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The Effect of Soil Moisture on the Yields of Co. 1 and Co. 3 or Co. 19 *Sorghum* Strains at Coimbatore

by

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Synopsis : The week-wise soil moisture data at depths of 3", 6" and 12" collected from the week of sowing to the week of harvest of *cholam* (*Sorghum*) crop each year both in the open observatory and in the two cropped fields were compiled separately for 13 years from 1951—'52 to 1964—'65 (except 1963—'64) along with respective grain and straw yields and data were analysed to bring out the effects of conditions, yields, depths and their interactions in the various weeks of the crop's life and are discussed in this paper.

Introduction : Under the All India Co-ordinated Crop Weather Scheme, investigation of soil moisture in relation to growth and yield of Co. 1 and Co. 3 strains of dry *sorghum* was taken up from the year 1949—'50 at Coimbatore. From 1959—'60 Co. 19, a hybrid derivative of Co. 3 with similar plant characters, was substituted in the place of Co. 3. The soil moisture data collected for 13 years from 1951—'52 to 1964—'65 (with the exception of the year 1963—'64, when the crop was not raised due to non-receipt of sowing rains in July, 1963) are critically examined in this paper.

Review of Literature : Bond *et al* (1964) discovered that grain yields of *sorghum* on a clay loam increased with available moisture at seeding time and the efficiency of water use by both grain and straw increased with soil moisture content at this critical period. Krishna Rao (1945) investigated the relationship between rainfall and yield of *sorghum* at Hagari and inferred that the yield was dependent on the amount and distribution of rainfall from July to October and that it would be possible to forecast the yield in a given year even by the middle of November by the general growth of the crop. With reference to *cholam* in Andhra Pradesh Subba Reddy and Sankara Reddy (1964) drew the inferences that (i) excessive rain at the time of germination affected germination, (ii) yield depended upon the available soil moisture at the shooting or jointing stage; (iii) rainfall at flowering time affected the crop, though the soil moisture at this stage was essential for seed-setting; (iv) soil moisture should be high at the time of grain formation and development, i. e., during the last thirty days prior to harvest in the life period of the crop; and (v) rain at the time of harvest was bad for the crop.

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Prashar and Mukhtar Singh (1963) found that the rate of water use was about 0·8 mm per day up to 50 to 55 days after sowing and increased to about 4·0 mm per day during the heading and grain development stages of crop growth. Bennett *et al* (1964) inferred that both evapotranspiration and yields of *sorghum* increased with available soil moisture levels. Holt *et al* (1964) stressed the importance of stored moisture in the soil for better yields especially in the rainfall areas of 19 to 26 inches in the North Central Sub-humid States of the United States. Taylor *et al* (1964) had suggested the corn straw mulching and application of farmyard manure as practical methods to check soil and water losses particularly in corn-after-corn crop rotation. Jayaraman and Balasubramanian (1958) found that the roots of *Sorghum* did not penetrate below a depth of 12" irrespective of whether the soil was black clay or red loam, which made them conclude that moistening the top foot of the soil for an irrigated *Sorghum* crop was quite enough to get good crop yield.

Materials and Methods: The week-wise soil moisture data at depths of 3", 6" and 12" collected from the week of sowing to the week of harvest each year both in the open observatory and in the two cropped fields were compiled separately for 13 years from 1951—'52 to 1964—'65 (except for the year 1963—64) along with the respective grain and straw yields.

(i) The yield of grain and straw were analysed separately to bring out the effects of strains and years. (Table I).

(ii) Significant difference in grain yield between the strains indicated the necessity for comparing the moisture data separately for the cropped fields of Co. 1 and Co. 3 or Co. 19. The comparison of the years indicated that the grain and straw yields were highest in the year 1953—'54, near about normal in the years 1954—'55, 1955—'56 and 1956—'57 and very low in the years 1951—'52, 1952—'53, 1958—'59 and 1960—'61. This inference was suggestive of the basis of comparison of the soil moisture as between high, average and very low yield both in respect of grain and straw.

For these three groups of years, the original soil moisture data for 3", 6" and 12" depths were transformed to their angular sine values and the transformed data for each week from the second week after sowing to the week preceding the week of harvest were analysed separately to bring out the effects of conditions (open and the cropped fields of Co. 1 and Co. 3 or Co. 19), yields (high, average and very low), depths (3", 6" and 12") and their interactions in the various weeks of the crops' life. The related data are presented in Tables II to IV.

TABLE I.

Analysis of variance of grain and straw yields of Co. 1 and Co. 3 or Co. 19 sorghum strains.

	Grain				Straw				
Comparison of varity means:	Co. 1	Co. 3 or Co. 19	SED	CD					
	57·19	36·68	9·72	21·18					
Conclusion: Co. 3 or Co. 19, Co. 1									
Comparison of year means:					Comparison of year means:				
1951–'52 (1)	1952–'53 (2)	1953–'54 (3)	1954–'55 (4)	1955–'56 (5)	1956–'57 (6)	1957–'58 (7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
18·12	4·17	232·30	59·47	92·31	73·82	35·72	197·16	206·65	1399·77	396·99	385·70	478·58	672·45
1958–'59 (8)	1959–'60 (9)	1960–'61 (10)	1961–'62 (11)	1962–'63 (12)	1964–'65 (13)	SED CD	(8)	(9)	(10)	(11)	(12)	(13)	
13·49	138·31	2·72	118·65	44·25	101·85	24·79 54·02	158·69	703·63	51·07	715·30	618·15	905 10	
									SED	CD			
									88·25	192·30			
Conclusion: 3, 9, 11, 13, 5, 6, 4, 12, 7, 1, 8, 2 10							Conclusion: 3, 13, 11, 9, 7, 12, 6, 4, 5, 2, 1, 8, 10						

TABLE II.

Comparison of conditions (open and cropped fields)

S. No.	No. of week after sowing	Nature of significance	Mean soil moisture: open	Mean soil moisture: field Co. 1	Mean soil moisture: field Co. 3 or Co. 19	SED	CD	Conclusion	Remarks
			I	II	III				
1	2	†	20·5	18·7	18·1	0·8	1·6	I, II, III	—Not significant.
2	3	...	...	...	...	...	...	... ...	
3	4	†	19·1	16·6	17·2	0·8	1·6	I, II, III	*Significant at 5 per cent level.
4	5	*	20 6	17·8	17·6	1·1	2·2	I, II, III	†Significant at 1 per cent level.
5	6	†	20·1	17.0	17·4	0·9	1·8	I, III, II	*N. B.*: All the second and third series of numbers in the conclusion column are under bar.
6	7	†	19·3	16·0	15·7	1·2	2·4	I, II, III	
7	8	†	19·9	16·5	16·5	1·1	2·2	I, II, III	
8	9	†	19·9	16·5	17·1	0·9	1·8	I, III, II	
9	10	†	21 7	17·1	17·4	1·2	2·4	I, III, II	
10	11	†	21 8	17·4	17·6	1·3	2·6	I, III, II	
11	12	†	22 4	17·9	18·5	0·7	1·4	I, III, II	
12	13	†	22·5	19·1	19 0	1·1	2·2	I, II, III	
13	14	†	22·3	18·9	19·2	0·9	1·8	I, III, II	
14	15	†	21·2	18·5	18·2	1·0	2·0	I, II, III	
15	16	†	22·1	19·0	19·0	0·9	1·8	I, II, III	
16	17	†	22·6	18·8	19·3	0·9	1·8	I, III, II	
17	18	†	23·2	19·5	20·4	1·2	2·4	I, III, II	
18	19	†	22 2	18·7	18 6	1·0	2·0	I, II, III	
19	20	*	22·0	18·9	18 1	1·1	2·2	I, II, III	
20	21	*	20·4	17·8	17·8	1 0	2·0	I, II, III	

TABLE III

Comparison of Yields.

High Yield (A), Average Yield (B) and Very Low Yield (C).

S. No.	No. of weeks after sowing	Nature of significance	Mean			SED			CD			Conclusion	Remarks
			A	B	C	A *vs* B	A *vs* C	B *vs* C	A *vs* B	A *vs* C	B *vs* C		
1.	2	*	22·6	19·6	17·8	1·0	1·0	0·7	2·0	2·0	1·4	A, B; A, C; B, C.	Initial Seedling Stage
2.	3	*	22·6	19·7	17·8	1·7	1·6	1·1	3·4	3·2	2·2	A, B; A, C; B, C.	
3.	4	*	19·9	18·5	16·4	1·0	1·0	0·7	2·0	2·0	1·4	A, B; A, C; B, C.	
4.	5—11	¶	...	...	...	...	...	...	...	...	...		
5.	12	*	24·0	19·1	18·9	0·7	1·3	0·9	1·4	2·6	1·8	A, B; A, C; B, C.	Pre-flowering and flowering period.
6.	13	*	24·4	22·6	17·3	1·5	1·5	1·0	3·0	3·0	2·0	A, B; A, C; B, C.	
7.	14	*	21·8	21·9	18·4	1·2	1·2	0·8	2·4	2·4	1·6	B, A; A, C; B, C.	
8.	15	*	20·4	20·4	18·1	1·3	1·3	0·9	2·6	2·6	1·8	A, B; A, C; B, C.	
9.	16	*	18·4	23·4	18·8	1·1	1·0	0·8	2·2	2·0	1·6	B, A; C, A; B, C.	
10.	17	*	21·9	22·3	18·8	1·2	1·1	0·9	2·4	2·2	1·8	B, A; A, C; B, C.	Grain formation period.
11.	18	¶	...	...	...	...	...	...	...	...	...	...	
12.	19	¶	...	...	...	...	...	...	...	...	...	...	¶ Not significant.
13.	20	¶	...	...	...	...	...	...	...	...	...	...	* Significant at 1% level.
14.	21	¶	...	...	...	...	...	...	...	...	...	...	

TABLE IV.

Comparison of depths (3", 6" and 12")

S. No.	No. of weeks after sowing	Nature of significance	Mean			SED	CD	Conclusion	Remarks
			3"	6"	12"				
1.	2	‡	16·6	18·5	22·1	0·8	1·6	12, 6, 3	* Significant at 5% level.
2.	3	‡	16·6	18·5	22·1	1·3	2·6	12, 6, 3	
3.	4	‡	14·5	17·3	21·1	0·8	1·6	12, 6, 3	
4.	5	‡	16·1	18·6	21·4	1·1	2·2	12, 6, 3	‡ Significant at 1% level.
5.	6	‡	15·2	18·3	21·0	0·9	1·8	12, 6, 3	
6.	7	†	14·8	16·9	19 2	1·2	2·4	12, 6, 3	
7.	8	‡	15·1	17·3	20·5	1·1	2·2	12, 6, 3	
8.	9	‡	16·0	17·0	20·4	0·9	1·8	12, 6, 3	
9.	10	*	17·3	18·3	20·7	1·2	2·4	12, 6, 3	
10.	11	*	17·1	18·4	21·1	1·3	2·6	12, 6, 3	
11.	12	‡	17·8	19·0	22·0	0·7	1·4	12, 6, 3	
12.	13	‡	18·6	19·8	22·2	1·1	2·2	12, 6, 3	
13.	14	‡	17·7	20·1	22·6	0·9	1·8	12, 6, 3	
14.	15	‡	16·0	19·1	22·0	0·8	1·6	12, 6, 3	
15.	16	‡	18·5	19·4	22·1	0·9	1·8	12, 6, 3	
16.	17	‡	19·1	19·7	21·8	0·9	1·8	12, 6, 3	
17.	18	‡	19·1	19·5	20·4	1·2	2·4	12, 6, 3	
18.	19	‡	17·5	16.5	22·8	1·0	2·0	12, 6, 3	
19.	20	‡	17·4	19·2	22·5	1·1	2·2	12, 6, 3	
20.	21	‡	15·9	17·9	22·5	1·0	2·0	12, 6, 3	

Results and Discussion: (i) (a) Co. 3 or Co. 10 was significantly superior to Co. 1, only in respect of grain yield under Coimbatore conditions. There is no difference between these two strains in regard to straw yield.

(b) Sharp variations were noticeable in both grain and straw yields between years, brought about by the changeable natural environmental conditions of which probably the meteorological factors are the most important ones. It was also inferred that generally if the grain yield was high in a particular year, the straw yield also would be high in that year, thus indicating the significant positive grain-straw relationship in both these strains of *cholam*.

(ii) The conditions in open and cropped fields, revealed that except in the third week after germination, when usually thinning is done, in all other weeks from the second week of sowing right up to the week perior to the harvest, the open always recorded significantly a higher moisture status compared to cropped fields. But between the cropped fields themselves there was no significant difference. This indicated the constant uptake of water by the crops throughout their life periods.

(iii) The soil moisture data on the basis of high, average and very low yields disclosed three critical phases of significant variations in moisture levels, as follows:

(a) *Initial Seedling Period (Two to Four weeks after sowing):* The soil moisture based on yields indicated that at this stage of the crop in years of very low yields, the soil moisture was also low. But in the case of years of high and average yields, the soil moisture status was almost alike. This finding is in consonance with that of Bond *et al* (1964).

(b) *Pre-folowering and Flowering Periods (Twelve to sixteen weeks after sowing):* In the pre-flowering and initial stage of flowering periods (12 to 14 weeks after sowing) the soil moisture status in years of high and average yields was practically the same. But in the years of low yields it was definitely low. In the fifteenth and sixteenth weeks, when the flowering would be in peak stage, the utilisation of soil moisture by the crops appeared to be at its maximum as found by Prashar and Muktar Singh (1963).

(c) *Grain Formation Period (17th week after sowing):* There was no difference in the soil moisture status in the years of high and average yields. But it was definitely low in the years of very low yields. This inference is in line with that of Subba Reddy *et al* (8).

(iv) Both in the open observatory and in *cholam* fields the soil moisture was highest at 12" depth in a red sandy loamy soil at Coimbatore. This might be due to the nature of the soil to allow easy percolation of moisture to deeper depths. Next to it came the soil moisture at 6" depth. Generally the soil moisture at the surface depth of 3" was lowest.

(v) As regards the interactions due to conditions, yields and depths they were not significant, connoting thereby that the soil moisture behaved as an independent factor both in the observatory as well as in *cholam* fields.

Summary and Conclusion: (i) Under Coimbatore conditions in red sandy loamy soil Co. 3 or Co. 19 *cholam* strain generally records a higher grain yield than that of Co. 1. (ii) There is a definite grain-straw relationship in the case of both these strains of *cholam*. (iii) Both the strains of *cholam* have idential capacity to utilise the available soil moisture. Therefore, the higher grain yield in Co. 3 or Co. 19 is to be attributed to its genetic character. (iv) Wide variations in yield of both grain and straw from year to year is due to the variations in the environmental and meteorological conditions during the life periods of the crops. (v) The availability of soil moisture in adequate quantity during the initial seedling phase, pre-flowering and flowering phases and grain formation phase significantly increases both the grain and straw yields. (vi) The speedy utilisation of soil moisture especially during the peak flowering period is noteworthy in the red sandy loamy soil of Coimbatore.

In the event of failure of natural rain, particularly during the pre-flowering and early flowering periods, it is advisable, therefore, to give one irrigation to get the optimum yield. In case irrigation is not possible, at least the existing soil moisture may be conserved to the extent possible by either dust mulching or cheap trash mulching. This may be taken as a general recommendation to get high yields from the rain-fed *cholam* crops in and round about Coimbatore.

REFERENCES

Bennett O. L., B. D Doss, V. J. Kilomen and R. C. Richardson	1964	Effect of soil moisture regime on yield, nutrient content and evapotranspiration for three annual forago species—*Agron. J.* 56 (2) 195—198.
Bond J. J., T. J. Army and O. R. Lahman	1964	Row spacing, plant population and moisture supply as factors in dryland grain *sorghum* production— *Agron. J.* 56 (1) 3-6.
Holt R. F., D. R. Timmons, W. B. Voorhees and C. A. B. Doren	1964	Importance of stored soil moisture to the growth of corn in the dry to moist sub-humid climatic Zone. *Agron J.* 56 (1) 82-85.
Jayaraman M. V. and C. Balasubramanian	1958	Soil moisture and growth of *cholam* Co. 1. *Madras Agric. J.* 45 (12) 469-70
Krishnan Rao, P.	1945	Observations on the rainfall and yield of crops in the dry lands of the Hagari Research Station. *Madras Agric. J.* 33 (3): 221-226.
Prashar C. R. K. and Mukhtar Singh	1963	Relationship between the consumptive use of water and evaporation from weather data. *Indian J. Agric. Sci.* 33 (3): 147-154.
Taylor, R. E., O. E. Hays, C. E. Bay and R. M. Dixon	1964	Corn stover mulch for control of run off and erosion on land planted to corn after corn, *Soil Sci. Soc. Amer. Proc.* 28: 123-125.
Subba Reddy K. and G. H. Sankara Reddy	1964	Correlation of rainfall and yields of *sorghum* at Nandyal—*Andhra Agric. J. XI* (3): 101-106.