Summary and Conclusion: NAR was maximum with July 15, as time of sowing and among the factors of climate medium rainfall and maximum hours of sunlight were noteworthy. TMV 2 had a higher NAR than TMV 1. 'Late' sowing reduced flower production and flowering duration. The parallel between NAR and mature pod weight with the associated feature of lowest production of immature pods per plant formed a significant aspect. July 15, was the suitable time of sowing for both TMV 1 and TMV 2.

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https://doi.org/10.29321/MAJ.10.A03743

A Preliminary Study on the Relation Between Soil Nutrients and Yield of Irrigated Cambodia Cotton

by

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Introduction: Efforts to evolve a quantitative relationship between the final yield and growth factors were made from time to time by soil investigators. In Mitscherlich's equation log (A – Y) = log A – C (b + x) where A = maximum yield, Y = yield obtained when 'b' units of the nutrient are originally present in soil and 'x' units of it are added as fertilizers while 'C' is the efficiency factor of 'b' and 'x' the soil growth factor 'b' was not analysed, but was calculated in terms of 'x' Spillman's modified equation $Y = A\,(1 — 10^{—Cx})$ also falls in the same line of conception. Balmukand (1928)

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Received on 25—10—1966.

showed that the 'A' values changed by the condition of other factors and he put forward his Resistance formula $1/Y = F'(N) + F''(P) + F'''(K) + \ldots\ldots C$, when F', F'', F''' etc. are inversely proportional to the nutrients available. Later Bray (1958) taking into account of original soil forms and added fertilizers, modified the original equation into $\log (A-Y) = \log A - C_1 b - Cx$ where C_1 and C are the efficiency factors of the soil form b and added fertilizer 'x' respectively. On further expanding this equation Balba and Bray (1956) have calculated the efficiency of the nutrient form in each layer of the rootzone. Application of Mitscherlich's equation have also been tried by various other workers to evolve the optimum manuring schedule of different crops (Bray, 1958; Crowther *et al.* 1941; Panse, 1945) and also to calculate plant composition due to manurial increments (Balba *et al.* 1956; Vavra *ei at.*, 1959).

Cotton in India responds well to the application of 'N' though the effect of 'P' and 'K' have been reported only in some tracts (Dastur, 1959; Sreedharan, 1952). The response curve due to 'N' is quadratic rather than hyperbolic. The yield of cotton *kapas* mostly decreases after a maximum dose of 'N' and follows quadratic function (Cardozier, 1957; Christidis *et al.* 1958; Dastur, 1959). Mitscherlich's equation can give cent per cent yield at infinite manuring and does not take into account the fall in yield after the maximum dose. Hence attempts have been made to introduce terms in Mitscherlich's equation to suit the requirements. Quadratic equations of the type $Y = a + bx + Cx^2$ have also been set up to predict the yield (Karunakar Shetti, 1961).

Material and Methods: The data obtained from the "Manurial Requirments of Cotton Experiment" were employed for studying the response of soil and added forms of nutrients with yield. The experiment was carried out on summer irrigated cambodia cotton in a 3^4 factorial design with the following four factors each in three levels.

Factors	*Levels in Kg per hectare*		
	1	2	3
1. Organic matter (O)	0	10,000	20,000
2. Nitrogen (N)	0	50	100
3. Phosphorus (P_2O_5)	0	30	60
4. Potash (K_2O)	0	30	60

All these four factors were applied as one full basal dose at the time of sowing. Soil samples were taken just before the application of manure from each plot and analysed for available N, P and K and are expressed in pound per half acre foot soil. The methods of analysis followed were as in Jackson (1962).

For studying the application of Mitscherlich's equation, soil available 'N' and yield were grouped under different other nutrients applied. Each group was further sub-grouped under their three levels of application. Thus three groups in each were made under (i) organic matter, 0, 10,000 and 20,000 kg per hectare, (ii) P_2O_5, 0, 30 and 60 kg per hectare, (iii) K_2O, 0, 30 and 60 kg per hectare.

The average yield and soil and available N for each group were arranged to find 'C_1' values using the equation $\log (A-Y) = \log A - C_1 b$. The yield factor was always taken as percentage over maximum yield obtained. Thus A = 100 and Y = the percentage yield obtained when no nitrogen was applied; and b = soil available N in lb per half acre foot soil. Using the values of 'C_1,' 'b' and 'x,' and applying Bray's modified equation $\log (A-Y) = \log A - C_1 b - Cx$; the values of C were calculated. Since the above modified equation of Bray could not satisfactorily explain the decrease of yield due to higher dose of N above the maximum level, a further correction factor $C_2 (x - x_m)$ was added to the above equation. Here x = the added from of N fertilizer when it exceeds the maximum dose x_m and C_2 is the regression coefficient which will negative the yield response when N is applied over and above the maximum dose. In the equation $\log (A-Y) = \log A - C_1 b - Cx + C_2 (x - x_m)$, other factors being known, the values of 'C_2' were calculated using the above modified equation. The expected yields were calculated for comparison with the yields obtained.

Results: The average yields of seed cotton are given in table 1.

TABLE 1 *Mean yields of seed cotton (kg/ha).*

	O_0	O_1	O_2	N_0	N_1	N_2	P_0	P_1	P_2	Mean
K_0	1417	1522	1465	1313	1443	1647	1438	1492	1474	1468
K_1	1540	1550	1485	1467	1638	1470	1429	1537	1608	1525
K_2	1389	1464	1511	1314	1591	1458	1443	1386	1535	1455
Mean	1449	1512	1587	1365	1557	1525	1437	1472	1539	1483

SE = 44 CD (P = 0·05) = 126

0 = First level of application.

1 = Second level of application.

2 = Third level of application.

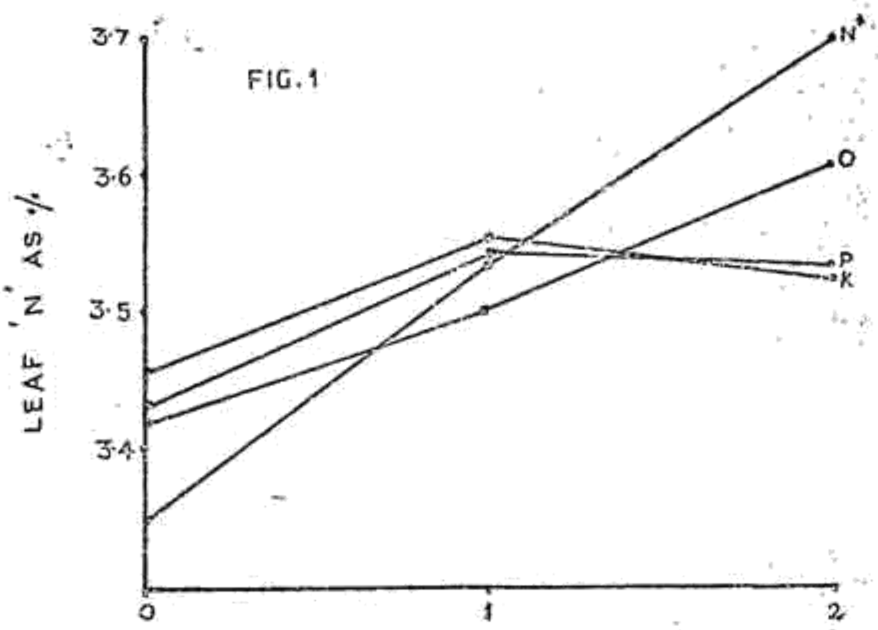
The composition of the cotton leaf at first flower stage as influenced by the application of O, N, P and K are given in Fig. 1, 2 and 3. The data in table 1. shows an yield response for N application but not for O or P or K. Further N application has produced a significant composition response in the standard third leaf. The lack of significant response for both yield and composition in leaves due to the application of P or K would indicate that they were not deficient in the soil under study. But the correlation studies between available nutrients in the soil and the final yield would indicate that there are significant relations among each other. Hence the yields were grouped under the three factors O, P and K and sub-grouped for each level of every factor. Since 50 kg N per hectare was arbitrarily proved to be the maximum level for cotton; x_m was fixed as 50 kg N per hectare for calculating 'C_2'. The data are presented in table 2.

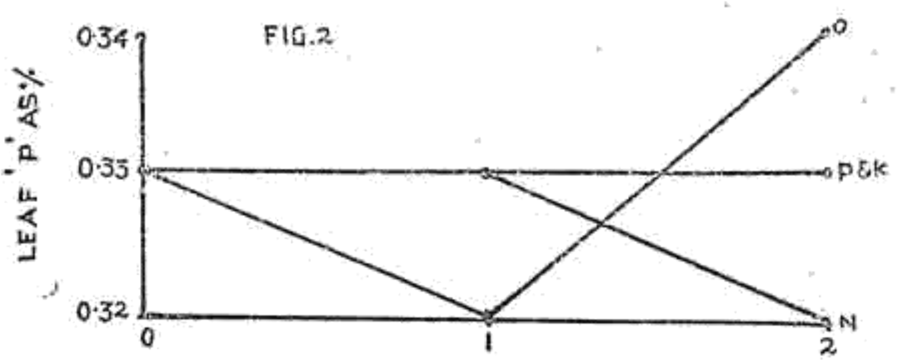
TABLE 2.

Factors	Levels	C	C_1	C_2	Soil average N in lb per half acre foot soil
O	0 kg/ha	0·0091	0·0070	0·0157	100
	10,000 kg/ha	0·0126	0·0077	0·0126	100
	20,000 kg/ha	0·0144	0·0070	0·0197	100
P_2O_5	0 kg/ha	0·0037	0·0050	0·0037	100
	30 kg/ha	0·0093	0·0069	0·0044	100
	60 kg/ha	0·0264	0·0068	0·0486	100
K_2O	0 kg/ha	0·0037	0·0070	0·0126	100
	30 kg/ha	0·0163	0·0087	0·0309	100
	60 kg/ha	0·0140	0·0070	0·0242	100

The yield values calculated using C, C_1 and C_2 were compared with the obtained values. There was a better agreement between the calculated and obtained yields. Totally 213 pairs of data were obtained and the calculated and obtained values varied only within the limits of error, 'F' value being 1·42 for 212 error degrees of freedom.

The average values of the calculated yields and the yields obtained are furnished in table 3.





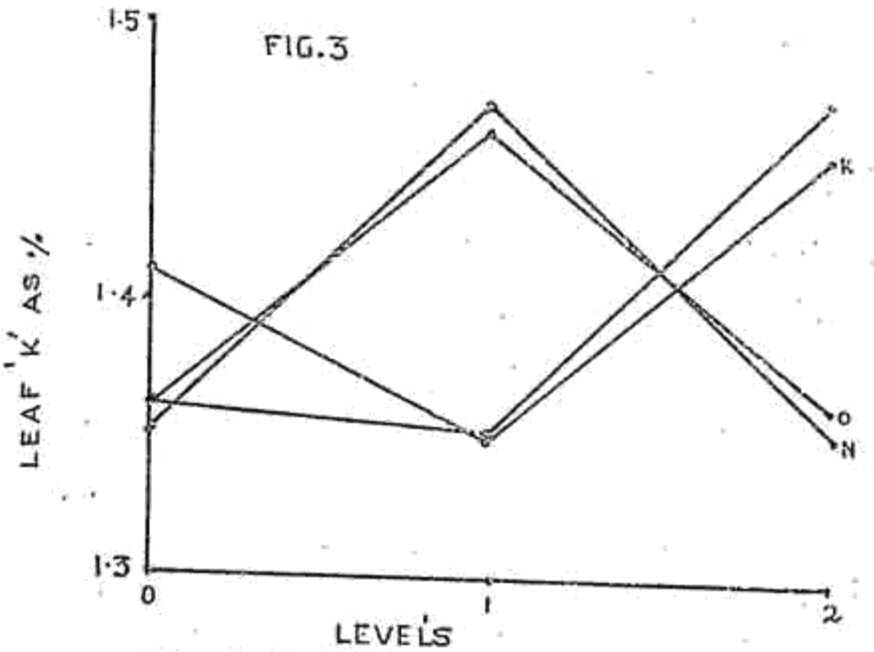


FIG. 1, 2, &3 COMPOSITION OF COTTON LEAF AT FIRST FLOWER STAGE FOR THREE LEVELS OF O, N, P, AND K, APPLIED
* SIGNIFICANT (P=0·05) CD=0·13

TABLE 3. *Average yield values expressed as percentage.*

S. No.	Treatment	0 kg N/ha level		50 kg N/ha level		100 kg N/ha level	
		cal.	obtained	cal.	obtained	cal.	obtained
1.	O_0	80	80	93	96	88	85
2.	O_1	83	83	96	96	96	96
3.	O_2	79	80	96	96	93	93
4.	P_0	82	80	89	87	95	93
5.	P_1	81	76	93	93	95	94
6.	P_2	80	89	93	100	88	87
7.	K_0	79	80	87	87	98	98
8.	K_1	86	87	98	98	88	89
9.	K_2	80	80	96	96	89	87

To assess the quadratic trend of the yield with application of N, curves were drawn with percentage yield along the Y axis and total available N along the X axis. The quadratic curves obtained were distinct when the study was made under three levels of applied potash viz., K_0, K_1 and K_2. The prediction equations set up are given below :

At K_0 level, $Y = 0{\cdot}9356\, x - 0{\cdot}002266\, x^2 - 22{\cdot}0$;

at K_1 level, $Y = 2{\cdot}223\, x - 0{\cdot}006428\, x^2 - 107{\cdot}4$; and

at K_2 level, $Y = 1{\cdot}5878\, x - 0{\cdot}004791\, x^2 - 54{\cdot}7$.

The yields predicted with these equations fell very near to the obtained yields. The goodness of fit was tested and they were significant (at $P = 0{\cdot}01$).

Since quadratic equations proved to be the best fit, (1) the maximum yield obtainable, (2) the nitrogen requirement for maximum yield, (3) the optimum economic dose and (4) the yield at optimum dose were calculated using the following equations :

1. Maximum yield $= a - \dfrac{b^2}{4C}$

2. N required for maximum yield $= \dfrac{-b}{2C}$

3. Optimum economic dose $= \dfrac{\frac{q}{P} - b}{2C}$

Where q = unit price of N and

P = unit price of yield.

The results are presented in table 4.

TABLE 4. *Yield expressed as percentage over maximum yield.*

Level	Maximum yield obtainable	N to be added for maximum yield	Optimum economic dose	Yield at optimum economic dose
K_0	74·4	106·5	49	67·2
K_1	83·2	72·5	53	81·1
K_2	76·8	65·7	39	73·4

Discussion: When Bray's modified equation $\log (A-Y) = \log A - C_1 b - Cx$ was applied to correlate soil N tests with yield, the predicted yield value and the obtained value varied to a larger degree that prediction with the above equation proved to be of no practical value. To increase the precision, the trend of yield due to N was studied. In cotton crop, there are two main phases of growth, the vegetative phase and reproductive phase. When the vegetative phase is prolonged by the increased application of N, the reproductive phase is delayed and since the season is lapsed, production decreases. Thus N over and above the maximum dose, functions as a negative factor in bringing up the yield. Hence the above equation which explains the hyperbolic trend of the yield against the growth factor, introduction of another term to represent the yield decrease above maximum dose was felt necessary. Thus the equation was written as:

$$\log (A-Y) = \log A - C_1 b - Cx + C_2 (x - x_m).$$

Since experimental evidences showed that above 50 kg. N per hectare the yield decreased, and on the assumption that C_2 comes into operation after this maximum dose is applied and also from the significant quadratic component of yield against N application 50 kg. N per hactare was arbitrarily fixed as the maximum dose.

The efficiency factors for different forms of growth factors inherent in soil and added form depend upon the sufficiency or deficiency factors for any particular growth factor is a constant, only when other factors are kept at sufficiency level. The efficiency factor for soil N is thus found to be dependent on levels of organic matter, P add K. At 10,000 kg. of organic matter per hectare the soil N is efficiently utilised while at 20,000 kg. per hectare the efficiency is decreased, probably more of soil N is used up for microbial decomposition of added compost. At P_1 and P_2 levels, the soil N is more efficiently utilised than at no P treatment.

Nitrogen efficiency is the greatest in K_1 level and is lower at K_0 and K_2 levels. Thus increasing K dose after K_1 level, decreases the efficiency of utilisation of N by cotton. This is also shown by the maximum yield obtained at N_1 K_1 treatment while at K_2 level, the yield decreases considerably even with the application of N. The efficiency factor for applied N increases steadily with the increase of any of the other nutrients applied except at K_2 level where it is slightly decreased.

The quadratic curves obtained with yield against total available soil N proved to be the best fit when compared with other types. These curves justify the inclusion of new term into Bray's modified equation. The effect of potash application over nitrogen was marked as the soil N yield curves were distinct when plotted under the three levels of potash viz., K_0, K_1 and K_2. The curves obtaided in all the three cases were of the same type in explaining the yield due to the variations in soil N (i. e.) $Y = bx - Cx^2 - a$. The influence of potash application on the effect of N on yield is shown in table 4. At K_1 level 83 per cent of the practical maximum yield is obtained. But at K_0 and K_2 levels the maximum yield obtainable is only 74·4 per cent and 76·8 per cent respectively. At K_1 level the maximum yield is also obtained at a lower N level than at K_0 level. Further upto 53 kg N per hectare can be applied economically for 81 per cent yield, while at K_0 level only 67·2 per cent of the maximum yield can be obtained at the optimum dose. Therefore, at K_0, the response curve is more flattened and at K_1 the response is more and sharp. Again at K_2 level, the response curve is flattened and the response to N is sluggish. Therefore, the application of more than K_1 level of potash is not to be recommended as it decreases the response of cotton to N manuring.

Consistent with the sharp response for N at K_1 level the efficiency factor 'C', for N calculated is also high at K_1 level compared to K_0 and K_2 levels. Therefore, potash beyond optimum limits are not favourable. The flattened response curve is explained by low efficiency factor of applied N at K_0 level and up to 100 kg N added, the response is shown though it is not remunerative. The low utilisation of N at K_0 and P_0 plots are also reflected in comparatively lower leaf N content at first flower stage. This clearly indicates the usefulness of the application of P and K for the efficient use of added N.

Summary and Conclusion: Application of N fertilizer has significantly increased the leaf N concentration and the yield, whereas application of organic matter or P or K has not significantly influenced the yield of cotton.

The response of cotton to N fertilizer is quadratic and the application of Mitscherlich's equation suits well only when a third factor 'C_2' is introduced into the equation to denote decrease in yield after the maximum level. The differences between the obtained yields and predicted yields from the modified equation varied only in a narrow range and were not statistically significant.

The effect of N on yield was also studied by fitting second degree polynomial curves under different potash levels. The results of such analysis indicated that the efficiency of N is maximum at K_1 level than at K_0 and K_2 levels.

The effect of N on the yield of cotton was thus studied both by fitting Mitscherlich's equation and quadratic type of equations. Both the approaches stress the usefulness and need for optimum amounts of P and K for the effective use of N.

Acknowledgement: The authors wish to record their sincere thanks to the Cotton Agronomist, Sri R. Sambandam and former Cotton Agronomist Sri K. Kannaiyan under whose directions the studies were made and to Dr. John Durairaj, Professor of Soil Science and Sri V. Ranganathan Assistant Soil Chemist for their useful suggestions in the preparation of this article. Thanks are also due to Indian Central Cotton Committee for partially financing the scheme.

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The Study of Seed Dormancy and Viability in Rice

by

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Introduction : It is common knowledge that in rice, the short duration varieties readily germinate after harvest, while medium and long duration varieties possess varying periods of after ripening. This trait though advantageous to raise the second crop with the early varieties, cause severe damage, in those regions where the monsoon season synchronise with the time of harvest, by sprouting in the field itself. A period of dormancy, for a month or even 15 days in short duration varieties would help greatly to

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Received on 28—2—1967.