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Crop-weather relationships of sugarcane under different manurial treatments

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सार — अनाकापल्ले में प्रायोगिक आंकड़ों का प्रयोग करते हुए विभिन्न प्रकार की खादों के उपचार के अन्तर्गत, गन्ने की फसल की पैदावार पर मौसमी कारकों के विचरण की प्रतिक्रिया का अध्ययन किया गया है। यह पाया गया है कि गन्ने के लिए फसल–मौसम संबंधों को बदलने में पौष्टिक स्रोत की महत्वपूर्ण भूमिका नहीं होती। खाद रहित फसल और खाद वाली फसल में कुछ अन्तर विशेष रूप से तापमान के प्रति उसकी प्रतिक्रिया में ही पाया जाता है। खाद रहित एवं खाद वाली फसलों पर सूर्य के प्रकाश की अवधि का विशिष्ट रूप से एक समान प्रभाव होता है

ABSTRACT. Yield response of sugarcane crop to the variations in meteorological factors has been studied for different manurial treatments, using experimental data at Anakapalle. It is found that the source of nutrients does not play a significant role in modifying the crop-weather relationships of sugarcane. The manureless crop shows some differences from the manured crops, particularly in its response to temperature. Duration of sunshine shows remarkably similar influence on manured as well as unmanured crops.

1. Introduction

Sugarcane is a tropical plant whose growth and yield are sensitive to weather conditions. The minimum and maximum temperature limits are generally known to be around 10°C and 40°C respectively, with 30°C as the optimum. Tromp (1980) notes that the extension of the stem is most sensitive to temperature. Regions having a well-distributed annual rainfall of about 120 cm are suitable for the crop (Wilsie 1974). Within these broad limits, variations of the weather parameters do contribute to sugarcane yield variability.

Several studies have been made in India on the crop-weather relationships of sugarcane, giving comparative descriptions (Rao 1929; Raheja 1951; Khanna 1960; Mallik and Pimpalwadkar 1963; Godhara 1963) as well as various quantitative aspects using correlation analysis (Gangopadhyaya and Sarker 1963; Subbaramayya and Rupa Kumar 1980), curvilinear graphical technique (Gangopadhyaya and Sarker 1964; Sarker 1965) and polynomial response functions (Khanna and Sehgal 1957; Acharya *et al.* 1960; Rupa Kumar 1984). These studies generally indicate the favourable meteorological conditions for sugarcane as : temperatures around 31°C with moderate rainfall during germination, higher temperatures and clear weather during tillering, low temperatures around 26°C and, good rainfall during vegetative growth and still lower temperatures and dry weather during maturity.

For obtaining increased yields, application of different types of manures, depending on the farmer's access to them, has been the practice since quite a long time. Though the nutrient contents of the manures may be similar, the form of availability can be different and the plant's ability to draw on the nutrients plays an important role in the yield-forming processes. However, some studies (Davies and Viltos 1968; Babu 1979) suggest that there are no significant differences in the efficiencies of different sources of nitrogen. In view of the fact that the plant's physiological activities are largerly governed by the environmental conditions and thereby its nutrient intake capacity, the author intends to examine whether the source of nutrients can modify the effects of weather parameters on sugarcane crop, and also whether a manured crop differs from an unmanured crop in this respect.

2. Data and analysis

Crop-weather data on sugarcane have been obtained from the Regional Agricultural Research station at Anakapalle (17° 38′N,; 83°01′E). The yield data are from the experimental plots of the permanent manurial experiment, for 27 years from 1952-53 to 1978-79. The variety of the crop is CO-419 which is grown under five types of manurial treatment, namely, (A) Ammonium sulphate, (B) Groundnut Cake, (C) Farm Yard Manure, (D) Mixture of a A and B in 1:2 ratio on N basis and (E) No Manure. Under the treatments A, B and D, a manure equivalent of 112 Kg N/ha is supplied in two equal doses, the first half given 45 days after planting and the second half given 90 days after planting. In the case of treatment C, a manure equivalent of 112

TABLE 1

Average values of meteorological factors during sugarcane crop season at Anakapalle and multiple correlations of response functions

Dates	Max. Temp. (°C)	Min. Temp (°C)	Relative humidity (morning) (%)	Relative humidity (after-noon) (%)	Rainfall total (mm)	Sunshine† (hr/day)
Average values of met. factors						
16 Mar-15 Apr	35.1	22.6	85.7	48.1	16.3	9.1
16 Apr-15 May	36.1	25.3	82.9	55.6	54.3	9.0
16 May-15 Jun	37.2	26.4	80.0	55.3	83.7	6.9
16 Jun-15 Jul	33.5	25.2	84.0	64.5	147.5	4.2
16 Jul-15 Aug	32.6	24.7	86.9	67.7	156.1	4.1
16 Aug-15 Sep	32.8	24.5	88.1	68.1	179.5	4.9
16 Sep-15 Oct	32.3	23.8	91.0	70.4	229.3	6.2
16 Oct-15 Nov	30.8	21.3	86.2	62.1	156.5	7.8
16 Nov-15 Dec	29.4	17.8	83.3	52.4	36.5	7.7
16 Dec-15 Jan	29.1	15.9	83.9	46.0	6.0	8.8
16 Jan-15 Feb	30.5	16.7	86.5	47.5	10.6	9.3
Multiple correlation coefficients of response regression function						
Treatment A	0.40	0.60**	0.47	0.35	0.52	0.73
B	0.34	0.56*	0.51	0.39	0.55*	0.70
C	0.40	0.57*	0.47	0.41	0.43	0.68
D	0.32	0.56*	0.49	0.39	0.51	0.70
E	0.46	0.62**	0.56*	0.42	0.54*	0.56

†Values for sunshine are based on 14 years data : all the others are based on 27 years data.
*Significant at 10% level; **Significant at 5% level.

Kg N/ha is supplied in one instant, at the time of puddling the soil before planting. The crop is planted in the middle of March every year and will be in active growth for about 11 months. Cultural operations are maintained uniformly every year.

Daily meteorological data on maximum and minimum temperatures, relative humidity (morning, 0700 IST, as well as afternoon, 1400 IST), rainfall and duration of bright sunshine have been collected for the period 1952 to 1979, from the observatory situated inside the research station campus. Sunshine data, however, are available from 1965 only.

The method used in the present study, for obtaining the response in yield for a unit change in the meteorological factor from its average at any stage of crop growth, is same as that used by Runge and Odell (1958) who adopted it from Fisher (1924). For the purpose of this analysis, the crop season has been divided into 11 monthly periods and the mean values of each of the meteorological parameters have been calculated for each period every year. The basic principle in the analysis is to represent the distribution of the meteorological factors during the crop sesason by a polynomial of suitable degree and then to develop a function relating this polynomial to the yield. Further details of this method and the assumptions involved are described by Rupa Kumar (1984, 1986). A preliminary examination of the 27-year average values of the meteorological factors shows that a third degree polynomial would adequately describe their distribution during the crop season, accounting for 90% of the variation. Therefore, third degree polynomials have been used to obtain the response functions for the present study.

3. Results and discussion

The 27-year average values of different meteorological parameters for all the crop periods are presented in Table 1. The average values of sugarcane yields under the manurial treatments A, B, C, D and E are 95.19, 88.94, 83.38, 90.59 and 51.58 tonnes/ha respectively.

The multiple correlation coefficients of the regression equations developed for obtaining the response functions are also included in Table 1. It can be seen that the correlations in the case of minimum temperature, rainfall and morning relative humidity are quite high and some are statistically significant.

The response curves are presented in Fig. 1. They indicate the per cent change in the final yield brought about by a specified increase of the respective meteorological factor above its average, for each month of the crop season. Some interesting points observed from the response curves are noted below:

From an overall examination of the response curves in Fig. 1, it may be stated that the responses follow a similar pattern for the four manurial treatments without any sharp contrast between among themselves.

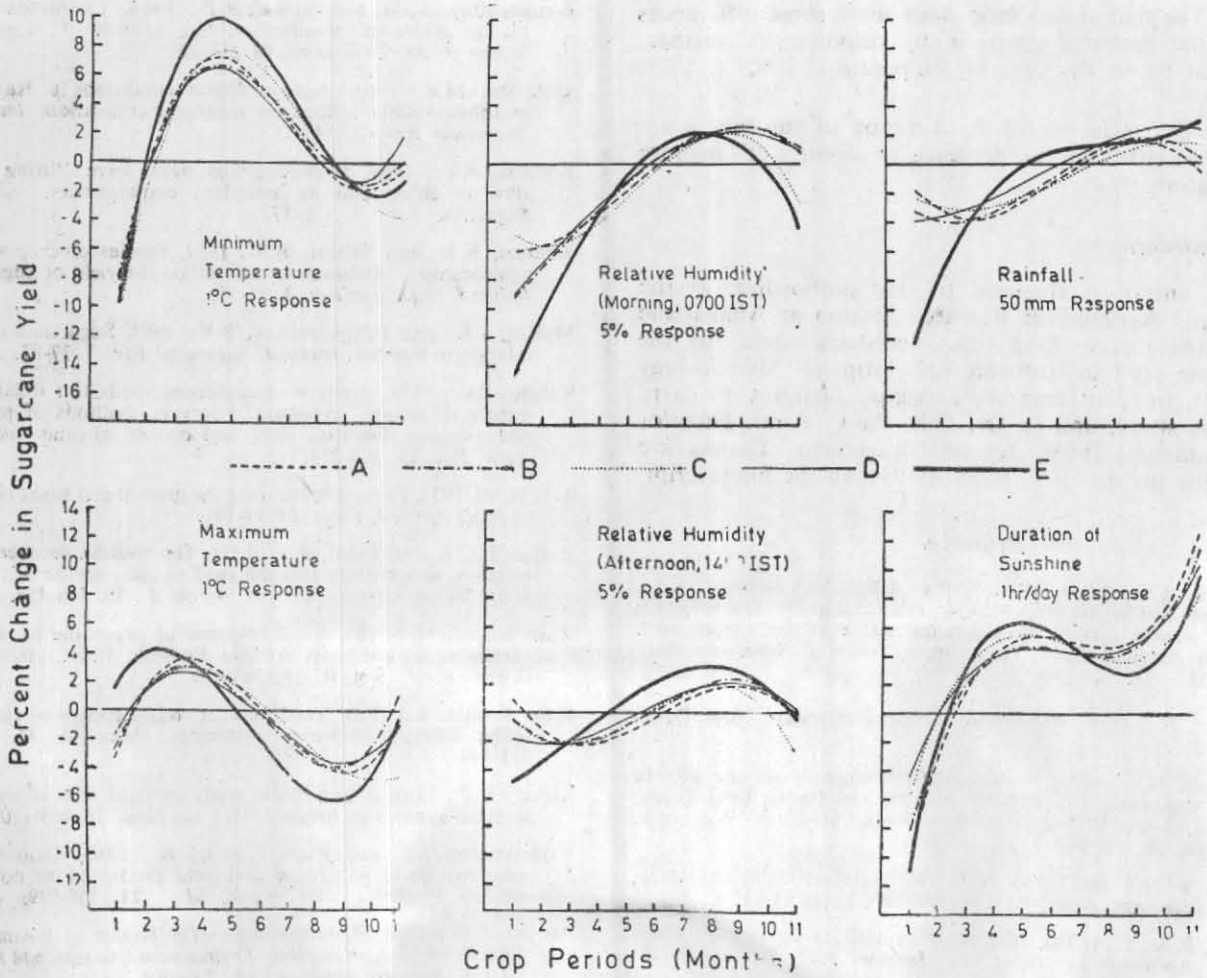

Fig. 1. Yield-weather response curves of sugarcane crop under different manurial treatments

However, it can be noticed that the crop under no manure deviates slightly from the manured crops in its response to some weather variables. This indicates that, though the form of availability of the nutrients does not significantly affect the crop-weather relationships of sugarcane, the amount of available nutrients has some effect. This aspect will now be examined in more detail.

The manureless crop shows a greater increase (+10%) in the yield for additional minimum temperature, around 4th and 5th months of the crop season, than the manured crop (+6 to +8%). Similar differences are noticed in the response curves of maximum temperature, during the first 3 months. In the later part of the crop season (6th-9th months), however, additional maximum temperature affects the manureless crop more adversely (—2 to—6%) than the others (0 to—4%). The difference between the manured crops and the manureless crop are similar for the moisture parameters humidity and rainfall, with slight variations in the magnitudes. It may be generally stated that the *manureless crop is more adversely affected by excessive* humidity and rainfall in the first 2 to 3 months. Additional humidity and rainfall are more favourable for the manureless crop during 5th to 7th months, and even over a larger part of the crop season in the case of afternoon relative humidity. The response to additional duration of sunshine is remarkably similar for all the treatments, including the manureless crop.

Clements (1953), from his extensive experimental observations at Hawaii, reported that the leaf nitrogen in sugarcane significantly influenced the sheath moisture level and leaf emergence, which in turn predominantly affected elongation and other growth factors. He found that minimum temperature exerted a negative influence on the leaf nitrogen while maximum temperature exerted a positive influence. Soil moisture had a weak negative influence. Light, however, did not seem to affect the nitrogen level. The response curves for the manureless crop, when compared with those for the manured crops during the period between 3rd and 6th months, broadly conform to the observations of Clements (1953).

4. Conclusions

A study of the weather-induced yield-response curves of sugarcane for different manurial treatments reveals the following features :

(*i*) The source of nutrients does not significantly modify the crop-weather relationships of sugarcane, as long as the nutrients quantity remains the same.

(*ii*) The manureless crop does show some differences from the manured crops in its response to weather, particularly in the case of temperature.

(iii) The influence of the duration of sunshine is not modified either by the presence or absence of manure application.

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