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Effects of Environments on Characters in Cotton.

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Introduction.—The great problem before the cotton growing nations of the world is how to meet world's shortage of cotton. The great portion of the cotton is supplied by the United States of America which produces 10 to 16 millions of bales annually. India standing second in rank produces 5 to 6 million bales. This position is of utmost importance to India, as cotton, next to food grains is the important crop with which the welfare of India is most intimately connected. Hence, it is the duty of the plant-breeder to increase the out put of cotton in all desirable ways but increased production has certain limitations. In a country like India where cultivation of crops has been going on from time immemorial the pressure of every increasing population has left very little margin for any new land to be profitably brought under cultivation. The possibilities of cotton extension have, therefore, reached the limit, except in few places where irrigation facilities are being extended. The only other way of having increased production is to follow the intensive method of cultivation viz., better tillage, judicious manuring, production of high yielding types by selection and proper rotation. Even if one may fulfil the above conditions yet the chances of his getting an ideal crop are dependent upon environment which is nothing but the actions of natural forces and agencies. If these are favourable a rich harvest is recorded while adverse actions of any one of them or some of them may nullify one's efforts.

Such adverse conditions are very common in black soil areas of the Ceded Districts where the crop is mainly rainfed. The yield thus depends upon the season. Cotton does best in most parts of the black cotton soil tracts if the rainfall even though below the average is well distributed. Under these conditions the growth in early stages is very rapid, the size of a mature plant is well above the normal and bolls mature early. Further there is little disease and boll shedding is insignificant. Heavy rainfall on the other hand is very harmful to the crop, growth is slow, the plants are stunted. the yield is low and the bolls burst late. In suce seasons various pests take a heavy toll. Thus the grower in the black soil area is at the mercy of the rainfall and yield is a matter of chance. Instances are innumerable where in spite of average or even more than average raintall the yields have been far below normal.

The reasons for such low yields are obvious. Environments are mainly responsible. These factors not only cause low yields in cotton but also affect their economic characters, and cause variations even in genetically pure material. It thus becomes preeminently incumbent on the plantbreeder to eliminate if possible or correctly to assess the influences that are brought about by physiological and enviromental disturbances before he is in a position to analyse the fluctuations engendered by the differences in genetic constitution. But the interaction of various environmental factors is so intimate that it is difficult to ascribe the fluctuations to any one cause. Of course it is a well known fact that all characters of a plant whether structural or functional are necessarily variable, but these variations are very much accelerated by the change in environments.

The environment as already said is mainly the action of natural forces and agencies, each affecting the physiology of the cotton plant either individually or collectively. Most important of these are (1) Rainfall, (2) Temperature (3) Humidity and wind velocity, (4) Soil variations and (4) Insect and fungoid diseases. It is beyond the scope of this short paper to explain the actions of each of these natural forces or to state how they affect individual characters in cotton, but an attempt is made here to illustrate their collective effect on important characters in cotton.

Yield is the most important of all characters and the type of cotton best suited for a tract is greatly determined by the yield. The part which directly yields cotton is the boll and cotton plants vary very widely as regards the number of bolls and these variations though intrinsic are greatly controlled by external influences. Individuals enjoying a slight advantage of plant food, moisture or space by virtue of their position bear a greater number of bolls than their neighbours less favourably located and this is one of the reasons why strains sometimes cause disappointment in yield when grown on plot scale. These can be avoided by maintaining bolling records in both single plants and also in the bulk. The following results that were noted for the pure strain H. 62 are interesting.

	1926–27	1927–28
Average No. of bolls in single plants ...	29·3	43·07.
Average No. of bolls in bulk ...	7·43	9·57.

The above differences in yields are mainly due to changes in environment between the two sets of plants. Similarly soil variations affect the yield and this is the main reason why varying yields are recorded in different fields of the same locality. For instance, the maximum yield of H. 62 at the Hagari Experimental Station was 520 lb. minimum yield was only 160 lbs.

Lint and seed weights are the next important characters affected by the environment. The variations are wide in both the cases though fluctuations in lint weight seem to be proportionately less than that in seed weight. With a view to study such wide variations in these characters the period of picking in M. 274 was divided into 5 parts and the pickings of each part were tested separately. 100 samples each containing 100 seeds of each part of the season were tested for lint and seed weights and the results are shown in the Table at the end. It is seen from the table that taking the results of each period separately we get smooth curves in each case but when the results of the whole season are taken together the curves become irregular. This clearly shows that development of seed and lint varies with the period of the season and irregular curves of lint and seed weights are thus mainly due to their irregular development. The reason for such irregularities is the immature bursting of bolls during the later part of the season due to early advent of summer and consequently high temperature; whereas early in the season the temperature is optimum for boll development and they take their own time for maturation. Actually the bolls take a greater number of days for maturation during the early part of the season and a less number of days in the later part of the season. The maturation periods for these were worked out separately in all the pure strains and there was a distinct difference of 4 days between the two periods. Even wide spacing of plants causes variations in these characters, for instance the averages of lint and seed weights of M. 274 in the bulk plot are 26 m. g. and 60 m. g. while those of single plant selections are 28 m. g. and 66 m.g. respectively. These clearly show the influences of environment on these characters.

The lint length however seems to be less affected than any of the above characters but it varies with the season and variation in soils. A good shower in the critical period i. e., within 4 weeks after the opening of the flower has disastrous effect and the season

1925–26 was a typical example of such bad effects. There was incessant rain during the blossom period and consequently the length of staple was reduced by 5 m.m. Untimely rains and their after—effects are responsible for such low lint lengths. Besides these the lint length is also effected by variation in soil and soil ingredients have much to do with this character. To find out the validity of this statement samples of kapas of M. 274 were obtained from different centres. 200 seeds were sampled out from the kapas of each centre, the seeds were combed and measurements were made The table below clearly shows the perceptible differences in averages between various centres thereby showing the influence of soil ingredients on the length of staple.

Localities.		Length of staples.
Hagari Experimental Station	...	24·51 m. m.
Godehal	...	23·84 m. m.
Hospet	...	23·54 m. m.
Adoni	...	24·84 m. m.
Tadpatri	...	24·69 m. m.

The above are the important characters that are influenced by environments but the loss sustained by the cotton grower by way of bud and boll sheddings is so great that the effective control of the same will undoubtedly double his present yields. To find out this percentage of sheddings in buds and bolls in the black soil tracts of Ceded Districts, regular plant descriptions were taken in H. 62 during 1926–27 and information on the following points was recorded daily:—(1) Bud production. (2) Flowering, and the interval between the appearance of a bud and opening of flower (3) Bursting of bolls including the time interval between opening of flowers and bursting of bolls (4) shedding of buds and bolls with periods of greatest liability to and cause of shedding. Final tabulations of figures showed that for 313·4 buds produced 94·2 flowers opened and 34·4 bolls were picked i. e., the effective bolling was only 11 per cent. and 89 per cent. of the buds produced either shed as buds or as bolls. The figures further reveal that sheddings were greater as buds than as bolls and there was

70 per cent. shedding in the former and only 19 per cent. in the latter. The reasons for such high percentage were mainly physiological as the damage due to boll-worms was too insignificant and the loss was even less than 1 per cent. These facts go to show the importance that one has to pay for knowing the causes of shedding and reduction of such high shedding even by a small percentage will materially help the ryots.

The above few examples have proved beyond doubt the influences of environment on characters in cotton and every breeder in cotton has to take special care of the influences of these environments before he attempts to isolate or introduce now strains. He has to study the physiological changes that take place in a cotton crop when a change occurs in environments and and it so happens that in certain peculiar seasons their influences are so great that it is very difficult to interpret the results correctly. One cannot even say that the influences were due to natural agencies. To avoid such an error one should be in a position correctly to assess the influences of these environments so that these may not vitiate the inherent qualities of new strains. These are possible only when the breeder is well equipped with necessary accessaries for such study. Hence it is suggested that all cotton breeding stations may be provided with necessary instruments for studying the effects of environments on cotton crops, so that the breeder may be in a position to interpret his results correctly.

TABLE I.

Mungari Periodical Pickings.

Table showing the variations in lint and seed weights between first and later pickings. M. 274.

Lint Weights.

Frequency arrays.

M. G.	First picking.	Second picking.	Third picking.	Fourth picking.	Fifth picking.	Total.
17	...	...	...	...	4	4
18	...	...	...	...	24	24
19	...	...	...	...	41	41
20	...	...	...	...	28	28
21	...	...	...	...	3	3
22	...	...	...	...	...	...
23	...	...	...	...	...	...
24	...	...	...	18	...	18
25	...	...	18	63	...	81
26	...	2	57	19	...	78
27	3	21	23	...	...	47
28	46	32	2	...	...	80
29	45	40	...	...	...	85
30	6	5	...	...	...	11
Total ..	100	100	100	100	100	500
Average ...	28·54	28·25	26·0	25·0	19·0,	25
Standard deviation ...	0·65	0·91	0·7	0·97	0·27	3·49
Probable ...	1·55	2·7	1·82	2·6	0·96	9·42
Co-efficient of variability.	2,29	3·22	2·69	3·8	1·42	13·96

(Continued from page 505)

SEED WEIGHTS.

Frequency arrays.

M. G.	First picking.	Second picking.	Third picking.	Fourth picking.	Fifth picking.	Total.
45	...	...	...	...	12	12
46	...	...	...	...	20	20
47	...	...	...	...	21	21
48	...	...	...	...	30	30
49	...	...	...	...	8	8
50	...	...	...	...	7	7
51	...	...	...	...	2	2
52	...	...	...	...	...	...
53	...	...	...	...	...	...
54	...	...	...	...	...	...
55	...	...	...	...	...	...
56	...	...	...	8	...	8
57	...	1	2	24	...	27
58	...	...	28	42	...	70
59	...	2	36	20	...	58
60	12	15	23	6	...	56
61	16	31	9	0	...	56
62	35	33	2	...	...	70
63	29	15	...	...	...	44
64	7	3	...	...	...	10
65	1	...	...	...	...	1
Total ...	100	100	100	100	100	500
Average ...	62·0	61·5	59·0	58·0	47·0	58
Standard deviation ...	1·1	1·6	1·06	1·0	1·5	5·5
Probable ...	1·2	1·2	1·21	1·16	2·15	6·4
Co-efficient of variability.	1·8	1·89	1·8	1·7	3·19	9·46