

Constituents of *Cannabis sativa* L., XX: the cannabinoid content of Mexican variants grown in Mexico and in Mississippi, United States of America

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ABSTRACT

Cannabis growing in 12 different localities in Mexico was analysed quantitatively for 10 cannabinoids by gas-liquid chromatography. Cannabinoid profiles of 12 variants from Mexico were compared with profiles derived when 7 out of these 12 variants were grown in Mississippi, United States of America. The effects of temperature and rainfall on the Δ^9 -THC content of these variants are presented.

Introduction

The crude marijuana produced from Mexican *Cannabis* is well known for its potent drug quality. Previous studies by Turner and others on a Mexican variant (ME-A) and Indian variants showed that the major cannabinoids cannabichromene (CBC), cannabidiol (CBD), Δ^9 -tetrahydrocannabinol (Δ^9 -THC) and cannabinol (CBN), vary in a cyclic pattern and are a function of time of day, sex, age of plants at sampling, and parts of plants sampled [1-4].

Cannabis has been divided into three distinct types – the drug, fibre and an intermediate type. The last is mostly used to produce hashish. The fibre type is used to produce fibres, and the drug type is used for its psychoactive properties. The psychoactive agent in *Cannabis* is generally referred to as (-)-*trans*- Δ^9 -tetrahydrocannabinol (Δ^9 -THC). As the supplier of research marijuana for the National Institute on Drug Abuse (NIDA), we have the responsibility to correlate analytical data, when possible, with biological data. Previous to recent work in these laboratories demonstrating that a *Cannabis* plant could be a fibre type one day and another type on a different day [2, 3], marijuana samples from a particular geographical location were assumed to be identical and Δ^9 -THC was thought to be the only cannabinoid of importance in understanding the pharmacology of the drug. The Δ^9 -THC content of any marijuana sample cannot explain all the biological properties experimentally observed. Therefore, the study of the fluctuation of cannabinoids in different types becomes important in correlating the pharmacology of marijuana with the analytical data.

The research findings discussed above prompted a complete evaluation of the cannabinoid profile and chemical classification of *Cannabis* grown in Mexico and subsequently grown in Mississippi, United States of America. The drug type *Cannabis*, grown in Mississippi and used to produce NIDA's standard research marijuana, originated from a seed stock obtained near Acapulco in the state of Guerrero, Mexico. Since Acapulco is on the west coast of Mexico, and since considerable illicit Mexican marijuana originates on the east coast near Veracruz, it was necessary to investigate *Cannabis* growing in diverse locations within Mexico.

Material and methods

Plant material

Twelve Mexican-grown *Cannabis* samples were collected near 12 cities in 10 different states in 1973, plus one *Cannabis* seed sample from the state of Oaxaca (see table 1). The dry plant material, mostly flowering tops, was manicured, and leaves were separated from stems and seeds by passing it through a 14-mesh sieve. During 1974 and 1976, seeds of seven Mexican variants of known geographic origin were grown in the medicinal plant garden at the Research Institute of Pharmaceutical Sciences, University of Mississippi, under the same soil and fertilization conditions.

Table 1
Samples of Mexican grown *Cannabis*

Container number	Seed code	Weight (g)	Weight after manicuring (g)	Seeds (g)	Location	
					City	State
1	ME-F	269.1	132.5	49.6	Compostela	Nayarit
2	ME-G	143.2	87.4	21.5	Campeche	Campeche
3	ME-H	259.0	95.0	88.9	Poza Rica	Veracruz
4		195.9	104.0	None	Chihuahua	Chihuahua
5	ME-I	97.5	33.3	6.6	Puebla	Puebla
6	ME-J	172.5	67.0	67.0	Guadalajara	Jalisco
7		29.6	15.1	None	Coatzacoalcos	Veracruz
8		244.4	67.3	None	Aguascalientes	Aguascalientes
9	ME-K	233.8	113.3	73.0	Chilpancingo	Guerrero
10	ME-L	216.4	82.8	85.3	Culiacan	Sinaloa
11	ME-M	195.8	125.0	9.3	Durango	Durango
12	ME-N	279.0	92.6	129.8	Acapulco	Guerrero
13	ME-O	37.9	No leaves	37.9	Oaxaca	Oaxaca

Leaves were randomly collected from bottom to top [1] from six different plants of the same variant at the same time and day of each week. The age of the plants was recorded from the dates of planting. Samples from vegetative, staminate and pistillate plants of each variant were collected, air dried and manicured.

For this investigation, 7 seed stocks were selected from 12 Mexican *Cannabis* samples originally collected in 1973 from the following 10 states: Aguascalientes, Campeche, Chihuahua, Durango, Guerrero, Jalisco, Nayarit, Puebla, Sinaloa and Veracruz. These locations provided a relatively good cross-section of different geographical locations within Mexico. A weekly cannabinoid analysis was performed on

the randomly collected leaves in order to determine the cannabinoid growth profiles for these variants grown in Mississippi. Data from these experiments were compared with data from the original analysis of the sample obtained in Mexico.

Cannabinoid analysis

Manicured plant material (1 g) of each variant was extracted with chloroform. The residue was dissolved in 1 ml of internal standard solution (androst-4-ene-3, 17-dione 1 per cent in ethanol). The resulting solution was quantitatively analysed by gas-liquid chromatography, using a Beckman GC-65 equipped with a 2 per cent OV-17 column. A 6 per cent OV-1 column was also used to quantitate cannabicyclol (CBL), (-)-*trans*- Δ^9 -tetrahydrocannabivarin (Δ^9 -THCV), CBC, and CBD [2].

Results

As a result of cannabinoid analysis of different Mexican *Cannabis* variants (see table 2) collected in different locations in Mexico, Δ^9 -THC was found to be the most abundant cannabinoid. The average content of Δ^9 -THC was 1.69 per cent, with the highest 2.97 per cent, and the lowest 0.14 per cent. Cannabinol (CBN) and (-)-*trans*- Δ^8 -tetrahydrocannabinol (Δ^8 -THC) were not present in fresh samples of *Cannabis*. However, during storage and the analytical process, Δ^9 -THC acid decarboxylates to give Δ^9 -THC, which then went through hydroxy intermediates to give CBN by air oxidation or Δ^8 -THC by isomerization [5]. When we combined the Δ^9 -THC, Δ^9 -THCV, Δ^8 -THC and CBN content, the average percentage of the psychologically active cannabinoids in samples of Mexican *Cannabis* grown in Mexico was 2.02, with the highest 3.27 and the lowest 0.71. All but one of the Mexican-grown *Cannabis* variants contained only trace, or undetectable, amounts of CBD. The exception, ME-H, was collected from Poza Rica, Veracruz, and had 0.54 per cent of CBD (see table 2). Plants of this variant grown in Mississippi also showed significant amounts of CBD. In 1974, only vegetative plants showed maximum CBD levels at 12 weeks of age (0.38 per cent) and 16 weeks of age (0.37 per cent), while staminate and pistillate plants contained only trace amounts of CBD (see table 3). Other Mexican variants planted in 1974 and 1976 in Mississippi usually contained less than 0.05 per cent of CBD (see tables 3 and 4). In 1976, vegetative plants contained 0.90 per cent of CBD at 13 weeks of age and 0.38 per cent at 16 weeks of age (see table 4). For staminate plants, maximum CBD amounts were found at 19 weeks of age (1.19 per cent) and 24 weeks of age (0.91 per cent). For pistillate plants, maximum CBD percentages were found at 19 weeks of age (0.67 per cent) and 21 weeks of age (0.63 per cent) (see table 4).

The fluctuation of Δ^9 -THC levels in ME-N planted in 1976, was similar to that of ME-A planted in 1971 [1]. Both ME-N and ME-A seeds came from Acapulco, Guerrero. Vegetative plants showed maximum levels of Δ^9 -THC at week 15 and minimum levels at weeks 17 and 18. Staminate plants contained maximum amounts of Δ^9 -THC at week 20 and minimum at week 22. The pistillate plants showed maximum amounts at week 19 and minimum at week 23. The highest Δ^9 -THC level was in the vegetative plant prior to any sexual differentiation at week 15. However, in 1974, ME-N vegetative plants showed a maximum amount of Δ^9 -THC at week 18. Staminate and pistillate plants had maximum levels of Δ^9 -THC at weeks 21 and 18 respectively, and then dropped sharply in succeeding weeks. In this case, the highest content of Δ^9 -THC was in the staminate plants at week 21. This pattern of two cyclic peaks is consistent with the data obtained in 1971 with ME-A seed stock [1].

Table 2
Cannabinoid analysis of Mexican *Cannabis* grown in Mexico
 (Results expressed as percentages by dry weight)

<i>Seed code</i>	Δ^9 -THC	Δ^8 -THC	Δ^9 -THCV	CBC	CBD	CBDV	CBL	CBG	CBGM	CBN	Total cannabinoids
ME-F	0.34	0.05	0.01	0.09	t ^a	t	t	0.03	0.01	0.31	0.84
ME-G	0.14	0.08	t	0.10	t	0.01	t	0.04	0.07	0.78	1.22
ME-H	1.99	0.04	0.05	0.09	0.54	0.02	0.01	0.06	0.01	0.26	3.07
- ^b	0.59	0.01	0.04	0.07	t	t	0.01	0.01	t	0.15	0.88
ME-I	2.15	t	0.06	0.27	t	0.01	0.01	0.04	0.00	0.10	2.63
ME-J	2.65	0.02	0.07	0.15	t	—	0.01	0.06	0.00	0.19	3.15
- ^b	1.00	0.01	0.03	0.12	t	—	0.01	0.03	0.02	0.07	1.29
- ^b	1.30	0.02	0.02	0.13	t	—	0.01	0.03	0.05	0.13	1.69
ME-K	2.11	0.02	0.09	0.16	t	0.01	0.02	0.04	t	0.04	2.49
ME-L	2.97	0.02	0.07	0.16	t	0.01	0.02	0.06	0.06	0.21	3.58
ME-M	2.45	0.01	0.06	0.26	t	0.01	0.01	0.03	0.03	0.06	2.92
ME-N	2.66	0.02	0.10	0.09	t	0.00	0.01	0.09	0.05	0.18	3.20

^a t = trace (less than 0.009%)

^b Only plant material, no seeds.

In 1974, vegetative plants of ME-H, ME-K, ME-L, ME-N and ME-O, at 13 weeks of age had higher Δ^9 -THC content than at weeks 12 and 14. They showed minimum Δ^9 -THC content at week 15. For the most part, 1974 staminate and pistillate plants grown in Mississippi produced a low Δ^9 -THC concentration. None of these plants had a Δ^9 -THC content higher than the original samples of material grown in Mexico in 1973 (see table 2). However, these same variants grown in 1976 showed a higher Δ^9 -THC content in at least one growth week than the original analysis. In general, variants grown in 1976 showed two periods of maximum Δ^9 -THC levels between weeks 13 and 15, and weeks 19 and 20. The minimum amounts were between weeks 17 and 18, and weeks 22 and 23 respectively.

In all variants, the average Δ^9 -THC content was higher in 1976 than in 1974. Also, a greater fluctuation of Δ^9 -THC levels was observed in 1976 than in 1974. More importantly, the major cannabinoid growth profiles for the same variant were found to differ significantly between 1974 and 1976. Since biosynthesis and metabolism of Δ^9 -THC in individual plants varies hourly [1], no simple explanation for the differences in Δ^9 -THC growth profiles is possible. Small amounts of cannabigerol monomethyl ether (CBGM) also existed in each Mexican variant. Such levels were also found to exist in a previous study of Indian variants [2, 3]. Small and Beckstead [6] classified *Cannabis* containing a small amount of CBGM, especially variants originating in north-east Asia, as phenotype IV.

In 1976, all Mississippi-grown Mexican variants (see table 4) showed increased CBC content when compared to the 1974 data. In most cases, pistillate plants showed less CBC content than staminate plants of the same variant.

From this study on Mexican *Cannabis* grown both in Mexico and in Mississippi, United States of America, we conclude that Mexican *Cannabis* is almost exclusively of the drug type (see tables 3 and 4), except in three cases. These exceptions were samples from staminate plants derived from ME-H at weeks 19, 23 and 24 (see table 4). This is the only variant in which CBD was detected. Although it is generally believed that the genetic character determines cannabinoid profile [7], these data indicate that environmental factors can influence the cannabinoid profile.

The results of the effect of temperature and rainfall on the Δ^9 -THC content of the different Mexican variants, ME-H through ME-O, are indicated in table 5. Thus it can be seen that, with a fairly high temperature and a reasonable amount of rain, an increase in Δ^9 -THC can be anticipated. In 1974, the temperature showed a cooler trend, starting from week 15 from the date of planting, when compared with that of the growing season of 1976. Also, the total amount of rainfall in 1976 (19.57 in.) was 28 per cent less than in 1974 (27.22 in.). This might explain why the Δ^9 -THC content of *Cannabis* grown in 1974 was much lower than that grown in 1976, although all plants were produced from the same seed stock and in the same garden using identical agricultural procedures.

From this study it is concluded that all these variants, with the exception of ME-H, had similar growth profiles. Accordingly, Mexican *Cannabis* could possibly include two variants. Using the Waller method [4], one variant is always a drug type no matter when samples are collected. Using the Small and Beckstead method [6], this variant belongs to different phenotypes. The second variant can be a drug or a fibre type, depending on when the collection was made, according to the Waller method. This variant generally contains appreciable amounts of CBD, whereas the other variants contain appreciable amounts of CBC and negligible amounts of CBD.

Table 3
Cannabinoid content of Mexican *Cannabis*, grown in Mississippi (1974)
 (Cannabinoids expressed as percentages by dry weight)

Seed code	Age ^a	Δ^9 -THC	Δ^8 -THC	Δ^9 -THCV	CBC	CBD	CBDV	CBL	CBG	CBGM	CBN	Total cannabinoids	Waller [4] (type)	Small [6] (phenotype)
ME-H (vegetative)	10	0.64	0.04	0.02	0.13	—	0.02	t ^b	0.08	—	—	1.01	D ^c	I
	11	1.00	0.04	0.01	0.24	0.07	—	0.01	0.01	t	0.07	1.47	D	I
	12	0.91	0.01	0.01	0.10	0.38	t	t	0.02	0.03	0.03	1.47	D	I, IV
	13	1.14	t	0.01	0.14	0.36	0.01	t	0.02	0.03	0.01	1.72	D	I, IV
	14	0.61	—	0.01	0.07	0.28	0.03	0.01	0.04	0.02	—	1.07	D	I, IV
	15	0.67	0.02	0.01	0.07	0.35	t	t	t	0.02	0.02	1.16	D	I, IV
	16	1.11	0.05	0.01	0.12	0.37	0.03	0.01	—	—	0.08	1.78	D	I
	17	0.88	0.06	—	0.01	0.30	—	0.02	0.06	—	0.01	1.26	D	I
	18	1.13	—	0.01	0.12	0.12	0.02	0.01	0.11	0.03	0.02	1.57	D	I, IV
ME-H (pistillate)	19	1.31	0.03	0.02	0.11	t	—	0.01	0.07	0.02	—	1.57	D	I, IV
	19+5d	1.46	—	0.02	0.19	t	—	0.01	0.06	0.02	0.01	1.77	D	I, IV
	21	1.43	0.02	t	0.20	t	—	0.01	t	0.02	0.20	1.70	D	I, IV
ME-H (staminate)	18	1.00	0.03	0.02	0.06	t	t	t	0.01	t	0.02	1.14	D	I
	19	0.57	0.04	0.01	0.10	t	—	t	—	—	0.11	0.82	D	I
	19+5d	0.98	0.05	0.02	0.07	t	0.02	0.01	0.07	—	0.05	1.27	D	I
	20	0.83	0.02	t	0.07	t	—	t	—	—	0.05	0.97	D	I
ME-J (vegetative)	11	0.84	0.03	0.03	0.09	t	—	0.01	—	—	0.05	1.05	D	I
	13	0.71	0.04	0.04	0.05	t	—	0.01	—	—	—	0.85	D	I
	14	0.91	—	0.06	0.03	t	—	0.01	0.08	0.03	0.02	1.14	D	I, IV
	16	1.19	0.02	0.01	0.10	0.01	0.01	t	t	0.01	0.02	1.37	D	I, IV
	17	1.01	0.04	0.03	0.04	t	—	t	—	—	—	1.12	D	I
ME-J (pistillate)	16	1.16	0.02	0.12	0.07	t	0.01	0.01	t	t	0.02	1.41	D	I
	17	1.17	0.03	0.10	0.05	t	0.02	0.01	0.11	—	—	1.49	D	I
	20	1.22	0.06	0.02	0.02	0.06	0.02	0.01	0.07	—	0.02	1.48	D	I
	21	0.70	0.02	0.01	0.07	t	—	t	t	—	0.04	0.84	D	I

ME-J (staminate)	16	1.41	0.04	t	0.15	0.01	t	t	—	—	0.08	1.69	D	I
	17	1.36	0.03	0.04	0.20	0.02	—	0.01	0.06	—	0.01	1.73	D	I
	18	1.49	0.03	0.03	0.32	t	—	0.01	0.05	—	0.08	2.01	D	I
	19	0.93	0.03	0.02	0.04	0.01	0.05	t	—	—	0.08	1.16	D	I
	20	0.79	0.02	0.03	0.20	0.01	0.02	0.02	0.08	—	0.02	1.19	D	I
	21	1.82	t	0.04	0.26	t	—	0.02	—	—	0.14	2.28	D	I
ME-K (vegetative)	10	0.78	0.03	0.01	0.04	t	0.02	t	t	t	0.02	0.90	D	I
	11	0.95	0.06	0.01	0.07	t	0.06	t	t	t	0.04	1.19	D	I
	12	0.79	0.02	0.01	0.04	t	0.01	t	t	t	0.01	0.88	D	I
	13	1.30	0.02	0.03	0.09	t	—	t	0.02	t	0.02	1.48	D	I
	15	0.72	0.03	0.01	0.09	t	t	t	t	0.01	0.02	0.88	D	I
	17	1.05	0.02	0.03	0.03	0.01	0.01	t	0.06	—	—	1.21	D	I
	18	1.91	0.05	0.03	0.07	0.07	—	t	—	—	—	2.13	D	I
ME-K (pistillate)	17	0.66	0.04	0.03	0.10	t	—	0.01	0.06	—	—	0.90	D	I
	17+1d	1.56	0.04	0.02	0.01	t	0.01	t	0.09	0.03	0.04	1.80	D	I, IV
	18	1.47	0.03	0.03	0.17	t	0.01	0.15	—	—	—	1.86	D	I
	20	1.97	0.04	0.05	0.17	t	—	t	0.13	—	—	2.36	D	I, IV
	21+1d	0.54	0.04	0.03	0.09	t	t	0.01	0.07	t	0.02	0.80	D	I
ME-K (staminate)	20	1.39	0.04	0.01	0.01	0.01	0.03	0.01	0.11	—	—	1.61	D	I
	21	1.39	t	0.04	0.10	t	—	t	0.12	0.02	0.04	1.71	D	I, IV
ME-L (vegetative)	10	0.52	0.03	0.01	0.02	t	—	t	0.06	—	—	0.64	D	I
	11	0.87	0.05	0.01	0.03	t	—	t	0.01	0.01	0.05	0.03	D	I, IV
	12	1.03	0.01	0.01	0.07	t	0.02	t	—	0.02	0.02	1.18	D	I, IV
	13	1.56	0.03	0.02	0.07	0.01	0.01	0.01	—	0.02	0.02	1.75	D	I, IV
	14	0.99	0.02	0.03	0.02	t	0.01	t	—	t	t	1.07	D	I
	15	0.69	0.02	t	0.03	0.01	0.02	t	t	0.02	0.02	0.81	D	I, IV
	16	1.25	0.01	0.02	0.06	t	0.01	t	0.01	0.04	0.03	1.43	D	I, IV
	17	2.13	0.04	0.03	0.07	—	t	0.11	0.04	0.04	—	2.46	D	I, IV
ME-L (pistillate)	16	1.60	t	—	0.02	0.03	—	—	0.10	0.05	0.04	1.84	D	I, IV
	18	1.74	0.03	0.02	0.01	t	—	0.01	0.06	0.04	—	1.91	D	I, IV
	20	1.67	0.04	0.02	0.02	t	—	t	0.13	0.03	—	1.91	D	I, IV
	21	0.98	—	0.03	0.01	t	0.02	t	0.10	0.03	0.02	1.19	D	I, IV

Table 3 (continued)

Seed code	Age ^a	Δ^9 -THC	Δ^8 -THC	Δ^9 -THCV	CBC	CBD	CBDV	CBL	CBG	CBGM	CBN	Total cannabinoids	Waller [4] (type)	Small [6] (phenotype)
ME-L (staminate)	20	1.25	0.03	0.02	0.06	0.01	—	t	0.06	0.02	—	1.45	D	I, IV
	21	1.78	0.04	0.02	0.03	0.01	0.02	t	0.10	0.04	—	2.04	D	I, IV
	21+1d	2.09	0.04	0.05	0.11	0.08	—	0.01	0.21	0.10	—	2.69	D	I, IV
ME-M (vegetative)	10	0.57	—	0.02	0.02	t	—	t	0.06	0.03	—	0.70	D	I, IV
	11	1.07	0.04	0.02	0.04	0.04	0.03	t	t	0.02	0.05	1.31	D	I, IV
	12	1.14	0.02	0.02	0.06	t	0.01	t	0.02	0.03	0.03	1.33	D	I, IV
	13	1.40	0.03	0.03	0.06	t	—	t	—	0.02	0.01	1.55	D	I, IV
	16	1.87	0.01	0.03	0.10	t	0.02	t	0.03	0.04	0.05	2.15	D	I, IV
	17	2.06	0.04	t	0.09	0.01	0.03	t	—	0.04	—	2.27	D	I, IV
	18	1.76	—	0.03	0.07	t	—	0.01	0.12	0.04	0.04	2.07	D	I, IV
ME-M (pistillate)	17	1.09	0.02	0.03	0.04	t	—	t	0.09	—	0.03	1.30	D	I
	18	1.19	0.03	0.02	0.03	t	—	t	—	—	0.13	1.40	D	I
	20	1.31	0.03	0.03	0.03	0.04	0.02	0.01	t	0.03	0.04	1.54	D	I, IV
	21	1.17	0.03	0.01	0.06	t	0.02	0.01	—	0.03	0.07	1.40	D	I, IV
ME-M (staminate)	17	1.76	0.03	0.03	0.06	t	0.02	t	0.13	—	t	2.03	D	I
	18	1.48	0.02	0.05	1.14	t	0.04	0.01	0.07	0.04	0.02	1.87	D	I, IV
	20	1.10	0.01	0.01	0.27	t	0.02	0.01	t	—	0.04	1.46	D	I
	21	1.60	t	0.04	0.32	t	t	0.01	0.04	0.05	0.06	2.12	D	I, IV
	21+1d	1.74	0.01	0.05	0.48	t	0.01	0.01	0.11	0.06	0.09	2.56	D	I, IV
ME-N (vegetative)	10	0.43	0.03	0.03	0.03	t	—	t	—	t	—	0.52	D	I
	11	0.79	0.05	0.01	0.05	0.01	—	t	—	t	0.03	0.94	D	I
	12	0.87	0.01	0.02	0.06	0.02	0.01	t	0.03	0.03	0.01	1.06	D	I, IV
	13	1.34	t	0.03	0.08	t	0.01	t	t	0.04	0.03	1.53	D	I, IV
	14	0.75	0.01	0.01	0.07	t	t	t	0.01	0.02	0.02	0.89	D	I, IV
	15	0.70	0.01	0.01	0.05	t	t	t	—	0.01	0.02	0.80	D	I, IV
	16	1.13	0.02	0.02	0.06	t	t	t	0.01	0.04	0.04	1.32	D	I, IV
	17	1.24	0.04	0.03	0.04	t	—	t	—	0.02	0.04	1.41	D	I, IV
	18	1.38	0.04	0.03	0.03	t	—	0.01	—	0.03	0.11	1.63	D	I, IV

ME-N (pistillate)	16	1.21	t	0.02	0.02	t	—	t	0.12	0.03	0.05	1.45	D	I, IV
	18	1.68	0.03	0.05	0.05	0.05	t	0.01	0.07	0.05	0.01	2.00	D	I, IV
	20	1.51	0.04	0.01	0.01	t	—	t	0.10	0.01	—	1.68	D	I, IV
	21	1.62	0.04	—	0.01	0.01	—	—	—	0.02	0.02	1.72	D	I, IV
	21+1d	0.59	0.04	0.02	0.03	t	0.02	t	0.11	—	—	0.81	D	I
ME-N (staminate)	18	1.59	0.03	0.04	0.11	t	—	0.01	0.05	—	0.06	1.89	D	I
	21	1.88	0.03	0.03	0.16	t	0.03	0.01	0.11	0.04	—	2.29	D	I, IV
	21+1d	1.17	0.02	0.02	0.30	t	0.03	0.01	0.05	—	0.02	1.62	D	I
ME-O (vegetative)	10	0.78	0.04	0.03	0.05	t	0.02	t	—	t	0.10	1.02	D	I
	11	1.20	0.05	0.03	0.08	t	0.07	t	t	t	0.08	1.51	D	I
	12	0.88	0.02	0.01	0.08	t	0.02	t	—	0.02	0.02	1.05	D	I, IV
	13	1.01	0.02	0.03	0.07	t	—	t	—	—	0.05	1.18	D	I
	14	0.58	t	0.03	0.03	t	0.01	t	—	0.01	0.01	0.67	D	I, IV
	16	1.32	0.03	0.06	0.08	t	0.01	t	t	0.04	0.02	1.56	D	I, IV
	17	1.16	—	0.04	0.04	t	—	t	0.08	0.04	0.03	1.39	D	I, IV
ME-O (pistillate)	12	0.55	0.03	0.04	0.10	t	0.01	t	t	0.01	0.01	0.75	D	I, IV
	16	0.57	0.05	0.16	0.06	t	0.01	0.01	t	0.01	0.02	0.80	D	I, IV
	17	0.92	0.04	0.02	0.03	0.03	—	t	0.07	—	—	1.11	D	I
	19	1.10	0.03	0.03	0.15	t	0.03	0.01	—	—	0.06	1.41	D	I
	20	1.11	0.03	0.05	0.09	t	t	0.01	0.09	0.01	—	1.39	D	I
	21	0.62	0.02	0.01	0.07	t	t	0.01	—	—	0.07	0.80	D	I
	21+1d	0.79	0.02	0.02	0.17	t	—	0.01	0.12	—	—	1.13	D	I
ME-O (staminate)	10	1.40	0.02	0.02	0.06	t	—	t	0.13	0.04	0.06	1.73	D	I, IV
	11	1.63	0.07	t	0.02	0.01	—	t	0.11	0.04	0.08	1.96	D	I, IV
	12	0.86	0.03	t	0.02	t	0.02	t	0.02	0.03	0.05	1.03	D	I, IV
	17	1.11	0.04	0.04	0.12	t	—	t	0.07	—	—	1.38	D	I
	18	0.74	0.02	0.02	0.01	t	—	t	—	—	—	0.79	D	I
	20+5d	0.83	0.07	0.02	0.98	t	0.01	0.01	0.11	—	—	2.03	D	I
	21	1.56	t	0.05	0.06	t	—	0.01	0.33	0.01	0.06	2.08	D	I, IV

^a Age in weeks^b t = trace (less than 0.009%)^c D = drug.

Table 4
Cannabinoid content of Mexican *Cannabis*, grown in Mississippi (1976)
 (Cannabinoids expressed as percentage by dry weight)

Seed code	Age ^a	Δ^9 -THC	Δ^8 -THC	Δ^9 -THCV	CBC	CBD	CBDV	CBL	CBG	CBGM	CBN	Total cannabinoids	Waller [4] (type)	Small [6] (phenotype)
ME-H (vegetative)	13	2.19	—	0.05	0.41	0.90	—	0.02	0.17	—	0.03	3.77	D ^c	II
	15	1.03	—	0.01	0.11	0.17	0.02	t ^b	—	—	—	1.34	D	I
	16	0.85	t	0.02	0.10	0.38	—	0.01	0.02	—	0.01	1.39	D	I
	17	0.94	0.02	0.01	0.10	0.35	t	t	0.05	0.04	0.02	1.53	D	I, IV
	18	0.73	0.03	t	0.06	0.28	t	t	0.01	0.05	0.06	1.22	D	I
ME-H (pistillate)	19	1.84	0.03	0.03	0.22	0.67	0.04	0.01	0.06	—	0.02	2.92	D	II
	20	1.74	t	t	0.17	t	t	t	0.01	0.02	0.02	1.96	D	I
	21	1.44	0.03	0.01	0.21	0.63	0.02	0.01	0.03	0.03	0.01	2.42	D	II, IV
	22	1.33	0.26	0.01	0.15	0.09	t	0.01	0.06	0.03	0.02	1.96	D	I, IV
	23	1.08	0.01	t	0.06	t	0.05	t	t	0.02	0.02	1.24	D	I, IV
	24	2.17	0.01	0.01	0.14	0.17	t	0.01	0.02	0.01	0.03	2.57	D	I, IV
	25	1.75	0.01	0.02	t	0.20	t	0.01	0.04	0.03	0.03	2.09	D	I, IV
ME-H (staminate)	19	1.10	0.02	0.02	0.13	1.19	0.01	0.01	0.07	—	0.02	2.57	F	II
	20	2.48	0.01	0.04	0.31	0.19	t	0.01	0.10	0.02	0.01	3.17	D	I, IV
	21	1.03	0.01	0.01	0.12	0.39	t	t	0.03	0.02	t	1.61	D	I, IV
	22	0.96	t	0.01	0.16	0.40	—	t	0.03	—	0.08	1.64	D	I
	23	0.59	0.27	t	0.07	0.78	t	t	0.10	—	0.01	1.82	F	II
	24	0.86	0.02	0.01	0.17	0.91	0.01	t	0.03	—	t	2.01	F	II
	25	1.57	—	0.01	0.15	0.23	t	t	0.11	—	—	2.07	D	I
ME-J (vegetative)	13	2.55	t	0.01	0.25	t	t	t	—	—	0.04	2.85	D	I
ME-J (pistillate)	15	1.28	t	0.05	0.02	0.01	—	t	—	0.12	0.02	1.50	D	I, IV
	18	1.91	0.01	0.01	0.14	0.03	0.01	0.01	0.01	t	0.04	2.17	D	I
	19	1.78	0.27	0.01	0.14	0.01	—	0.02	0.02	0.03	0.03	2.31	D	I, IV
	20	1.94	0.02	t	0.17	0.01	—	t	0.01	—	t	2.15	D	I
	21	1.60	0.01	0.01	0.14	t	0.01	0.01	—	0.03	0.04	1.85	D	I, IV
	22	1.14	0.01	0.02	0.12	0.01	0.02	0.01	0.01	0.02	0.06	1.42	D	I, IV
	23	2.33	0.01	0.02	0.19	0.04	—	0.01	0.02	t	0.05	2.67	D	I
	24	2.04	0.01	0.03	0.36	0.02	0.02	0.02	0.06	0.01	0.08	2.65	D	I, IV
	25	2.07	0.06	0.26	0.22	0.04	—	0.02	0.16	0.02	0.01	4.77	D	I, IV

(staminate)	17	0.73	t	t	0.08	0.01	0.02	t	—	t	0.02	0.86	D	I, IV
	18	1.57	0.01	0.02	0.17	t	0.02	t	0.03	0.03	0.06	1.91	D	I, IV
	19	3.78	0.01	0.08	0.76	t	t	0.03	0.04	t	0.14	4.84	D	I
	20	2.21	0.01	0.01	0.32	t	t	0.01	0.03	0.01	0.05	2.65	D	I, IV
	21	1.16	t	0.03	0.14	t	0.04	0.01	—	0.02	0.05	1.45	D	I, IV
ME-K (vegetative)	13	2.32	t	0.01	0.20	0.01	t	t	0.07	0.01	0.03	2.65	D	I, IV
	16	1.38	0.01	0.02	0.11	0.01	t	0.01	—	—	0.02	1.56	D	I
ME-K (pistillate)	15	2.15	0.01	0.02	0.19	0.03	—	0.02	t	—	0.02	2.44	D	I
	17	1.08	0.33	t	0.07	0.02	—	t	—	0.03	0.03	1.56	D	I, IV
	18	1.16	0.02	0.01	0.08	0.01	0.04	0.01	—	0.01	0.11	1.45	D	I, IV
	19	1.47	t	0.15	0.11	0.01	t	0.02	—	—	0.03	1.79	D	I
	20	1.42	0.01	0.03	0.09	0.01	0.03	t	t	0.02	0.05	1.66	D	I, IV
	21	1.45	0.02	0.02	0.10	t	t	0.01	0.01	0.02	0.07	1.70	D	I, IV
	22	1.47	0.01	0.01	0.10	t	t	t	0.03	0.02	0.05	1.69	D	I, IV
	23	1.73	t	0.01	0.07	0.05	0.01	t	0.06	—	0.03	1.96	D	I
	24	2.46	0.01	0.11	0.14	0.03	t	0.01	0.04	t	0.02	2.81	D	I
	25	2.58	t	0.06	0.07	t	0.01	0.15	0.05	0.01	0.03	2.96	D	I, IV
ME-K (staminate)	15	1.25	0.01	0.02	0.05	0.02	—	0.01	t	0.03	0.03	1.42	D	I, IV
	17	1.27	0.01	0.03	0.10	0.01	t	t	0.04	0.01	0.06	1.53	D	I, IV
	18	1.50	0.01	t	0.05	t	t	t	t	0.01	0.09	1.66	D	I, IV
	19	2.07	0.02	0.02	0.48	t	0.02	t	0.50	0.01	0.20	3.44	D	I, IV
	20	2.62	0.02	0.02	0.43	0.01	0.02	0.01	0.21	0.01	0.06	3.41	D	I, IV
ME-L (vegetative)	13	2.46	t	0.03	0.25	0.03	0.01	0.01	0.12	0.05	0.02	2.98	D	I, IV
	15	2.14	t	0.03	0.17	0.02	—	0.01	0.04	0.03	0.03	2.47	D	I, IV
	16	1.24	0.01	0.03	0.13	0.01	0.02	0.02	0.05	0.03	0.03	1.57	D	I, IV
	17	1.44	0.01	0.02	0.16	0.02	0.02	0.02	0.06	0.02	0.05	1.82	D	I, IV
	18	1.69	t	0.02	0.12	0.01	t	0.01	0.01	0.03	0.02	1.91	D	I, IV
ME-L (pistillate)	19	2.31	0.28	0.03	0.37	0.03	0.03	0.02	0.07	0.03	0.03	3.20	D	I, IV
	20	2.16	0.01	0.03	0.32	0.01	0.02	t	0.02	0.05	t	2.62	D	I, IV
	21	2.22	—	0.02	0.15	0.01	t	t	0.03	0.04	0.01	2.48	D	I, IV
	22	1.66	—	t	t	t	—	t	0.05	t	0.02	1.73	D	I
	23	1.44	0.01	0.01	0.11	0.01	t	t	0.02	0.02	0.02	1.64	D	I, IV
	24	1.31	t	0.01	0.08	0.02	—	t	t	0.01	t	1.43	D	I
	25	1.56	0.02	0.01	0.07	0.03	t	t	0.03	0.02	0.01	1.75	D	I, IV

Table 4 (continued)

Seed code	Age ^a	Δ^9 -THC	Δ^8 -THC	Δ^9 -THCV	CBC	CBD	CBDV	CBL	CBG	CBGM	CBN	Total cannabinoids	Waller [4] (type)	Small [6] (phenotype)
ME-L (staminate)	19	3.50	t	0.04	0.13	0.01	t	0.01	0.09	0.05	0.03	3.86	D	I, IV
	20	2.35	0.01	0.04	0.25	0.01	t	0.01	0.04	0.05	t	2.76	D	I, IV
	21	2.19	t	0.03	0.32	0.01	t	0.02	0.02	0.04	0.03	2.66	D	I, IV
	22	1.78	t	0.02	0.33	0.01	t	0.01	0.05	0.04	0.02	2.26	D	I, IV
	23	1.10	t	t	0.25	t	—	t	0.03	0.03	0.03	1.44	D	I, IV
	24	1.30	0.01	0.02	0.43	0.01	t	0.02	0.01	0.04	0.03	1.87	D	I, IV
	25	1.25	0.01	0.04	0.39	0.01	0.01	0.01	0.06	0.04	0.02	1.84	D	I, IV
ME-M (vegetative)	13	2.05	t	0.01	0.09	0.01	t	0.01	0.14	0.04	0.05	2.40	D	I, IV
	15	2.47	t	0.03	0.10	0.02	—	0.01	0.04	0.03	t	2.70	D	I, IV
	16	1.47	0.31	0.03	0.12	t	—	t	0.04	0.03	0.02	2.02	D	I, IV
	17	0.93	t	t	0.03	0.01	0.02	t	0.04	0.01	0.01	1.05	D	I, IV
	18	0.69	t	t	0.03	0.01	t	t	t	0.01	t	0.74	D	I, IV
	19	2.13	t	0.02	0.08	0.02	0.01	t	0.05	0.02	t	2.33	D	I, IV
ME-M (pistillate)	21	1.16	—	0.02	0.05	0.01	t	t	0.02	0.03	0.02	1.31	D	I, IV
	22	1.05	0.25	0.01	0.04	0.01	—	t	0.03	0.02	0.03	1.44	D	I, IV
	23	2.56	t	0.01	0.02	0.02	—	t	0.05	0.04	0.05	2.75	D	I, IV
	24	2.13	t	0.04	0.08	0.01	t	t	0.04	0.02	0.02	2.34	D	I, IV
	25	2.50	0.02	0.05	0.04	0.03	t	t	0.07	0.06	0.05	2.82	D	I, IV
ME-N (vegetative)	13	2.52	—	t	0.35	0.01	0.03	t	0.07	—	0.03	3.01	D	I
	15	2.78	0.03	0.04	0.31	0.02	—	0.01	0.04	0.03	0.03	3.29	D	I, IV
	16	1.80	0.01	0.03	0.14	0.02	0.01	0.01	0.04	0.01	0.03	2.10	D	I, IV
	17	1.13	0.01	0.01	0.12	0.01	0.05	0.01	0.04	0.01	0.04	1.43	D	I, IV
ME-N (pistillate)	18	1.38	0.02	t	t	0.18	0.06	0.01	0.02	0.05	0.10	1.82	D	I, IV
	19	2.73	0.01	0.06	0.28	0.01	0.04	0.01	0.08	0.04	0.03	3.29	D	I, IV
	20	2.30	t	0.04	0.09	t	—	t	0.05	0.01	0.01	2.50	D	I, IV
	21+2d	1.47	t	0.03	0.19	t	t	t	0.01	0.03	0.01	1.74	D	I, IV
	22	0.88	0.01	0.01	0.09	t	0.04	t	0.01	0.03	0.01	1.08	D	I, IV
	23	0.81	t	0.01	0.05	0.01	t	t	t	0.03	0.01	0.92	D	I, IV

	24	0.08	0.02	0.05	0.15	0.01	—	0.01	t	0.02	0.02	1.94	D	I, IV
	25	1.39	0.01	0.03	0.05	0.02	t	0.01	0.02	0.02	t	1.55	D	I, IV
ME-N (staminate)	18	2.06	0.03	0.05	0.02	0.03	0.06	0.01	0.03	0.10	0.14	2.53	D	I, IV
	19	2.24	0.29	0.07	0.39	0.04	0.01	0.02	0.06	0.04	0.05	3.21	D	I, IV
	20	2.73	t	0.03	0.22	0.03	0.02	0.01	0.05	0.05	0.01	3.15	D	I, IV
	21	1.50	0.01	0.02	0.20	t	t	0.01	0.03	0.02	0.02	1.81	D	I, IV
	22	1.15	0.23	0.02	0.13	t	—	0.01	0.04	0.03	0.08	1.69	D	I, IV
	23	1.35	0.23	0.03	0.08	0.01	t	t	0.03	0.02	0.02	1.77	D	I, IV
	24	1.66	0.01	0.09	0.27	0.02	0.05	0.01	0.04	0.03	0.01	2.19	D	I, IV
	25	1.93	—	0.03	0.11	t	0.03	t	0.07	0.03	—	2.20	D	I, IV
ME-O (vegetative)	13	2.23	0.01	0.06	0.25	0.01	0.01	0.01	0.05	0.03	0.03	2.69	D	I, IV
	15	1.75	0.01	0.21	0.09	0.03	0.02	0.02	0.04	0.03	0.02	2.22	D	I, IV
	16	1.11	0.13	0.03	0.14	0.10	0.02	0.01	—	—	0.02	1.56	D	I
ME-O (pistillate)	18	1.23	0.01	0.01	0.13	t	0.04	0.02	—	0.02	0.05	1.51	D	I, IV
	19	2.53	0.02	0.03	0.18	0.01	0.01	0.01	0.01	0.02	0.02	2.84	D	I, IV
	20	2.03	0.01	0.06	0.21	0.01	t	0.01	0.01	0.04	0.01	2.39	D	I, IV
	21	1.22	0.01	0.08	0.16	0.01	0.04	0.03	t	0.01	0.03	1.59	D	I, IV
	22	0.97	0.01	0.02	0.10	t	0.02	0.01	0.01	0.03	0.02	1.19	D	I, IV
	23	3.13	0.32	0.03	0.16	0.02	—	0.01	0.06	0.03	0.05	3.81	D	I, IV
	24	1.45	0.01	0.13	0.02	t	t	0.01	0.04	t	0.04	1.70	D	I
	25	0.95	0.01	0.08	0.16	0.01	0.02	0.01	0.10	0.02	0.04	1.40	D	I, IV
ME-O (staminate)	15	1.40	—	t	0.25	0.03	0.01	t	—	—	0.02	1.71	D	I
	17	1.42	0.01	0.02	0.18	t	0.02	0.01	0.06	0.02	0.04	1.78	D	I, IV
	18	1.54	0.02	0.03	0.31	0.03	0.03	0.01	0.03	0.03	0.03	2.06	D	I, IV
	19	2.19	0.02	0.05	0.59	0.01	0.02	0.03	0.04	0.04	0.05	3.04	D	I, IV
	20	3.09	0.01	0.03	0.88	t	t	0.01	0.08	t	0.02	4.12	D	I
	21	1.51	0.01	0.03	0.25	0.02	0.02	0.01	0.05	0.04	0.03	1.97	D	I, IV
	22	1.14	0.02	0.01	0.12	t	—	t	0.08	0.04	0.03	1.44	D	I, IV
	23	1.30	t	0.06	0.36	0.03	t	0.02	0.05	0.03	0.03	1.88	D	I, IV
	24	1.07	0.01	t	0.13	0.01	t	t	0.07	0.02	0.05	1.36	D	I, IV

^a Age in weeks^b t = trace (less than 0.009%)^c D = drug.

Table 5
Effects of temperature and rainfall^a on the Δ^9 -THC^b content of the variants of Mexican *Cannabis* grown in Mississippi in 1974 and 1976

1974 ^c										
Age (weeks)	Temperature (°F)		Rainfall (in.)	Δ^9 -THC content (%) of seed code ME						
	Average max.	Average min.		H	J	K	L	M	N	O
10	85.29	63.14	—	0.64		0.78	0.52	0.57	0.43	0.78
11	87.71	63.00	0.55	1.00	0.84	0.95	0.87	1.07	0.79	1.20
12	92.71	64.43	0.02	0.91		0.79	1.03	1.14	0.87	0.88
13	88.86	66.86	3.33	1.14	0.71	1.30	1.56	1.40	1.34	1.01
14	87.57	64.71	0.55	0.61	0.91		0.99		0.75	0.58
15	85.86	65.43	0.02	0.67		0.72	0.69		0.70	
16	88.86	67.29	2.10	1.11	1.19		1.25	1.87	1.13	1.32
17	89.00	64.86	1.44	0.88	1.01	1.05	2.13	2.06	1.24	1.16
18	87.14	69.14	0.63	1.13		1.91	1.74	1.76	1.38	
19	74.56	57.29	1.01	1.31						1.10
20	82.71	67.71	0.95	1.46	1.22	1.97	1.67	1.31	1.51	1.11
21	84.43	58.00	1.30	1.43	0.70	1.99	0.98	1.17	1.62	0.79
22	71.86	54.43	5.93							
23	72.00	40.29	0.60							
24	75.43	45.00	0.63							
25	70.71	42.14	1.33							

1976 ^d										
Age (weeks)	Temperature (°F)		Rainfall (in.)	Δ^9 -THC content (%) of seed code ME						
	Average max.	Average min.		H	J	K	L	M	N	O
10	81.00	58.14	0.61							
11	86.71	66.14	0.10							
12	85.14	60.07	0.90							
13	90.57	63.50	—	2.19	2.55	2.32	2.46	2.05	2.52	2.23
14	89.28	62.00	1.19							
15	93.57	67.71	0.76	1.03	1.28	2.15	2.14	2.47	2.58	1.75
16	88.29	63.57	0.35	0.85		1.38	1.24	1.47	1.80	1.11
17	86.29	59.71	1.03	0.94	0.73	1.08	1.44	0.93	1.13	
18	91.86	63.86	0.20	0.73	1.91	1.16	1.69	0.69	1.38	1.23
19	90.00	60.00	—	1.84	1.78	1.47	2.31	2.13	2.73	2.53
20	89.14	64.00	0.11	1.74	1.94	1.42	2.16		2.30	2.03
21	82.29	65.71	3.87	1.44	1.70	1.45	2.22	1.16	1.47	1.22
22	80.57	53.71	0.20	1.33	1.14	1.47	1.66	1.05	0.88	0.97
23	83.71	57.43	0.91	1.08	2.33	1.73	1.44	2.56	0.81	3.13
24	81.29	56.57	0.70	2.17	2.04	2.46	1.31	2.13	1.68	1.45
25	80.14	51.29	—	1.75	3.97	2.58	1.56	2.50	1.39	0.95

Note: Blank spaces indicate that analysis was not performed.

^a Total rainfall for the growing season of 1974 and 1976 was 27.22 in. and 19.57 in., respectively. Rainfall from date of planting (until week 9) was 14 in. and 9.50 in. in 1974 and 1976, respectively.

^b Δ^9 -THC values are those of young female plant material.

^c Date of planting was 26 April.

^d Date of planting was 14 April.

Thus, seed code ME-H is of variant two and all others are of variant one. If we use both the Waller and the Small and Beckstead methods and apply these methods to all seed codes, we find that all seed codes fall predominantly into phenotype I, or phenotypes I and IV, depending on the age of the sample when analysed; whereas all fit in the drug type, according to Waller. The exception of both of these is the variant which contains sufficient quantities of CBD (ME-H) which fits in phenotypes I, II or IV and in the drug or fibre type in the Waller system. These data strongly indicate that a single analysis gives a classification for this sample only and not for the variant.

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