https://doi.org/10.29321/MAJ.10.A04942


# Madras Agricultural Journal

(ORGAN OF THE M. A. S. UNION)

Vol. XXI] FEBRUARY 1933 [No. 2


CONTENTS



## THE RELATION OF SIZE & SHAPE OF PLANT TO THE YIELD OF COTTON


By S. N. VENKATRAMAN, B.A., B.Sc. (Ag.) & C. JAGANATHA RAO, B.A.,

*Assistants to the Cotton Specialist.*


The relation of branching habit to economic characters in Cotton has been the subject of study by many workers. Prominent among characters investigated in this connection are earliness (Leake 1914), shedding (Cook 1911, Harland 1917) and yield per plant (Burt 1919, Cook 1911, Patel 1921 and Kottur 1920). Besides such economic relationships, the genetic behaviour has also been studied. The habit of the plant and the production of basal monopodia have been found more or less, heritable in a number of American and Indian types as the Cawnpores (Leake 1914), Kumptas (Kottur 1920) Gujerats (Patel 1921), Cawnpore-Americans (Burt 1919) and Americans. There is however evidence from other sources to show that considerable environmental modification occurs (Hudson 1920) which can even have large economic significances (Cook 1911). Of particular interest in plant breeding is the evolution of special types associated with good yields. Many workers (Cook, Leake, Kottur loc. cit.) prefer a purely sympodial habit in the plants as more of these could be grown per acre to give higher yields. It should however be mentioned that part of the above behaviour is dependent on the variety of cotton examined. The results of such a study on a type of *G. indicum*, which, along with a variable mixture of *G. herbaceum*, forms the commercial "Northerns" crop of this Presidency is presented in this paper.

**Material and Methods.** The plants examined comprised the progeny of forty six single plant cultures grown in the Nandyal Agricultural Research station during the year 1931—32. Altogether 5970 single plants spaced three feet by two feet, were examined. Of these 3,880 plants were attacked by the shoot borer (*Earias sp.*) but these were also included to investigate the part played by this insect in the yield of the plant. To ensure uniformity in all strains, border plants were excluded for a distance of ten feet at the ends. The characters taken up for study were as follows :—

(1) Height of plant.
(2) Number of nodes per plant.
and (3) Number of bearing monopodia per plant.

Very small or poorly developed monopodia were not included in the counts. On the basis of these three characters, which essentially determine the plant configuration for this species of Cotton, the relation of yield (kapas per plant) were investigated. For purposes of comparison, similar data on a species of *G. herbaceum* forming the *Uppam* Cotton of the Presidency and grown in the Coimbatore Cotton Breeding Station during the years 1925—27 are also included in places.

**The correlation of yield to other characters.** Taking into consideration each of the forty six cultures separately, the coefficient of correlation of yield with height nodes and monopodia were determind. The frequencies of these correlation coefficients are given in Fig. I. for bored and normal plants respectively.

An examination of figure I shows that the correlations are generally higher in the normal plants than in the bored ones. This difference was found significant in all cases. (Student's method. Fisher 1932). The values of these mean correlation coefficients are given in Table I.

TABLE I. **Correlation of yield of the plant with other characters within the same strain :—**

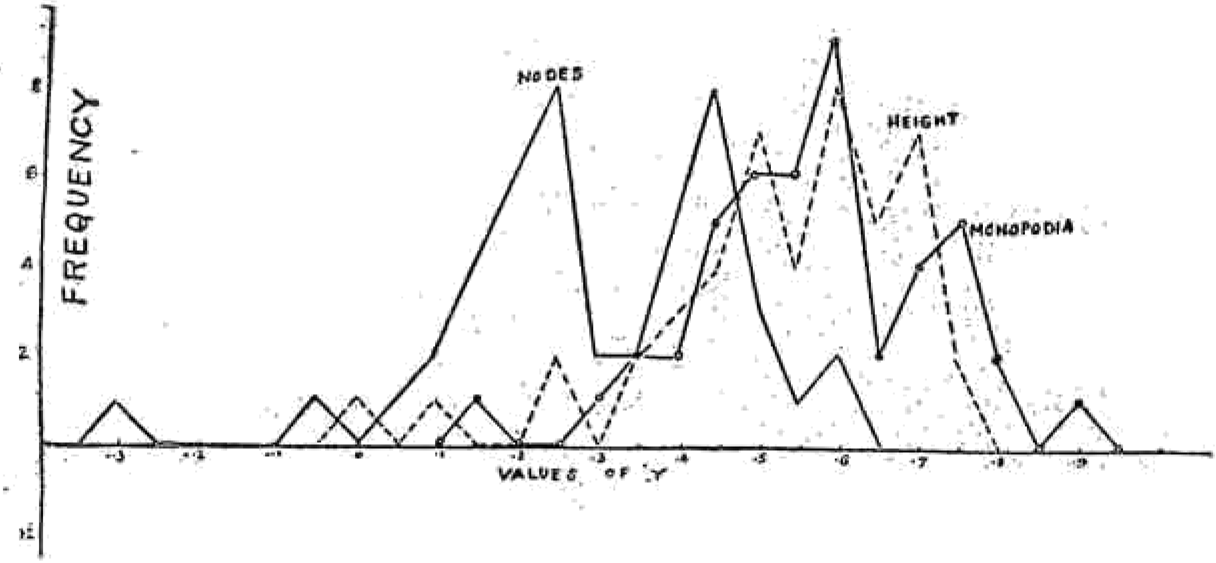
(Mean value of '*r*' (forty-six strains)

| Relative. | Subject, (1) yield of plant. (Kapas weight) In bored plants. | In normal plants. |
|---|---|---|
| 2. Number of monopodia. | 0·483 ± 0·013 | 0·571 ± 0·015 |
| 3. Height of plant. | 0·251 ± 0·012 | 0·532 ± 0·016 |
| 4. Number of nodes. | 0·129 ± 0·014 | 0·301 ± 0·016 |

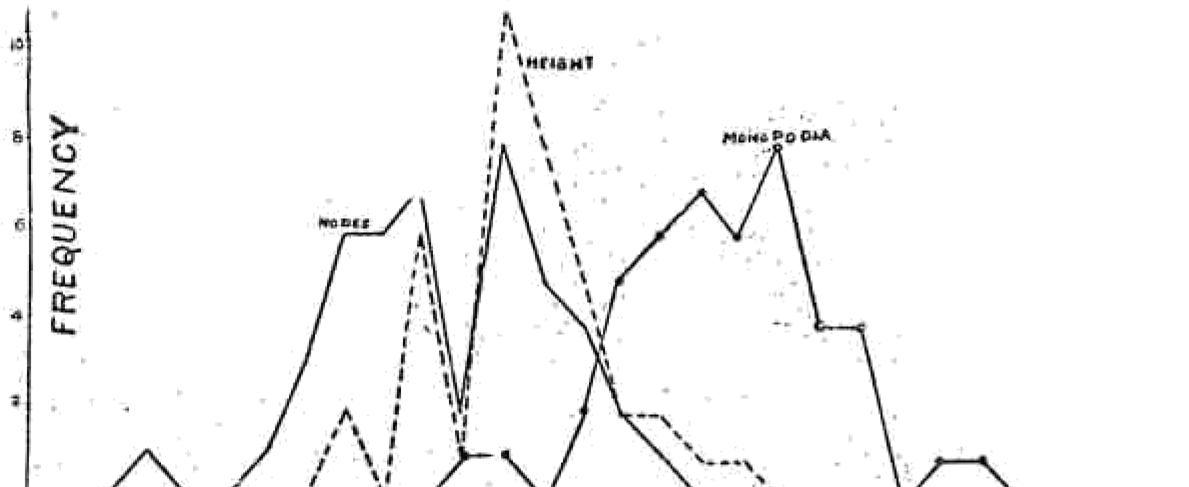
Fig. I.

FREQUENCIES OF CORRELATIONS OF YIELD WITH OTHER CHARACTERS

**Normal Plants.**




**Bored Plants.**



It will be seen that the coefficients are all significant. An examination of Figure I shows that in normal plants the monopodia ($r = \cdot 571 \pm \cdot 015$) and height of plant ($r = 0 \cdot 532 \pm \cdot 016$) are markedly related to the yield, while the relation of number of nodes although significant is variable. In bored plants however, the relation of monopodia ($r = \cdot 483 \pm \cdot 013$) is much greater than that of height of plant ($r = 0 \cdot 251 \pm \cdot 012$) while the effect of number of nodes is again small. These relations refer to variations from plant to plant within the same strain as determined by environmental influences, but what is of more interest in genetic studies is the behaviour from strain to strain i. e., the part played by the different characters in determining the yield from one selection to another.

**Relation of characters from strain to strain.** For the above purpose, the mean values of the forty six selections for the different characters were correlated with the corresponding mean yield. The resulting coefficients are given below.

TABLE II. **Correlation coefficients of yield of strain with other characters**

| | Subject. Yield of strain (1) | | Partial correlation Coefficients. | |
|---|---|---|---|---|
| | Bored. | Normal. | Bored. | Normal. |
| 2. Number of monopodia. | 0·598±0·064 | 0·648±0·058 | $r$ 12·3=0·532±·071 | 0·637± .059. |
| 3. Height of strain. | 0·324±0·088 | 0·175±0·096 | $r$ 13·2=·034±·100 | 0·081± .099. |
| 4. Number of nodes. | 0·220±0·095 | 0·075±0·100 | | |

It will be seen that the number of monopodia is the only character on which the correlations can be held significant. The partial coefficients indicate that the height of strain is of little importance. It would appear therefore that selection for yield on a height basis will not be lasting in the succeeding generations, but selection of monopodial types will be of more permanent value. To investigate these relationships more fully, it will be necessary to know how changes in yield are associated with changes in the other characters.

**Regression on characters of the yield of the plant**: In finding this relation of yield to other characters, all the 5970 plants were grouped together into two categories as bored and not bored, and the regressions of yield determined on each character. The curves representing these relationships are given in Figures II, III and IV.

An examination of Figure II will show that in the case of monopodia, the regressions are rectilinear and similar for bored and normal plants. This shows a more or less, proportionate increase in yield with increase of monopodia.

*Figure II.* As regards height, the relation is rectilinear for normal plants and very nearly so for a considerable height in bored ones.

*Figure III.* In the case of number of nodes the relationship is definitely more complex than in the two other characters, and very dissimilar in bored and normal plants.

*Figure IV.* Judged by the pronounced curvilinear regression of the character, and taking into account, the small values of its correlation coefficients, the number of nodes does not appear to be a factor on the basis of which selection for yield will be profitable. Greater significance attaches to the relation of height of plant and monopodia, where the relationship is rectilinear. Of these two characters, the influence of height has been shown to be purely environmental. As the effect of monopodia is both environmental as well as genetic, it is obvious that it deserves greater attention in the choice of high yielders.

**The effect of the borer (*Earias sp.*) on the yield of the plant**:— A point of interest in these studies is the part played by the borer in the yield of the plant. The attack of the borer in the present case is so high as 65%. Considering the pronounced modifications it introduces in the plant scaffolding the effect requires fuller study. An examination of the yield of bored and normal plants in the forty-six selections shows that the attacked plants have given a significantly higher yield than the others. Table III (a).

TABLE III (a). **Mean difference between bored and normal plants.**

| Variety. | Character. | Difference Bored—Not bored. | S. E. of difference |
|---|---|---|---|
| *G. indicum.* | Yield (ounces per plant.) | 0·2204. | ·0144 oz. |
| Northerns. | Number of monopodia per plant. | 0·609. | 0·079. |
| | Rate of increase of yield per monopodium | 0·025. | 0·008 oz. |

An examination of Table III shows that the increased yield is brought about in two ways. Firstly, there is an increased production of monopodia. Secondly, there is an increased productivity per monopodium. (Figure II). The rate at which yield increases with increase of monopodia is greater in the bored plants (Fisher. Page 123).

An examination of the standard errors given in Table III (a) shows that the differences are significant in both of these cases.

It should be mentioned that the increased yield due to borer attack is opposed to the findings from other species of Cotton as *G. hirsutum* (Cambodia—Ramanathan 1931) or *G. herbaceum* (Uppam). Table III (b) below.

Fig. II.

REGRESSION OF YIELD ON MONOPODIA

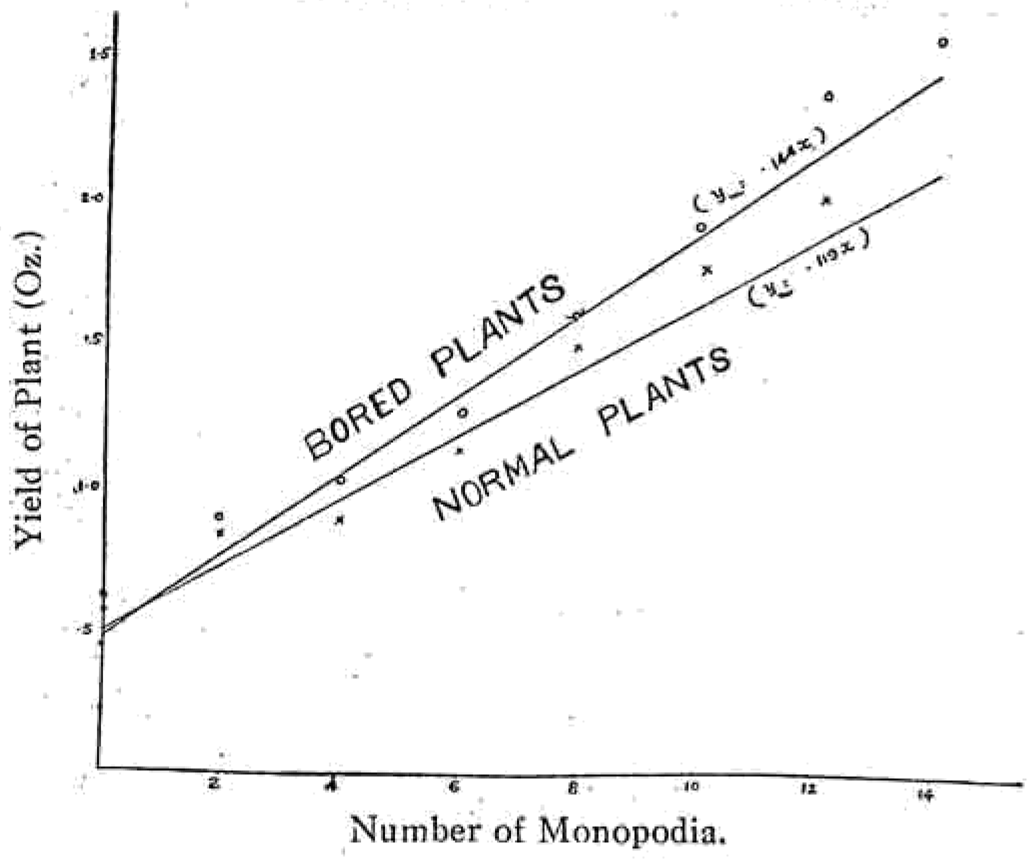



Fig. III.

REGRESSION OF YIELD ON HEIGHT OF PLANT

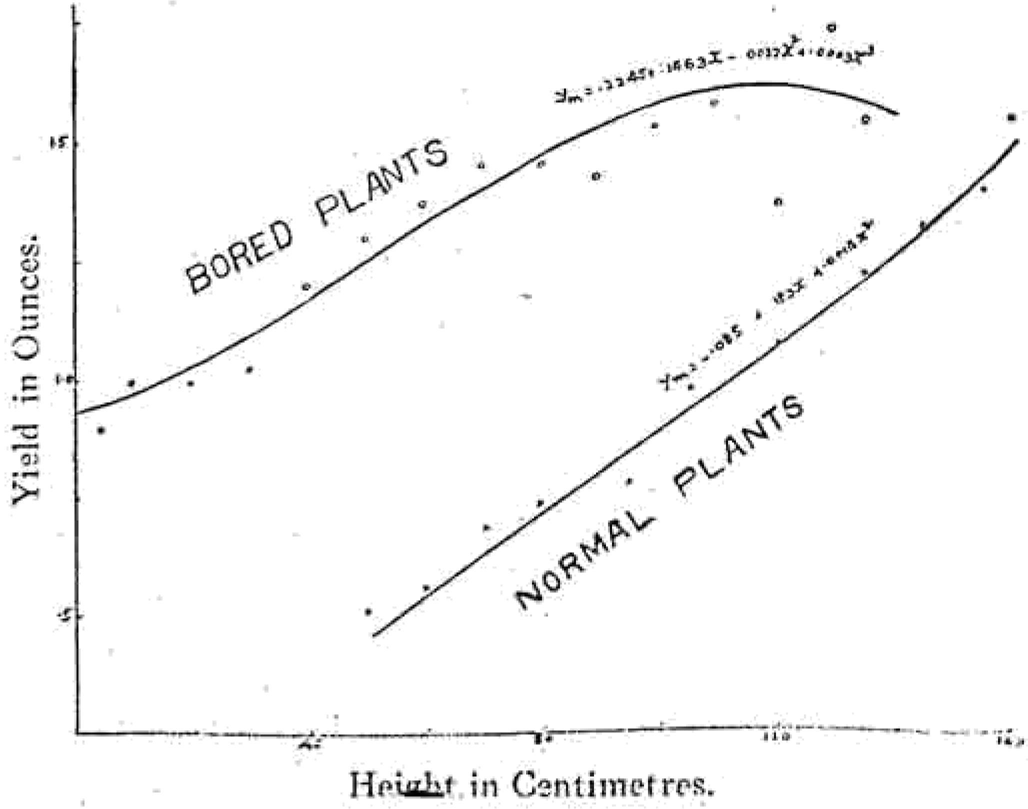


Fig. IV.

REGRESSION OF YIELD ON NUMBER OF NODES

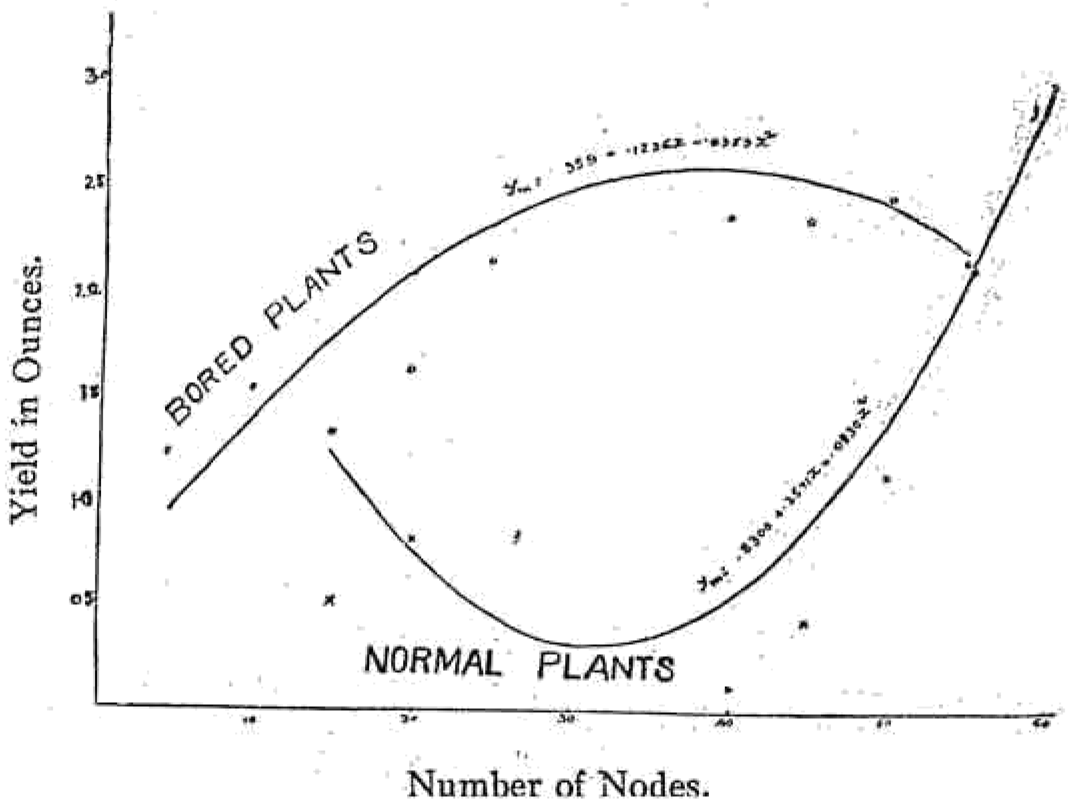



Fig. V.

REGRESSION OF MONOPODIA ON HEIGHT

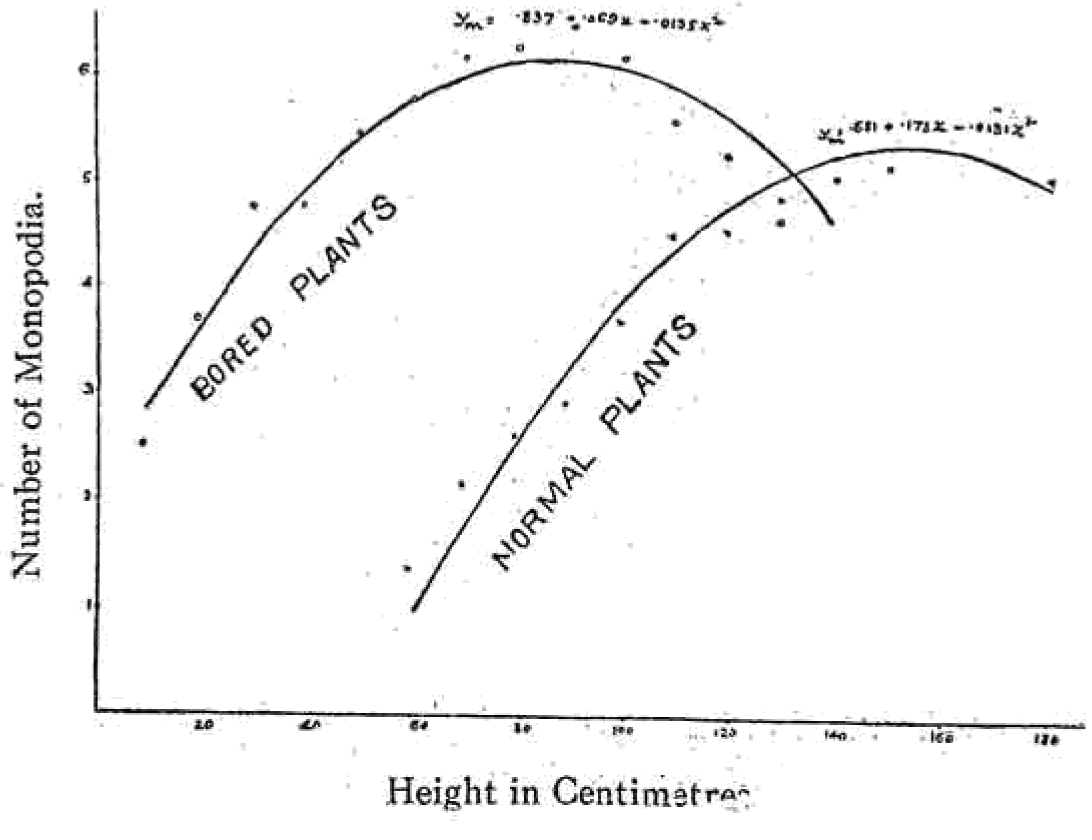


TABLE III (b). **Mean difference in yield between bored and normal plants in G. herbaceum (Uppam).**

| Strain No. | Year. | Number of bolls per plant. | | Difference in favour of normal plants. |
|---|---|---|---|---|
| | | Mean of bored plants. | Mean of normal plants. | |
| 54 | 1924—25 | 50·76 | 55·20 | 4·44 |
| | 1925—26 | 32·22 | 50·13 | 17·91 |
| | 1926—27 | 19·42 | 33·14 | 13·72 |
| 615 | 1924—25 | 33·51 | 37·57 | 4·06 |
| | 1925—26 | 36·19 | 48·09 | 11·90 |
| | 1926—27 | 25·11 | 27·05 | 1·94 |
| 1885 | 1924—25 | 31·75 | 32·70 | 0·95 |
| | 1925—26 | 25·76 | 33·62 | 7·85 |
| | 1926—27 | 30·25 | 27·75 | 2·50 |
| 2405 | 1924—25 | 30·07 | 27·12 | 2·95 |
| | 1925—26 | 42·24 | 48·76 | 6·52 |
| | 1926—27 | 28·14 | 28·47 | ·33 |
| 146 | 1924—25 | 29·07 | 27·62 | 1·45 |
| | 1925—26 | 33·89 | 44·38 | 10·49 |
| | 1926—27 | 25·57 | 30·42 | 4·85 |
| 480 | 1924—25 | 17·38 | 24·66 | 7·28 |
| | 1925—26 | 34·04 | 41·43 | 7·39 |

It is probable that the difference in behaviour between the 'Northerns' Cotton and the other two is due to the very high monopodial nature of the former type. Whereas in Cambodia the first sympodial node occurs within a range of five to ten nodes, and in 'Uppam' within seven to twelve, the range in Nandyal Cottons varies so high as thirteen to twenty-two. As such there is a greater chance for more monopodia to develop from the attack.

This effect of the borer appears also to be decided by the time at which the attack occurs. For instance, a well defined relationship is indicated between the growth stage of the plant at boring and the response in yield. An examination of Figure II shows that the higher on the plant the attack the greater is the yield, and to a large extent the production of monopodia (Figure V.)

*Figure V.* Although the above relationship of height and monopodia persists even from one strain to another, ($r.23 = 0{\cdot}501 \pm 0.074$) it is not the case between height and yield ($r.13 = 0{\cdot}324 \pm {\cdot}038$ $r.13.2 = .034 \pm .100$). The conclusion is probable from this that the quicker growing plants in a strain are likely to benefit more by attack, while this is not necessarily true of more quickly growing strains in a group of selections. In other words, the yield relationship is more or less environmental. A practical application of this will be that forcing the growth, by manuring for instance, and topping the plants will induce higher yields in this type. Experiments are now being undertaken to test this point.

**Discussion.** It will be interesting to compare the above results with the findings of other workers. In Goghari Cotton (*G. herbaceum*) Patel (1921, 1924) prefers a tall strain with open habit and large number of vegetative branches, but in another variety of the same species (Kumptas) Kottur finds the reverse to be the case (8). The relation of monopodia to yield is not so pronounced in other species of cotton as for Northerns. In American cottons (U. S. A. Dept. Bull. 169) positive correlations between these characters ranging from 0·029 to 0·435 were got, while it was concluded that the isolation of a strain producing few basal limbs would not influence its productiveness. Burt (1919) prefers a compact type with a limited number of monopodia in Cawnpore-American cottons. In the Uppam cotton plant (*G. herbaceum*) the relation of yield and basal limbs is small ($r = 0.290 \pm .019$) although significant. It should however be recalled that some of these are sympodial types where the change from basal limbs to fruiting branches occurs early and is usually abrupt. In "Northerns" cotton however the production of monopodia is more continuous and the differences in behaviour can be attributed, as before, to this monopodial habit.

A problem of very common interest amongst cotton workers is the isolation of branching types adaptable to high acre yields. Although individually less productive, a sympodial type of plant is preferred in many species as the greater number of plants per acre more than make up for this deficiency. (Cook, Leake, Kottur loc cit). This type is early (Cook 1911) and has been found to produce bigger bolls in Kumpta cotton. (Kottur 1920). On the other hand it has been shown that in the species of Northerns cotton investigated, environmental and genetic conditions which favour the production of monopodia are also conducive to good yields. This is also true of Gujarat cotton (Patel 1921, 1924). As however the height of the strain by itself has no particular significance to the yield, it does not seem desirable to bestow too much attention to the selection of taller types. The indications are towards selection of medium sized compact types with moderate production of monopodia, as these will have the advantage of more plants per acre preferred by other workers. Observations have shown that the differential tendency of types to produce monopodia persists also in bulk plants, although it is not so pronounced as in the wider spaced single plants examined for this study. Selection on the basis of monopodia is therefore justifiable in "Northerns" (*G. indicum*) cotton.

**Summary.** The relation of height, nodes and number of monopodia to the yield of cotton was investigated in 6000 plants, being the

progeny of forty six selections of Northerns cotton. (*G. indiceum*) grown at Nandyal.

It was found that in plants of the same strain, the number of monopodia and height of plant were markedly correlated with yield. The genetic relation from strain to strain was however different. While taller types were not necessarily good yielders, strains with more monopodia were more productive. The number of nodes was not of much significance towards yield either from plant to plant of the same strain or from one strain to another.

The correlation of yield to other characters was significantly more in normal plants than in those attacked by the shoot borer (*Earias sp.*) A study of the regression of the plant yield on these characters showed that the relation of monopodia and to a large extent of height was rectilinear. This shows a proportionate increase of yield with increase in these characters. The regression on nodes was more complex.

From an examination of yield from bored and normal plants in all the strains, it was found that the attacked plants gave a significantly higher yield. This increase of yield was associated with an increase in the number of monopodia per plant, as well as an increased rate of productivity per monopodium. It was also observed that the higher on the main stem the attack, the greater the yield. This was not however the case from one strain to another.

From a comparison of other strains, as Cambodia and particularly Uppam (*G. herbaceum*) where the effect of the borer was just the reverse, it was shown that the difference in behaviour could be attributed to the more monopodial habit of this type.

The relation of yield to monopodia was much higher in this Cotton than in more sympodial types as Americans or Uppams' Selection for high yielders on the basis of monopodia is justifiable in 'Northerns' Cotton.

**Acknowledgments.** To M.R.Ry. K. Gopalakrishna Raju Garu, Deputy Director of Agriculture, Bellary, we are indebted for facilities. The work on Uppam cotton included was done while the first of the authors was an Assistant in the Madras Herbaceum scheme financed by the Indian Central Cotton Committee.

**Literature cited.**

1. BURT B. C.  Cawnpore American Cottons. *Pusa Bulletin* 88 (1919)
2. COOK O. F.  Abortion of fruiting branches. *U. S. Dept. Circular* 118 (1911).
3. ——  A new system of Cotton culture. „ Circular 115 (1911)
4. Correlation of characters in Cotton. *U. S. A. Dept. Bull.* 169.
5. FISHER R. A.  Statistical methods for research workers (1932)

6. HARLAND S. C. Manurial experiments with Sea Island Cotton. *West Ind. Bull.* Vol. XVI (1917).
7. HUDSON, *Arkansas Expt. St. Bull* 168 (1920).
8. KOTTUR. Kumpta Cotton and its improvement. *Mem. Dept. Agri. India* X, 6 (1920)
9. LEAKE H. M. Studies in Indian Cottons. *Mem. Dept. Agriculture India* Vol VI. No 4 (1914)
10. Hybridisation in Indian Cottons. *Journ. Asiatic Soc. Bengal* Vol. IV (1910)
11. PATEL M. L. Studies in Gujerat Cottons I. *Mem. Dept. Agriculture India* Vol XI No. 4 (1921).
12. ........... do do Vol XII No. 5 (1924)
13. RAMANATHAN V. Report of Subordinate officers of the Madras Agr. Dept. 1931—32. P. 101.


# A NOTE ON CLOVE CULTIVATION IN SOUTH INDIA

(*From The Director of Agriculture, Madras.*)

**Botanical Origin and Distribution**: The clove is known botanically as *Eugenia caryophyllata* and belongs to the family *Myrtaceae* to which the Myrtle, Eucalyptus, Rose apple and other well-known plants also belong. It is a small conical tree 30—40 feet tall and it is a very slow grower. It is said to continue prolific up to 75 years in favourable localities.

The clove is said to be indigenous to five small islands in the Moluccas, but it has spread through the agency of man to many parts of the tropical world and it grows particularly well in the islands of Zanzibar and Pemba which produce the greater part of world's supply. The clove is also grown in the Tinnevelly District and on the southern slopes of the Nilgiris of the Madras Presidency on a small scale, where it thrives up to 2,500' elevation.

**Cultivation**: The clove prefers a somewhat sandy soil and a well distributed annual rainfall of not less than 60". The seeds should be collected for sowing as soon as mature, i.e. when the seed covering becomes soft and purple in colour. They should be sown as soon as collected in nursery beds made up of any good garden soil to which a quantity of sand and leaf mould has been added. Select a site away from the roots of trees and dig the ground to a depth of one foot or more. The width of the beds should not exceed 4 feet, the length being determined by the number of seeds sown. The seed beds should be covered with a pandal to keep off the sun's rays, and the soil kept moist, but not waterlogged. Germination will take place in about six weeks, when more light should be given, otherwise the seedlings will become weak and leggy. The seedlings should be transplanted to planting baskets or established in balls of soil and moss when about 6" tall and grown on for planting out in their permanent quarters the