STATISTICAL NOTES FOR AGRICULTURAL WORKERS.

NO. 7.—THE EFFECT OF THE TIME OF APPLICATION OF FERTILIZERS ON THE YIELD AND THE RATE OF SHEDDING OF BUDS, FLOWER AND BOLLS IN THE COTTON PLANT IN SURAT.

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1. Mr. K. V. Joshi of the Cotton Research Laboratory, Surat, sent us last year for statistical analysis the results (given in Appendix I) of his experiments conducted in 1930-31 with fertilizers on a selected strain of the cotton plant.

Mr. Joshi stated that the cotton plant in Surat produces on an average about 300 buds of which about 225 are ordinarily shed as buds, so that only about 75 develop into flowers. Out of these 75 flowers no less than about 45 are again shed in a premature condition, so that only about 30 (out of 75 flowers or 300 buds) mature into open bolls and thus contribute to the final yield. The effect of fertilizers is often complex. It may give increased production of buds, but if the shedding of buds, or the shedding of flowers is also increased there may not be any gain in the final yield. On the other hand even if the production of buds remains the same but the shedding of buds or of flowers is appreciably decreased, the final yield may be considerably increased. Mr. Joshi enquired how these different factors may be disentangled, and whether it is possible to construct a generalized index which would give due weight to the different factors. In our opinion the best procedure in this case would be to study each stage separately, and also to study the over-all or total yield by itself.

If we neglect any possible effect which fertilizers may have on the variability of production*, we can use Fisher's method for the analysis of the results. A discussion of Mr. Joshi's data on these lines is given below. The details of the analysis will be found in Appendix II.

2. In the first experiment with dry manures, a control plot (with 20 plants) was maintained without any artificial fertilizers, another plot (also consisting of 20 plants) was treated with 40 lbs. of nitrogen per acre applied in the form of sulphate of ammonia in the month of July, a third plot (with 19 plants) was treated with the same quantity of the same manure in August.

*The effect on variability has been considered in greater detail in a seperate note (No. 6, this Journal 3, 131.

3. The mean yields of buds per plant under the different treatments are given in Table I.

Buds.

TABLE I.

Treatment.	Mean number of buds per plant	Difference in yield from		
		Control	July-manure	August-manure
Control	254·0	..	—126·2	—3·3
July-manure	380·2	+126·2	..	+122·9
August-manure	257·3	+3.3	—122 9	..

The z-test is positive indicating a significant difference in mean values. Standard error of difference in mean=32·96.

The July application gave a definitely larger yield of buds, while the August application is practically ineffective.

4. For flowers we have the following results.

Flowers.

TABLE II.

Treatment	Number of flowers per plant	Difference in yield from		
		Control	July-manure	August-manure
Control	99·3	..	—39·3	—19·4
July-manure	138·6	+39·3	..	+19·9
August-manure	118·7	+19·4	—19·9	..

The z-test is negative, and the standard error of difference in means=22·24. Differences in the number of flowers per plant are negligible.

5. Finally for bolls the results are given below.

Bolls.

TABLE III.

Treatment	No. of bolls per plant	Difference in yield from		
		Control	July-manure	August-manure
Control	31·6	..	—8·1	—3·1
July-manure	39·7	+8·1	..	+5·0
August-manure	31·7	+3·1	—5·0	..

The z-test is on the verge of significance. Standard error of difference in means=3·20.

The July-manure produces an appreciably larger number of bolls than the untreated plants, but August-manuring is ineffective.

6. The mean percentage of success of buds developing into flowers is given in Table IV.

Flowers : Buds.

TABLE IV.

	Mean proportion of flowers : buds	Difference from		
		Control	July-manure	August-manure
Control	39·0	..	+2·5	—7·1
July-manure	36·5	—2·5	..	—9·6
August-manure	46·1	+7·1	+9·6	..

The z-test is positive, and the standard error of difference in means=3·00.

The August-manure shows the largest percentage of flowers (that is the lowest rate of shedding of buds), the difference from the July-manured or untreated plots being statistically significant. The July-application, however, shows no advantage over the unmanured plants.

7. Mean percentage of success of flowers developing into bolls is given in Table V.

Bolls : Flowers.

TABLE V.

Treatment.	Mean proportion of bolls : flowers	Difference from		
		Control	July-manure	August-manure
Control	31·9	..	+3·3	+2·7
July-manure	28·6	—3·3	..	—0·6
August-manure	29·2	—2·7	+0·6	..

The z-test is negative, standard error of difference in means=1·55.

The application of nitrogen has no appreciable effect on the whole.

8. The mean percentage of success of buds growing into bolls is given in Table VI.

Bolls : Buds.

TABLE VI.

—	Mean proportion of bolls : buds	Difference from		
		Control	July-manure	August-manure
Control	12·4	..	+2·0	—1·1
July manure	10·4	—2·0	..	—3·1
August-manure	13·5	+1·1	+3·1	..

Standard error of difference in means=·93.

August-manuring has no effect, while July-manuring gives the worst results.

9. We may now summarize the effect of the time of application of fertilizer separately.

(*a*) *July-manuring.*

Manuring in July definitely stimulates the production of a larger number of buds per plant which is about 30 per cent. higher than that of the untreated plants. During the flowering and bolling stage, the rate of loss is slightly larger than that

of the control plot, so that ultimately the number of bolls per plant is only 26 per cent. higher than that of the untreated plants.

(*b*) *August-manuring.*

August-manuring does not lead to any appreciable increase in the number of either the buds, flowers or bolls. The rate of shedding during different stages too indicate no significant improvement over the control, except a slight stability of the buds during the flowering stage.

Summary.

Results of certain fertilizer experiments on the cotton plant conducted in 1930-31 by Mr. K. V. Joshi of the Cotton Research Laboratory, Surat, have been discussed in this paper. The effect of applying 40 lbs. of nitrogen in July to certain plants, and the same quantity of nitrogen in August to other plants has been studied in detail with reference to the following factors :- The production of (1) Buds, (2) Flowers, and (3) Bolls, and the percentage of (4) Buds developing into flowers, (5) Flowers developing into bolls, and (6) Buds developing into bolls. It was found that manuring in July gave a significant increase in the yield of buds and flowers, and although it showed an appreciably greater rate of shedding of buds, the increase in the final yield of bolls was also found to be significant.

Fuller details of the experiment will be published by Mr. Joshi himself in due course.

REFERENCE.

Mahalanobis, P. C. (1933). *Ind. J. Agric. Sci.* 3, 131.

Appendix I.

	Buds			Flowers			Bolls			Bud to flower			Flower to boll			Bud to boll		
	"A"	Control	"B"	"A"	Control	"B"	"A"	Control	"B"	"A"	Control	"B"	"A"	Control	"B"	"A"	Control	"B"
1	378	366	331	136	104	136	42	34	36	36·0	28·4	41·1	30·8	32·7	26·5	11·1	9·3	10·9
2	375	258	156	145	90	74	37	28	19	38·7	34·9	47·4	25·5	31·1	25·7	9·9	10·85	12·2
3	169	184	205	66	79	83	20	31	29	39·1	42·9	40·5	30·3	39·2	34·9	11·8	16·8	14·2
4	622	184	306	234	60	130	67	22	40	37·6	32·6	42·5	28·6	36·7	30·8	10·8	11·95	13·05
5	293	308	402	114	120	176	36	35	44	38·9	39·0	43·8	31·6	29·2	25·0	12·3	11·4	10·9
6	216	159	259	84	56	104	27	19	35	38·5	35·2	40·2	32·1	34·1	33·7	12·4	11·9	13·5
7	410	358	178	141	126	83	41	40	27	34·4	35·2	46·6	29·1	31·7	32·5	10·0	11·2	15·2
8	280	86	306	117	39	147	28	12	38	41·8	44·3	48·0	23·9	30·8	25·9	10·0	13·6	12·4
9	470	386	289	141	133	132	39	41	45	30·0	34·5	45·7	27·7	30·8	34·1	8·3	10·6	15·6
10	431	375	126	133	137	61	40	43	17	30·9	36·5	48·3	30·1	31·4	27·9	9·3	11·5	13·5
11	266	152	..	102	68	..	26	21	...	38·4	44·7	...	27·5	30·8	...	10·5	13·8	...
12	504	234	225	166	94	101	45	32	33	32·9	40·2	44·9	27·1	34·0	32·7	8·9	13·7	14·7
13	639	260	224	186	111	110	58	39	27	29·1	42·7	49·1	31·2	35·1	24·5	9·1	15·0	12·0
14	386	175	221	131	85	107	44	29	33	33·9	48·6	48·4	33·6	34·1	30·8	11·4	16·6	14·9
15	592	295	296	193	117	155	53	41	44	32·6	39·7	52·4	27·5	35·0	28·2	8·95	13·9	14·85
16	219	224	208	99	96	103	24	28	32	45·2	42·9	48·5	24·2	29·2	31·1	10·95	12·5	15·4
17	337	184	276	150	95	139	37	23	39	44·5	51·6	50·0	24·7	24·2	23·1	11·0	12·5	14·1
18	309	315	149	152	151	80	43	42	19	49·2	47·9	53·7	28·3	27·8	23·8	13·9	13·4	12·7
19	397	253	460	169	104	217	51	33	60	42·6	41·1	47·2	30·2	31·7	27·6	12·8	13·0	13·0
20	308	328	271	113	120	116	54	40	42	36·7	36·6	42·8	30·1	33·3	36·2	11·0	10·4	15·5

APPENDIX II.

Analysis of variance.

(*1*) *Buds.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	204,419	102,210	1·1207	·5138
Residual errors . . .	56	608,588	10,867		
Total .		813,007			

Standard error of difference in means=32·96.

(*2*) *Flowers.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	15,438	7,719·0	·2215	·5138
Residual errors . . .	56	276,950	4,945·5		
Total .		292,388			

Standard error of difference in means=22·24.

(*3*) *Bolls.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	684·69	342·35	·5718	·5738
Residual errors . . .	56	6,109·29	109·09		
Total .		6,793·98			

Standard error of difference in means=3·20.

(4) *Flowers : Buds.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	952·53	476·27	·8250	·5738
Residual errors . . .	56	5,032·55	91·46		
Total .		5,985·08			

Standard error of difference in means=3·00.

(5) *Bolls : Buds.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	108·21	54·11	·9179	·5738
Residual errors . . .	56	483·40	8·63		
Total .		591·61			

Standard error of difference in means=·93.

(6) *Bolls : Flowers.*

Variation due to	D. F.	Sum of squares	Mean square	z	5 per cent. z ($n_1=2$, $n_2=60$)
Manures	2	111·13	55·57	·4185	·5738
Residual errors . . .	56	1,347·86	24·06		
Total .		1,458·99			

Standard error of difference in means=1·55.