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Preliminary studies on the pattern of accumulation of proline in coffee cultivars during drought

Abstract. Experiments are planned and realized to investigate whether proline can be used as a parameter for drought tolerance/resistance in coffee.

It is well known and established that adverse climato-edaphic factors like higher light intensity, atmospheric temperature and low moisture status of the soil during drought lead to die-back of arabica coffee plants which is a common physiological disorder occurring in coffee- growing tracts of southern India, resulting in death and defoliation of the plants (2). The need for protecting the plants during such a period is of utmost importance from the point of view of practical agriculture. One such method is to protect the coffee plants by providing judicious overhead shade by both permanent and temporary shade trees, and also mulching the plants, which helps to conserve soil moisture during hot weather (3, 10, 11); another method is to evolve strains which are tolerant/resistant to drought.

Earlier work has shown that the chlorophyll stability index can be considered a reliable test to know whether a cultivar is drought resistant or not (5). More recently, it was found that accumulation of proline, an important aminoacid, during water stress can be used as a parameter for drought tolerance or resistance (6, 9). It is pertinent to mention here the correlation established in barley between proline accumulation and drought tolerance (7).

The present communication deals with results of the study on proline accumulation in leaves of coffee cultivars during drought.

Young and mature leaves were collected from San Ramon, S.288, S.795, Tafarikela and Kents materials from the Central Coffee Research Institute Estate. The leaf samples collected at random from the above source came from different blocks with different degrees of shade intensities. Quantitative estimation of proline was carried out in both young and mature leaves of the above five cultivars from December 1979 to March 1980, by following the method of Bates *et al.* (1), using a Unicam spectrophotometer.

The results of the study indicate that proline content in young leaves ranged from 2.31 (Tafarikela) to 13.10 (S.288) whereas in mature leaves it ranged from 1.64 (San Ramon) to 5.29 μ moles/g fresh weight (S.795) (Figure 1). However, if the mean value

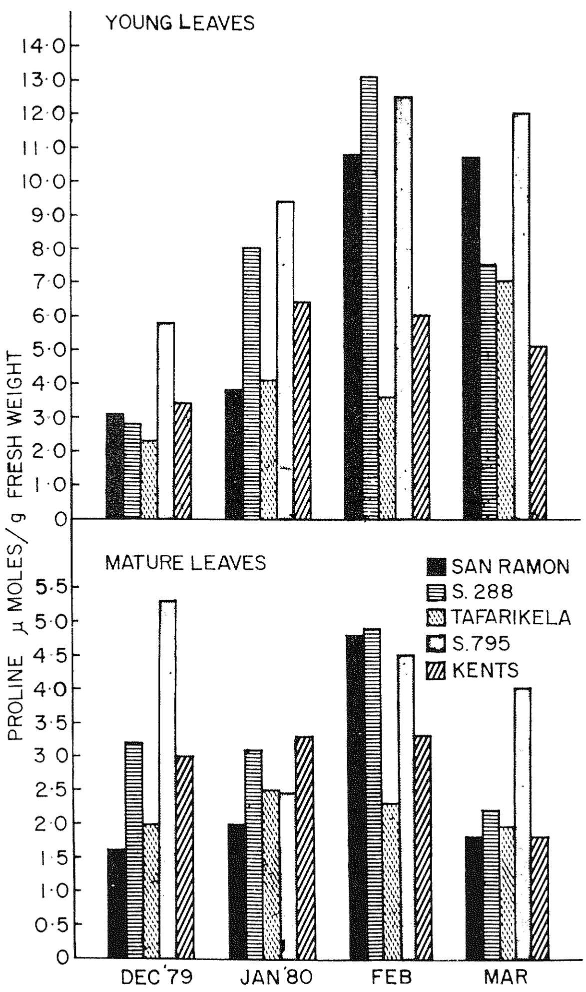

Fig. 1. Proline accumulation in leaves of coffee cultivars during drought period.

Table 1. Percent increase/decrease in proline content in young leaves of five different plant types of coffee from December 1979 to March 1980.

Plant type	Young leaves			
	1 20th Dec – 23rd Jan	2 23rd Jan – 23rd Feb	3 23rd Feb – 20th Mar	4 TOTAL OF 1 To 3 (Dec 79 to Mar 80)
San Ramon	25.08	179.95	- 0.37	204.66
S. 288	184.10	62.94	- 42.44	204.60
Tafarikela	77.49	- 12.93	97.20	161.76
S. 795	62.13	32.48	- 3.69	90.92
KENTS	87.98	- 7.18	- 13.61	67.19

for the entire period of experimentation (four months) is considered, Tafarikela recorded the minimum proline content, while the maximum was in S.795. The same trend was observed in both young and mature leaves.

Though no definite trend was observed in the accumulation of proline in leaves during different periods of drought, the following points can be made out:

1. In young leaves, maximum increase in proline content was recorded from December to January in S.288, S.795 and Kents. In San Ramon, the maximum increase was observed during January and February. In the case of Tafarikela, maximum accumulation of proline was recorded during February and March (Table 1). Regarding mature leaves, the pattern of accumulation was entirely different; Tafarikela and Kents recorded maximum increase from December to January; whereas, S.288, S.795 and San Ramon recorded maximum increase from January to February (Table 2).

2. If cumulative increase is taken for the entire period of drought, San Ramon recorded maximum per cent increase in proline content in both young and mature leaves and Kents showed minimum proline content (Table 1 and 2). The order of proline accumulation in the different plant types studied is as follows:

Young leaves – San Ramon > S.288 > Tafarikela > S.795 > Kents.
Mature leaves – San Ramon > S.795 > Tafarikela > S.288 > Kents.

The climatological factors during the period of drought are given below:

1. Total hours of sunshine (per month) ranged from 249.5 to 297.1.

2. Mean minimum temperature ranged from 11.3°C to 14.4°C.

Table 2. Percent increase/decrease in proline content in mature leaves of five different plant types of coffee from December 1979 to March 1980.

Plant type	Mature leaves			
	1 20th Dec – 23rd Jan	2 23rd Jan – 23rd Feb	3 23rd Feb – 20th Mar	4 TOTAL OF 1 to 3 (Dec 79 to Mar 80)
San Ramon	21.95	138.00	- 62.39	97.56
S. 288	- 3.74	59.87	- 55.06	1.07
Tafarikela	25.50	- 9.56	- 14.10	1.84
S. 795	- 53.69	84.08	- 11.09	19.30
KENTS	12.16	- 1.20	- 44.51	- 33.55

3. Mean maximum temperature ranged from 29.4°C to 34°C.

4. The soil moisture, in general, starts decreasing from October onwards and reaches minimum level in the month of March (4).

The present investigation has shown maximum increase of proline in San Ramon (in both young and mature leaves) during drought, indicating the possible correlation between proline accumulation and drought tolerance/resistance. This was further substantiated by an earlier report that the San Ramon cultivar is drought-hardy (8); the practical performance of the material in the field also confirms the drought-hardy nature of San Ramon.

In addition to proline accumulation during drought, the aspect of water requirement of coffee cultivars during different periods of the year, is also important and needs detailed study. The water requirement of different cultivars of the same species may be different based on age, size and spread of the bush. Therefore, the cultivar which has the inherent ability to economize in the utilization to water during drought, plays a significant role in crop production, since coffee is predominantly a rain-fed crop.

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El kelvin. Corresponde a 1/273.16 de la temperatura termodinámica del puntro triple del agua (su símbolo es K).

La candela. Es la intensidad luminosa –en dirección perpendicular y con una superficie igual a 1/600 000 de metro cuadrado– de un cuerpo negro, a la temperatura de solidificación del platino a una presión de 101 325 newton por metro cuadrado.

La mole. Es la cantidad de sustancia de un sistema que contiene tantas entidades elementales como átomos hay en 0.012 kilogramos de carbono 12.

El radián. Es la medida de un plano cuyo vértice coincide con el centro de un círculo y cuya abertura es igual a la longitud de su radio subtendido como arco.

El steradián. Es la medida de un ángulo sólido con su vértice al centro de una esfera y que abarca sobre su superficie el área de un cuadrado cuyos lados tienen la longitud del radio.

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