2 and 11 (73.3%) in F_3. Superdominance was obtained in 3 F_2 hybrids (20.6%) in 1953 and 8 F_2 hybrids (53.3%) in 1954. In F_3 the phenomenon of increased vigour was also observable but the differences were not substantial.

DISCUSSION

The results show that the degree of heterosis in practically all the crosses was at its maximum in F_1 in the case of total yield and other characters. The increase over the parental average in different crosses varied from 0.92 to 99.54% for total yield during 1953 and −8.75 to 53.1% in 1954 with their means of 52.08 and 26.16% respectively. In F_2 the mean value of all the characters dropped by about 25% as compared to F_1 but this was unusually higher than the mean of parents and in some cases, the differences were significantly marked. The number of leaves, however, showed a marked depressing effect and was even less in F_2 than the mean of the parents. The gain accrued as mean of all the crosses in F_2 with reference to total yield was 16.18% in 1953 and 3.90% during 1954. Some of the hybrids, however, have shown heterosis in F_2 in all the characters to a considerable extent. Cross 22×24 for example gave an increase of 39.5% in 1953 and 17.7% in 1954 over the mean of the parents and 28.3% and 16.8% over the better parent in respect of total yield respectively. The heterosis in other characters of F_2 generations for this cross gave similar results and mean increase for two years over the superior parent was 18% in leaf yield, 27% in stalk yield, 12% in height of plants, 3% in length of leaf and 2% in breadth of leaf. This cross also showed a definite tendency towards earliness which is of great economic significance in tobacco, especially in *N. rustica*. Instances are already on record where the F_2 generation has been observed to show significant vigour not only in a greater yielding capacity but also in other associate characters. (Stasevskaja, 1957; *Jakovuk,* 1941; Rave, 1934; Tomaovskii, 1950; and Bolsunov, 1954). The work of Larson and Currence (1944) and Powers (1952) in tomato; Martin (1949) in barley; Harrington (1944) in wheat and Basil (1955) in cotton also lend sufficient support to the above contention. Thus the retention of heterosis in F_2 of this particular cross which also emerged out as one of the best F_1 hybrids, is quite encouraging. Considered genetically, the retention of heterosis in F_2 can be attributed to linkage of genes in parental combinations preventing random assortment and their interaction with other genes. Genes linked in favourable combinations are known to transmit *en bloc* without random assortment in segregating population.

In F_3 (which was tested in 1954 only) almost all the characters were marked for absence of heterosis. This is in harmony with the observations that vigour in successive hybrid generations as compared with F_0 (parents) was already in order of F_0 F_1 F_2 F_3 (Selby and Houser, 1912 and Mather and Vines, 1952 in tobacco; Engledow and Pal, 1934 in wheat; and Pal and Singh, 1945 in egg plant).

The above results can be adequately explained in the light of hypothesis put forward by Jones (1917). The linkage of dominant genes accounts for the fact that F_2 from crosses which exhibit vigour in F_1, are less vigorous and less productive than the F_1. In other words, if a large number of factors are involved they are bound to be linked and thus it is extremely difficult to obtain all the necessary favourable growth factors in the later segregating generations. Consequently the average growth of F_2 population exhibits considerably

less increase over the mid-parental values than F_1 and the subsequent generations display much less of the beneficial effects of the original cross combinations.

The residual heterosis seen in F_2 was significant. This indicated a possibility of evaluation of heterosis in F_2 generation for commercial exploitation in crops where it is somewhat difficult to obtain F_1 seed in sufficient quantities.

SUMMARY

Attempts were made to assess the F_2, F_3 generations for heterosis involving a number of characters in *Nicotiana rustica,* a tobacco grown for smoking in Hookah (country pipe) and manufacture of snuff. The studies were conducted at the Tobacco Research Sub-Station, Ferozepur for two years 1953 and 1954. Results indicate the followings :

In the F_2 generation, some of the combinations were found to retain the vigour of F_1, though not to the same extent and other not so to a greater or lesser extent in many characters.

In the F_3 which was tested in 1954 there was generally a suppression of vigour in all the characters studied.

Varying degrees of heterosis were observed in different characters in different hybrid progenies in F_1 as well as in generations subsequent to it.

Hybrid 22×24 gave the best performance for all the characters both in F_1 and F_2. In F_3, however, it did not show any heterosis. The over-all increase for two years over the best parent was 38.0% in F_1 and 22% in F_2. (Table II).

On acre basis, the magnitude of increase in final yield comes to 720 lbs. over the better parent in F_1 and 430 lbs. in F_2 giving an average net gain of Rs. 426.50 nP. and Rs. 255.25 nP. per acre respectively.

From the results of these investigations it is concluded that the residual heterosis in F_2 is of that order, that the annual production of hybrid seeds can easily be dispensed with especially in crop where it is difficult to obtain F_1 in sufficient quantities.

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Table I. Heterotic effects in different generation hybrids

(Data expressed in percentage)

Hybrids	Average plant height					Average No. of leaves per plant				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	33.5*	25.6*	7.5	10.9	− 0.2	9.4*	9.4*	0.6	3.9	− 3.9
22×16	23.9*	13.7*	16.4*	− 2.3	−13.1	5.8	4.5	0.0	− 4.1	− 6.1
22×40	45.2*	24.6*	21.8*	5.5	− 5.0	19.4*	9.7*	3.3	0.6	− 3.3
22×60	37.9*	30.5*	12.6	0.2	7.9	10.7*	6.3	− 3.3	− 9.2	− 0.6
22×80	34.0*	21.0*	21.5*	8.6	10.9	11.1*	13.9	4.1	− 0.6	− 0.6
24×16	14.2*	14.5	16.3*	− 5.5	− 5.5	5.7	3.8	11.4	− 2.1	3.5
24×40	21.3*	10.0	9.0	− 0.5	− 4.1	3.2	5.1	5.5	0.0	7.5
24×60	21.5*	13.2*	12.1	10.8	9.5	6.8	1.2	8.9	0.0	− 3.4
24×80	27.5*	6.0	19.3*	5.0	3.9	8.2	0.0	8.5	4.2	1.4
16×40	6.4	0.0	1.2	− 0.5	− 7.4	1.3	− 7.2	0.0	2.8	− 6.4
16×60	− 6.0	1.6	− 1.0	−10.9	5.3	−13.5	− 6.4	1.4	− 5.0	4.2
16×80	1.5	− 0.9	0.5	− 9.4	0.5	− 5.0	− 7.8	0.0	1.4	7.4
40×60	10.0	5.2	7.6	9.7	3.9	− 0.6	− 5.8	2.7	4.1	− 1.3
40×80	12.8*	3.9	0.0	− 0.5	− 0.8	5.0	− 4.2	− 1.4	0.0	− 3.5
60×80	11.8	− 6.2	− 2.5	0.8	2.5	2.7	−14.5	− 3.5	1.4	0.0
Mean	19.31	9.8	6.3	1.6	− 3.5	4.75	− 0.3	2.5	− 0.1	− 0.4

Hybrids	Average length of larger leaf					Average breadth of larger leaf				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	11.6*	4.6	− 0.7	7.0	−11.1	17.2*	14.8*	1.6	4.4	− 3.9
22×16	16.6*	2.9	2.1	− 0.8	− 7.1	19.0*	2.2	6.0	0.0	− 6.0
22×40	17.8*	5.3	7.9	− 7.5	−10.0	25.9*	11.7	11.8	− 6.8	− 8.6
22×60	18.3*	14.9*	0.0	− 6.6	− 3.3	29.9*	24.5*	11.5	− 2.1	2.8
22×80	15.9*	−17.3†	17.9*	15.5*	−16.0†	31.8*	− 1.5	21.8*	21.8*	− 8.2
24×16	11.4*	− 2.0	− 3.3	− 1.6	− 2.9	4.9	− 8.4	− 5.2	− 5.2	− 6.4
24×40	5.5	− 5.5	4.1	− 5.3	0.0	12.3*	− 9.1	1.1	− 1.7	− 4.1
24×60	8.6*	2.2	14.5*	1.4	0.0	11.2	8.5	15.2*	6.9	− 5.5
24×80	10.8*	9.2	19.1*	6.5	− 1.8	13.3*	6.6	18.5*	9.2	5.7
16×40	5.6	− 6.6	− 1.4	− 1.9	− 2.8	7.2	− 7.9	− 9.0	− 1.2	−11.6
16×60	2.0	9.0	1.6	11.6	− 6.6	1.4	− 6.4	0.0	8.3	− 9.9
16×80	− 0.9	− 9.2†	9.8	− 7.6	6.0	− 1.0	− 5.9	15.8*	− 6.3	10.3
40×60	10.2*	1.6	4.8	5.9	4.3	12.8	3.2	11.0	7.0	8.6
40×80	12.1*	− 2.0	11.3	0.0	2.7	13.6	1.9	9.8	0.8	0.0
60×80	11.11*	−10.0	13.4	12.1	3.2	24.4*	− 6.4	26.2*	15.1	15.1
Mean	11.1	− 1.7	6.3	1.6	− 3.5	14.5	1.6	8.1	2.7	− 1.5

* Excess significantly at 5%

† Less significantly at 5%

Table I. Heterotic effects in different generation hybrids—*(Continued)*

Hybrids	Average No. of days taken to flower					Green Weight				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	— 4.6*	— 3.3	—16.8*	— 1.5	—15.9*	63.1*	30.2*	33.4*	30.1*	— 8.8
22×16	— 6.4*	— 3.0	— 7.5	— 4.6	— 5.2	53.0*	3.4	28.3	—15.7	—10.9
22×40	— 2.6	— 3.9	— 7.9	— 4.2	— 3.9	76.9*	28.8*	33.0*	— 7.6	—16.8
22×60	— 5.0	— 7.2*	— 5.3	7.8	— 0.9	75.5*	47.5*	14.7	—15.6	10.4
22×80	0.5	—14.4*	— 3.8	— 2.7	— 8.4	65.0*	—37.8*	24.1	21.6	—23.0
24×16	— 7.8*	— 1.0	— 3.5	12.3*	6.3	62.0*	5.5	10.3	3.3	— 0.2
24×40	— 8.3*	— 3.1	— 1.6	3.8	11.7	31.9*	1.4	17.8	— 7.1	— 6.9
24×60	— 7.6*	— 5.9*	14.3†	7.2	1.9	42.2*	11.0	28.5	4.9	—12.2
24×80	— 5.9*	— 6.3*	20.2*	8.1	3.0	39.1*	13.1	40.4*	— 1.1	— 5.2
16×40	— 3.8	—15.3*	— 0.5	— 1.8	10.3	14.7	—19.2	— 4.2	9.6	— 4.0
16×60	—14.6*	— 8.5*	2.8	6.2	— 5.3	— 6.1	—11.3	5.0	5.5	—10.6
16×80	— 6.7*	—10.5*	7.8	8.8	4.5	— 8.0	—16.0	32.1	—14.0	3.3
40×60	— 7.7*	— 3.3	— 1.5	— 3.9	3.2	17.8	— 0.6	15.1	16.8	5.4
40×80	— 5.9	1.1	3.1	— 3.3	6.6	26.9	— 9.6	6.8	— 5.7	—18.0
60×80	— 8.8*	—15.2*	14.2	4.8	7.2	18.9	—37.9	25.0	5.9	20.1
Mean	— 6.5	— 6.5	0.2	0.8	0.4	41.2	2.9	21.4	2.4	— 6.0

Hybrids	Stalk Yield					Leaf Yield				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	81.1*	68.3*	25.4	22.7	0.5	65.2*	35.0*	25.8*	15.7	— 6.4
22×16	63.1*	5.3	59.7*	—10.5	—14.7	56.8*	8.3	25.9*	—13.5	—11.3
22×40	118.8*	71.5*	57.7*	— 3.4	—19.6	93.5*	48.0*	38.1*	— 9.5	—22.9
22×60	124.4*	88.4*	42.8	7.2	18.6	82.4*	60.6*	25.8	—15.8	15.6
22×80	87.4*	11.8	39.7	17.9	—10.3	75.7*	—16.7	34.4*	16.0	—19.5
24×16	58.1*	16.8	15.1	16.1	— 5.8	63.5*	15.6	16.6	8.8	— 3.7
24×40	76.5*	13.3	34.7	2.6	—21.8	57.5*	7.9	22.3	— 7.0	— 6.5
24×60	101.3*	50.8*	51.4*	37.8	— 3.2	61.0*	20.4	47.7*	12.8	— 7.0
24×80	61.4*	31.0	47.4*	2.1	17.8	47.7*	23.6	58.2*	— 1.3	0.6
16×40	20.7	—12.0	—14.2	— 2.0	—13.7	19.7	—15.1	— 6.0	7.7	—11.1
16×60	1.0	— 0.8	0.2	—11.4	— 8.5	8.5	— 6.4	14.4	8.1	— 4.0
16×80	— 0.6	10.9	12.3	— 8.1	4.6	0.9	5.3	26.7	— 1.1	16.1
40×60	25.5	31.1	34.0	37.2	24.8	18.4	22.0	15.7	8.4	1.7
40×80	—27.8	15.1	— 7.9	5.3	—16.6	28.4	2.6	0.3	— 3.8	—24.3
60×80	30.5	—31.0	18.9	21.0	20.2	40.9	—31.8	26.3	6.7	35.4
Mean	58.1	23.9	38.3	8.4	— 2.9	50.5	13.6	25.4	1.8	4.8

† Less significantly at 5%

* Excess significantly at 5%

Table I. Heterotic effects in different generation hybrids—*(Continued)*

Hybrids	Total Yield					Nicotine Content				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	68.6*	39.5*	25.7*	17.6	— 4.5	9.5	—29.1	3.6	0.9	—32.5
22×16	58.4*	7.7	36.1*	—12.6	—12.3	2.5	— 9.3	28.1	6.1	14.2
22×40	99.5*	52.4*	43.7*	— 7.8	—22.0	— 5.8	— 6.2	6.2	19.3	— 0.3
22×60	93.0*	66.8*	30.9*	— 8.8	16.5	36.0	135.4	21.5	— 3.7	4.7
22×80	78.5*	9.9	35.8*	16.5	—16.9	12.4	37.2	5.7	— 1.2	4.7
24×16	62.3*	15.1	16.1	11.1	— 4.2	—22.0	—43.3	2.8	— 3.6	5.4
24×40	62.1*	9.3	25.9*	— 4.1	—10.9	2.6	—14.8	— 2.1	9.9	—12.3
24×60	71.7*	28.4	48.9*	20.5	— 5.9	110.1	20.2	— 3.8	19.3	0.3
24×80	51.0*	24.7	55.1*	— 0.4	5.6	—46.4	—17.3	— 8.7	— 5.7	— 5.7
16×40	18.6	—13.0	— 8.7	4.5	—11.9	25.9	—43.0	6.4	20.5	6.4
16×60	6.2	— 4.7	9.3	1.1	— 5.6	95.1	44.4	13.7	45.5	24.8
16×80	0.9	6.9	18.7	— 3.5	12.2	38.0	— 5.4	39.5	32.1	0.3
40×60	20.4	24.7	21.8	18.0	9.4	—16.3	5.7	—13.9	— 1.8	3.7
40×80	28.3	6.1	— 2.2	— 1.0	—21.9	—37.8	—57.3	6.0	7.5	10.5
60×80	37.7	—31.4	23.7	11.6	30.0	—37.3	24.2	17.5	21.6	28.0
Mean	52.0	16.1	26.1	3.8	— 3.6	5.7	— 3.7	7.6	10.7	3.2

* Excess significantly at 5%

† Less significantly at 5%

Table II. Superdominance effects in different generation hybrids

(Data expressed tn percentage increase or decrease over parent)

Hybrids	Average plant height					Average No. of leaves per plant				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F
22×24	24.5*	17.1*	5.0	8.3	— 2.5	8.0*	8.0*	— 3.1	0.0	— 7.6
22×16	10.5	1.3	12.9	— 5.2	—15.7†	3.8	2.5	— 7.0	—10.8†	—12.7†
22×40	31.1*	12.5*	21.4*	5.3	— 5.3	17.1*	7.6*	— 0.6	— 3.1	— 7.0
22×60	21.5*	15.0*	11.7	— 0.5	7.0	11.3*	6.9	7.0	—12.7†	— 4.4
22×80	28.7*	16.3*	12.2	0.2	2.3	1.2	—10.1†	— 3.1	— 7.6	— 7.6
24×16	8.8	— 3.3	15.2*	— 6.4	— 6.4	2.4	0.6	6.8	— 6.1	— 0.6
24×40	17.1*	6.2	6.5	— 2.7	— 6.3	0.0	1.8	4.7	— 0.6	6.8
24×60	14.0*	6.1	10.4	9.1	7.8	6.2	0.6	8.9	0.0	— 3.4
24×80	23.6*	2.7	8.1	— 4.8	— 5.8	— 2.4	— 9.9†	4.7	0.6	— 2.0
16×40	5.0	1.4	— 1.9	— 3.7	—10.4	0.6	— 7.8†	— 3.4	— 0.6	— 9.6
16×60	— 7.5	0.0	— 3.4	—13.2	2.7	—15.7†	— 8.8†	— 2.7	— 8.9	0.0
16×80	— 6.1	— 8.3	— 9.7	18.7	— 9.7	—11.9†	—14.5†	— 0.7	0.7	6.6
40×60	6.7	2.1	6.8	8.9	3.1	— 3.1	— 8.1†	1.3	3.4	— 2.0
40×80	5.7	— 2.5	— 7.4	— 7.9	— 8.2	— 3.2	—11.8†	4.8	3.4	— 6.8
60×80	1.8	—14.5†	—10.4	— 7.3	— 5.7	— 6.9	22.6†	6.8	— 2.0	— 3.4
Mean	11.9	3.2	5.1	— 2.6	— 3.6	0.4	4.3	0.9	— 3.5	— 3.7

* Excess significantly at 5%

† Less significantly at 5%

Table II. Superdominance effects in different generation hybrids—(*Continued*)

Hybrids	Average length of larger leaf					Average breadth of larger leaf				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	6.6*	— 2.5	— 1.4	6.2	—11.8	5.5	3.3	— 2.7	0.5	— 7.5
22×16	10.5*	— 2.4	— 9.3	—11.9	—17.6	13.1*	4.8	1.7	— 4.0	—10.4
22×40	6.8	— 4.4	— 2.9	—16.8	19.1†	22.9*	9.0	4.6	—12.7†	—14.5†
22×60	— 0.8	— 3.6	—20.9	—26.2†	—23.5†	15.9*	11.1	—10.4	—21.5†	—17.4†
22×80	2.8	—26.7†	— 6.3	— 8.2	—33.3†	20.8*	9.7	— 5.8	— 1.0	—29.0†
24×16	1.1	—11.1†	—14.7†	—13.2†	—14.3†	0.5	—12.2†	—12.4†	—12.4†	—13.5†
24×40	7.7†	—17.4†	—17.0	—15.4†	—10.7†	— 1.1	—20.0†	— 8.6	—11.3†	—13.5†
24×60	—11.8†	—17.0†	— 9.9†	—20.2†	—21.4†	— 9.4	—11.6†	—10.2	—16.7†	—17.8†
24×80	— 5.1	—13.3†	— 5.9	—15.8†	—22.5†	— 5.5	—11.1†	—10.2	—17.2†	—20.0†
16×40	0.9	—10.8†	— 3.2	— 3.7	— 4.6	— 1.8	—15.7†	—11.3	— 3.7	—13.9†
16×60	— 8.1	—18.0†	—11.1†	— 2.4	—18.3†	—14.5†	—21.2†	—17.0†	—10.1	—25.3†
16×80	— 7.6	—15.3†	— 3.3	—18.8†	— 6.7	—14.5†	—18.7†	— 7.5	—25.3†	—12.0
40×60	0.9	— 6.9	— 9.8	— 8.8†	—10.2	2.9	— 5.8	— 6.0	— 9.3	— 8.0
40×80	9.4†	— 4.4	— 3.7	—13.5†	—11.2	6.5	— 4.3	—10.6	—18.0†	—18.6†
60×80	4.1	—15.6†	12.7	11.4	2.5	20.8*	— 9.1	—20.1*	9.6	13.4
Mean	1.4	—11.1	— 7.0	—11.2	—15.8	3.1	— 9.4	— 6.3	—11.0	—14.7

† Less significantly at 5%

* Excess significantly at 5%

Hybrids	Average No. of days taken to flower					Green Weight				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	— 4.1	— 1.1	—12.5*	3.5	—11.6*	49.4*	19.2*	32.7*	29.4*	— 9.2
22×16	0.5	4.2	12.5	16.6†	15.2†	42.7*	— 3.5	12.6	—25.4†	—21.7
22×40	13.2†	11.7†	11.2	15.6†	16.0†	44.7*	5.4	12.4	—21.8	—29.0†
22×60	3.6	1.3	18.0†	34.4†	23.5†	31.8*	10.8	—17.0	—38.9†	—20.2
22×80	15.1†	2.0	24.6†	26.1†	18.6†	28.9*	—51.3†	— 7.4	— 9.3	—42.6†
24×16	1.7	9.2	10.8	29.1†	22.2†	39.3*	— 9.3	— 3.5	— 9.6	—12.7
24×40	9.4†	15.7†	12.3	9.7	27.6†	0.9	—22.4†	— 0.75	—21.7	—21.5
24×60	3.3	5.2	34.6†	9.1	20.0†	0.8	—20.7†	— 7.4	—24.4	—36.7†
24×80	14.4†	10.0†	46.8†	32.1†	25.9†	2.1	—16.9	4.3	—26.5	—29.5†
16×40	3.4	— 9.0	0.0	— 1.3	11.0	— 0.4	—29.8†	— 8.2	4.5	— 8.1
16×60	13.5*	— 7.2	5.0	8.5	— 3.3	—25.7†	—29.8†	—16.6	—16.1	—28.9
16×80	—1.2	— 5.2	13.9	14.9	10.3	—24.0	—41.7†	8.8	—28.7	—14.8
40×60	2.1	2.4	1.1	— 1.3	6.0	5.4	—11.0	— 5.3	— 3.9	—13.4
40×80	— 4.5	2.6	9.5	2.6	13.2	19.5	—14.7	— 8.7	—19.3	—29.5
60×80	— 4.7	11.4*	18.0	8.2	10.7	12.4	—41.2†	19.2	1.0	14.5
Mean	1.8	1.7	12.9	13.5	13.1	16.5	—15.0	1.1	—14.8	—21.7

* Excess significantly at 5%

† Less significantly at 5%

Table II. Superdominance effects in different generation hybrids—(*continued*)

Hybrids	Stalk Weight					Leaf Yield				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	64.1*	40.8*	23.0	20.4	— 1.2	52.5*	24.6*	23.7*	13.7	— 8.0
22×16	45.7*	5.8	59.3*	—10.7	—14.9	49.1*	3.0	6.2	—27.0†	—25.1†
22×40	116.2*	69.4*	48.5*	— 9.0	—24.3	66.11*	27.0*	19.3	—21.8†	—33.4†
22×60	112.3*	78.2*	16.1	—12.8	— 3.5	36.0*	19.8	—13.0	—41.8†	20.0†
22×80	68.5*	0.5	9.1	— 7.8	—30.0	38.3*	—34.4†	— 2.2	—15.6	—41.4†
24×16	55.7*	15.1	13.3	—14.2	— 6.5	44.2*	2.0	— 0.1	— 6.8	—17.5
24×40	58.2*	1.6	24.6	— 5.0	—27.7	26.6*	—13.2	7.3	—18.4	—18.0
24×60	73.6*	31.2*	21.3	10.4	—22.5	14.1	—14.7	3.1	—21.2	—35.1†
24×80	33.0*	7.9	13.5	—21.3	— 9.21	10.0	— 8.0	16.4	—27.4†	—25.9†
16×40	2.5	—22.2	19.4	— 7.9	—18.9	7.5	—23.8	— 8.7	4.7	—13.6
16×60	—14.0	—15.6	—18.7	—28.1	—25.78	—16.1	—27.6†	—10.9	—15.8	—25.3
16×80	—19.1	— 9.9	—12.4	—28.4	—18.4	—17.3	—13.7	5.3	—17.8	— 3.4
40×60	20.1	25.5	14.5	17.2	6.6	— 0.1	2.9	—11.7	—17.3	—22.4
40×80	16.2	4.8	—24.7	—13.8	—31.8	15.6	— 7.5	—18.5	—21.9	—38.5†
60×80	23.6	—34.6	23.0	14.7	14.0	30.8	—36.7	16.2	— 1.7	24.6
Mean	42.4	11.6	12.4	— 5.0	—15.0	25.2	— 5.3	3.0	—16.2	—21.2

* Excess significantly at 5%

† Less significantly at 5%

Hybrids	Total Yield					Nicotine Content				
	1953		1954			1953		1954		
	F_1	F_2	F_1	F_2	F_3	F_1	F_2	F_1	F_2	F_3
22×24	57.8*	28.3*	24.8*	16.8	— 5.1	—11.9	—42.9	— 2.1	— 4.6	—36.3
22×16	56.8*	6.6	20.7	—22.2	—22.2	—16.4	—26.1	16.0	— 3.8	3.4
22×40	75.7*	35.0*	27.2*	—18.4	—30.9	—34.9	—35.2	— 0.3	12.0	— 6.4
22×60	51.7*	31.6*	— 5.1	—34.0	—15.6	21.6	110.5	17.2	— 7.1	0.9
22×80	44.8*	—26.7†	0.7	—13.5	—38.3	—23.1	— 6.1	— 2.9	— 9.3	— 3.8
24×16	47.6*	— 4.8	3.6	— 0.8	—14.5	— 5.9	—31.6	—11.4	—17.0	— 9.3
24×40	33.3*	— 9.9	12.2	—14.6	—20.7	—16.3	—30.6	— 2.7	9.2	—12.9
24×60	26.9*	— 4.5	8.2	—12.3	—31.6	85.1	5.9	— 5.9	16.7	— 1.8
24×80	13.8	— 5.0	15.6	—25.7	—21.2	—57.0	—33.6	—11.4	— 8.5	— 8.5
16×40	5.9	—22.0	— 8.9	4.2	—12.1	2.9	—53.4	— 8.9	3.0	— 8.9
16×60	—16.5	—24.2	—13.7	—20.1	—25.4	71.3	24.8	— 0.3	27.5	9.4
16×80	—18.4	—12.5	— 3.5	—21.6	— 8.7	11.0	—23.9	17.0	10.81	—15.8
40×60	5.3	9.1	— 3.6	— 6.6	—13.4	—37.9	—21.5	—16.3	— 4.6	0.9
40×80	15.1	— 4.1	—20.4	—19.4	—36.4	—39.3	—58.3	3.5	4.9	7.9
60×80	32.7	—33.9	19.0	7.4	25.1	—54.2	— 9.2	11.7	15.5	21.7
Mean	9.8	— 0.8	6.1	—12.5	—19.4	—13.0	—20.8	0.1	2.9	— 4.0

* Excess significantly at 5%

† Less significantly at 5%

Gleanings From WORLD LITERATURE on TOBACCO

Chemical & Physical Properties :

BARNARD, C.: Leaf structure in relation to quality in flue-cured tobacco Astral. J. Agr. Res. 2(2) : 169-85, Mar. 1960. graphs. illus. tables.

Indirect evidence suggests that 'lustre' is an indicator of chemical composition. "Body" and "grain" of the cured leaf might be forecast from the anatomical structure of the green leaf, but "elasticity" and "lustre" could not be forecast. (From summary)

BOOTH, V. H.: Extraction of pigments from plant material Analyst. 84 : 464-5, 1959.

An equal weight of quartz and a few mg of quinol are added to the samples, followed by ~ 5 ml of acetone, and the material is ground in the beaker. Light petroleum (~ 5 ml) is then added and, after ~ 1 min, the supernatant liquid is decanted into a layer of light peroleum on a half-saturated solution of $(NH_4)_2SO_4$ in a separator. The residue is ground again and extracted as before, the procedure being repeated until all the pigment has been extracted. The combined extracts are washed with water and the procedure is then as described in Analyst 75 : 568, 1950.

AA 7(3) : No. 1126, Mar. 1960.

FREUDENBERG, K.: Catechine und Hydroxy-flavandiole als Gerberstoffbildner. (Formation of tannins by catechins and hydroxy-flavandiols.) Experientia 16(3) : 101-5, 1960, graphs. (German)

Of the colorless hydroxy-flavans, 4 different hydroxy-flavan -3-ols (catechins and epicatechins), as well as 8 hydroxy-flavan-3, 4-diols, have so far been encountered in nature. These substances are also procurable by synthesis. On treatment with hot water or dilute acids, they are easily converted into soluble tannins or insoluble phlobaphenes. The mechanism of the self-condensation is explained using catechin via the isolation of a dimeric product. A probable path for the self-condensation of the diols has been indicated. In contrast to the products of their self-condensation, the monomeric polyhydroxy-flavans are not real tannins. A particular accumulation of phenolhydroxyl groups in the molecule, the tendency to form supersaturated solutions and low solubility in water in the crystalline state are pre-requisites for tanning properties. In nature, the self-condensation of polyhydroxy-flavans proceeds without the assistance of enzymes. Dehydrogenative polymerization occurs with formation of brown or red phlobaphenes which are generally insoluble. (From summary)

HORNUNG, H.: Uber Standweitenversuche mit verschiedenen Tabaksorten im Jahre 1959. (Plant spacing trials with different tobacco varieties in 1959.) Deut. Tabbau 40(9) : 81-3, May 1, 1960. tables. (German) (N.C.S.)

The cigar varieties Havanna II/c and Geudertheimer III and the cigarette varieties Virgin 230 and 232 were grown in the North Baden, Germany, tobacco growing area at spacings of 62.5 × 40, 62.5 × 60 and 62.5 × 80 cm. The widest spacing resulted in better color, leaf size and weight (the last high but still normal), structure, elasticity and consistency, burn.

aroma and taste. Nicotine and sugar content increased slightly. The smallest spacing resulted in greatest labor saving during transplanting, topping, suckering, harvesting and sorting.

POPOV, V. R.: Quantitative determination of ammonia in plants containing tannins—Biochemistry 23(1): 33-6, 1958. (Translation of Biokhimiia).

Tannins, in the presence of alkali, are vigorously oxidised by O_2 present in the air to quinones, which in turn elicit oxidative deamination of amino acids present in plant materials, evolving ammonia. The quantity of ammonia produced is dependent on the nature of the polyphenols and amino acids concerned and will be greater as the concentration of these substances in the plant materials increases. Obtaining more accurate results in the quantitative determination of ammonia in tannin-containing plants may be achieved by several alternative approaches and, in particular, by using under the given conditions, substances which exhibit anti-oxidant action with respect to tannins.

BA 35(6): No. 16971, Mar. 15, 1960.

SUGGS, C. W.; SPLINTER, W. E.: Physical properties of green Virgina-type tobacco leaves. II. Frictional characteristics, Tobacco 150(17): 19:24 (Tob. Sci. 4:84-8), April 22, 1960. Illus. tables.

Angles of sliding and static friction of 4 varieties of green (uncured) tobacco (*Nicotiana tabacum* L) leaves in contact with plywood, galvanized sheet metal and neoprene impregnated canvas were determined. Measurements were mad by use of the inclined plane method. The mean angle of sliding and static friction varied from 45° to 54° depending on the maturity of the leaf variety, leaf position and the surface material against which the leaf was tested. The angle of sliding friction was 3—7° smaller than for static friction. Response values for galvanized sheet metal and neoprene impregnated canvas were about equal but higher than for plywood. (Abstract).

Cultural Practices:

JONES, G..L.; MATZINGER, D. F.; COLLINS, W. K.: Comparison of flue-cured tobacco varieties repeated over locations and years with implications on optimum plot allocation. Agron. J. 52(4): 195-9, Apr., 1960. Illus. tables.

Variety X environment first order interactions were small and non-significant for most traits studied. But the interaction of variety X location X year was highly significant although small in relation to the variety component for most of the characters. From a comparison of theoretical variances of treatment means with varying plot allocations, adequate information on the relative performance of tobacco varieties in North Carolina can be estimated from data obtained in 2 years, at each of 5 allocations with 3 replications. (Synopsis).

KINCAID, R. R.: Crop rotation and fallowing in relation to tobacco disease control. Bot. Rev. 26(2): 261-76, Apr.-June, 1960. table.

Correlations have usually been found between the susceptibility of alternate crops and the incidence of disease on tobacco. However, the behaviour of the bacterial wilt pathogen, *Pseudomonas solanacearum*, is not fully explained. A nematode relationship is clearly indicated. Oxygen relationships may also have a part in the maintenance of its virulence. Suitable rotation crops include primarily Gramineae and Leguminosae. Weeds, especially compositae, should be considered as alternate crops. Disease control by resistance and soil treatment has a direct bearing on the results of various crop rotations. Nematode control by rotation, resistance and soil treatment has an indirect effect on the control of certain other diseases such as black shank, *Fusarium* and bacterial wilt. Soil fertility factors and yield and quality of the tobacco crop must also be considered (From discussion).

TOLSTOV, E. P.: Double stalk system of raising the tobacco *Nicotiana rustica L.* Trud. Plodoovoshchn, Inst. im. I. V. Michurina (9): 315-27, 1956.

This method consists of removing the growing point of the seedlings upon planting in the ground or after the roots take hold, as a result of which there forms from the buds in the leaf axils a number of shoots, 2 of which remain for further cultivation; these consequently produce 2 solitary stems in which technical ripeness occurs at the same time. Three years of field tests with 2 varieties have shown that the double stalk system of cultivation increases the yield by 66% without lowering the quality of the raw product. Pinching off the tops should be performed on the seventh day after planting the

shoots in the ground. The sprouts or transplants are taken in the phases where 4-5 true leaves are present.

BA 35(10): No. 27845, May 15, 1960.

Diseases Nematodes:

COUCH, H.B.; BLOOM, J. R.: Influence of soil moisture stresses on the development of the root—knot nematode Phytopathology 50(4): 319-21, Apr., 1960. illus. table.

With a split-root technique the root systems of Pearson and Rutgers tomato were held at 2 soil moisture stresses; field capacity (FC) and permanent wilting percentage (PWP). About 750 eggs of *Meloidogyne haple* were added to each soil system. After 30 days all roots at FC and ½ at PWP were collected and knot counts made per g fresh root weight. The remaining roots were held at FC for 30 additional days. On both tomato varieties, knot counts were significantly higher on roots grown at FC and absent or few on roots at PWP. It is concluded that the eggs of *M. hapla* hatch equally well at FC and PWP, but that the hatched nematodes are unable to migrate at the higher soil moisture stress.

TURLYGINA, E. S.; VERSHINSKII, N. V.: Application of an electric current for the distribution of nematodes in the soil Priroda (8): 97-8, 1957. placed in glass tubes, at the ends of which were (Russian).

Soil infested with root-knot nematodes was placed electrodes from tin foil connected with high frequency alternating current. The period of soil processing lasted from fractions of a second to several seconds. After the soil was processed cucumber seeds were planted; the plants were grown for 1 month; they were tested for infection by root-knot nematodes. The plants were only slightly infected when an electrical gradiant of 30-100v/cm was applied; with an electrical gradient of 500-600v/cm there was no infection. Death of the larvae was ascribed to the electrotraumatic action of the high tension current.

BA 35(9): No. 25280, May 1, 1960.

Insects:

HARWOOD, R. F.; AREEKUL, S.: Identification of insecticides and acaricides by comparative bioassay. Science 131(3410): 1369-70, May 6, 1960. graph.

Toxicants in purified form can be indentified by applying a base dose, consisting of the amount causing 50% mortality in 1 organism to other susceptible organisms. This yields a mortality pattern which "fingerprints" the compound. (From Abstract).

Physiology and Bio-Chemistry:

MEHTA, B. V.; DESAI, R. S.: Salt tolerance studies: Effect of soil salinity on the growth and chemical composition of plants. I. II. J. Soil/Water Conserv. India 7: 101-15, 1959.

Guvar, cotton, tobacco and bajri showed strong tolerance, tomato medium tolerance and beans, peas and cabbage weak tolerance. In general, contents of Ca, Na, and Cl increased and K and Mg, decreased with increasing NaCl concentration. The sum of the cations is practically unaffected until injury point is reached. With $CaCl_2$ treatment Na, K and Mg, contents of the leaves decreased.

Soils Fert. 23(2): No. 746, Apr. 1960.

TUKEY, H. B., JR.; TUKEY, H. B.: Nutrient loss from above ground plant parts by leaching. Atompraxis 5: 213-8, 1959.

Leaching varies among various plants and is greater in older leaves. In light, cations are unaffected, but sulphate and phosphate are leached 3 times as easily in the dark. Na and Mn are easily leached, Ca, Mg, S, K, and Sr are moderately leachable while Fe, Zn, P and Cl are leached with difficulty. The probable mechanism and practical consequences of leaching are discussed.

CA 54(4): 3613d, Feb. 25, 1960.

Key to abstract source Abbreviations:
AA — Analytical Abstracts.
BA — Biological Abstracts.
CA — Chemical Abstracts.

'New Synthetic Shade Fabric, Lumite Rovana, Called Successful in America Sumatra Test'. Tobacco Leaf, Vol. xcvi, No. 4994, October, 29, 1960, P. 30.

A new fabric named 'Lumite Rovana' that is being manufactured by M/s. Chicopee Manufacturing corporation is being tested for its use as a shade cloth in the cultivation of Sumatra Wrapper tobacco. Preliminary tests showed that the fabric is light in weight, unaffected by weather, mildew or rot and will not burn or

support combustion. Though the initial cost of the fabric is about 50% higher than cotton, its life of three or longer and the less annual replacement charges, etc. are less compared to cotton cloth. The cloth is further being prepared in suitable sizes with filling bars, etc., so that it can be rolled up and left secured in off-seasons.

Further tests are in progress.

PARUPS, E. V.: Effect of gibberellic acid applications on leaves of *Nicotiana* on nornicotine anabasine, metanicotine, oxynicotine and nicotinic acid content. *Tobacco, U.S.* 1960, 151-7, pp. 19-22.

Several species of *Nicotiana* including varieties of *N.Tabacum* were sprayed with aqueous gibberellic acid solutions, or kept in these solutions, to test the influence of this compound on the content of anabasine, nornicotine, metanicotine, oxynicotine and nicotinic acid. The amounts of the four alkaloids and of nicotinic acid. The amounts of the four alkaloids and of nicotinic acid in treated leaves were lower than in the controls. It is postulated that gibberellic acid inhibits the synthesis of alkaloids in *Nicotiana* by inhibiting the formation of nicotinic acid, known to be a precursor of nicotine.... Author's summary.

Coresta Information Bulletin, No. 4, 1960, abst. No. 4244.

ELLIOT, J. M.; VICKERY, L. S.: The effect of some physical variables on the rate of burn of ground tobacco. *Tobacco, U.S.* 1960, 151-14, p. 19-23.

A method is described for the determination of the rate of burn of cigarettes made from ground tobacco. The rate of burn decreased with increased cigarette moisture content and was a linear function of moisture within the range of 6.9 and 15.5 per cent (7%—500 sec.; 15%—630 sec.). Cigarette weight was affected by particle size and moisture of the tobacco and by the amplitude of vibrations during filling. ....Authors' summary.

Coresta Information Bulletin, No. 4, 1960, abst. No. 4169.

SEMINAR

Some important flue-cured varieties — An appraisal of their relative performance

The seminar group of the Central Tobacco Research Institute, Rajahmundry met on 31st December 1960. Dr. D. M. Gopinath gave a talk on the above subject.

The speaker informed that data obtained from 1959-60 trials were only comprehensive for a comparative assessment as in the previous years either all the varieties were not common in the treatments or in the main and sub-plots were not identical. The varieties whose performance for 1959-60 was reviewed were (1) Delcrest, (2) Hicks, (3) Dixie Bright 224, (4) Virginia Gold, (5) Dixie Bright 101, (6) Chatham, (7) Harrison Special, (8) Bissettes Special, (9) Putcha, (10) Bottom Special, (11) 402, (12) Selection 232, (13) White Gold, and (14) S. A. 53-27. Each of the varieties was assessed for total green weight yield, total bright grade leaf and Total Bright Leaf Equivalent under both topped and untopped conditions.

Presenting the consolidated data on the above and also on the leaf-burn score, the speaker said that the overall performance of Hicks was superior in regard to the characters studied during the year. He also presented a preliminary study on the discriminatory analysis of the above varieties in which data on percentage Bright grade, percentage T.B.L.E., Unit weight in gms. of 10 discs, Leaf burn in seconds, percentage of curable leaves upto and including third pick, total number of curable leaves, moisture percentage and medium grade percentage were collected for 6 plants per variety per replication at random. These data indicated that Hicks was again a better performer than the other varieties.

The speaker then said that by using the D^2 statistic of Mahalnobis *et al.*, the fourteen varieties could be clustered under four groups and their distance as measured for the characters Bright grade %, unit weight, leaf burn, % of cured leaves upto 3rd pick, could be fixed. Speaking on the implication of this study which so far as the varietal trial was concerned was still in a preliminary stage, he said that in breeding programmes this type of study was a considerable value in determining the programme of hybridization based on varietal differences.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Utilization of the services of retired scientists in the field of Agriculture, Animal Husbandry and allied sciences

The existing rules regarding superannuation sometimes put an abrupt end of the research work of an active scientist or, at any rate, make the continuation of such work extremely difficult as a result of which the talent of a good number of scientists who are physically fit and mentally alert is wasted after retirement for lack of opportunities to pursue work in their fields of specialization. In order that the experience and talent of such scientists as have finished with their active professional career is not wasted, the Indian Council of Agricultural Research has initiated a scheme for the utilization of the services of retired scientists in the field of agriculture, animal husbandry and allied sciences.

2. Under the scheme retired/retiring scientists of established reputation who are still active in research will be enabled to continue their researches with suitable financial assistance from the Indian Council of Agricultural Research. The retired or retiring scientist should try to secure a sponsoring Institution (which may be one from which he has retired or a different one) which would provide him necessary facilities for continuing his work e.g. access to the laboratory and library, accommodation for work etc. The choice of the Institution at which the retired scientist would continue his researches will be left to the scientist himself but such Institution should be one acceptable to the Council. The retired or retiring scientist (within a year of his retirement) will submit to the Council an outline scheme of research which he intends to undertake after retirement. In doing so, he will clearly give an account of the research work done by him during the five years preceding the date of his retirement or application whichever is later.

3. An annual allowance not exceeding Rs. 6,000 will be provided to the retired scientist himself, if asked for by him, and a grant ordinarily not exceeding Rs. 4,000 for expenses as may be decided by the Council. The amount of the grant may be increased in exceptional cases where the investigations involve field work necessitating undertaking of tours or where costly equipment/apparatus have to be purchased.

4. The allowances and grants to the scientists under the scheme will be provided, in the first instance, for a period of three years only. As usual, annual progress reports shall be submitted to the Council by the Scientist. Where the retired scientist would like the grant to be renewed, he will have to submit a year in advance of the termination of the first sanction, an application to that effect indicating the progress made under the scheme and the programme proposed to be followed during subsequent years. The allowances and grants to the retired scientists will be payable on a monthly basis through the Institution to which the retired scientist is attached.

All applications for grant under the scheme during the year 1961-62 should be submitted to the Council in the prescribed proforma which can be obtained, free of cost, from the Additional Secretary, Indian Council of Agricultural Research, Krishi Bhavan, Dr. Rajendra Prasad Road, New Delhi. *Last date for receipt of applications is* 15*th July*, 1961.

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