

***Aloe vera* Response to Plastic Mulch and Nitrogen**

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INTRODUCTION

The exudate of *Aloe vera* L., Liliaceae, is used for numerous medical and cosmetic applications since ancient times (Morton 1961). The gel of *A. vera* possesses various biological and physiological activities: (1) healing ability of skin burns and cutaneous injuries; (2) prophylactic effect against radiation leucopenia; (3) anti-ulcer; (4) inhibitory action against some bacteria and fungi; (5) inflammation-inhibiting effect; (6) inhibition of the prostaglandin synthesis by anthraquinone-type compounds; and (7) inhibition of the AIDS virus by acemannan.

Commercial exploitation of *Aloe vera* gel has been carried out for at least 50 years. Various companies in the US act as primary growers and processors of the plant and manufacture bulk supplies of the gel for domestic and export market. Many other companies are secondary processors of *A. vera* products, and cosmetics firms and chain store often buy the gel for incorporation into their own brand name products (Grindlay and Reynolds 1986).

The cultivation of *A. vera* has acquired great commercial importance for medicinal products and cosmetics processing but information is scarce about agronomic management of this crop.

The present study was carried out to (1) determine the effect of mulching on yield of *A. vera* at three levels of nitrogen (0, 100, and 150 kg/ha) per cutting (two cuts a year is the common practice); (2) evaluate the concentration of N, P, and K in the gel and juice of *A. vera*; and (3) correlate leaf morphology measurements with fresh weight in order to predict yield nondestructively.

METHODOLOGY

The study was conducted at the Antonio Narro University's experimental field in Saltillo, Coahuila, México. The *Aloe vera* plants were transplanted in March 1998, under a random block design with four replications. The experimental arrangement of the experiment was a split plot with mulch and bare soil treatments as the main plot; three fertilization doses (0, 100, and 150 kg/ha) represented the subplot. Crop data recording started on May 2001. Initially the plots were irrigated and plants were clipped and left with only four to five leaves.

The mulched plots consisted in three beds 1.2 m wide, 6 m long, and 1.8 m from center to center. The bed was covered with black polyethylene (100 μ m). Two drip irrigation tapes were installed under the black polyethylene. The *Aloe* plants were sown in double furrows to yield a population of 25,000 plants/ha. The nitrogen fertilizer subplot consisted of a single bed.

The bare soil plot consisted of 8 furrows, 6 m long each, with a separation of 1 m. One drip irrigation tape was installed in each furrow. *Aloe* plants were sown with a separation of 0.40 m for a population of 25,000 plants/ha. The nitrogen fertilizer subplot consisted of 2 furrows (the subplots were separated by a furrow).

The soil was loam-clay, with 40–60 cm depth and approximately 1.4 mm/cm available soil water. The soil was characterized by a pH of 8.1, P content 22.5 kg/ha, and K of 900 kg/ha, with a total content of N of 0.20% (medium rich). Tensiometers were installed in the center of the furrows between two plants, soil humidity tension was recorded 30 cm deep. Irrigation was performed when the tensiometer showed a reading of 70 centibars.

Fertilization was done through fertigation; N fertilizer was applied in four monthly supplies (April–July); P and K were applied in doses of 30 and 100 kg/ha, respectively, distributed in four applications. Fertilization sources were ammonia sulphate (20.5–0–0), phosphoric acid (0–85–0); and potassium nitrate (11–0–44).

Leaves were collected monthly from May to August; 4 plants/treatment (1 plant/replication). Leaves were weighed and length, width, and thickness determined. Gel and bagasse were separated from the juice using a laboratory roll processor, and weighed.

During the period of Apr. 18 to Aug. 28, 8 irrigations were carried out for the treatments with and without mulching (Table 1). Humidity tension of soil, before watering, reached values between 60 and 70 centibars (Fig. 1). During the experimental period precipitation was 227 mm (Fig. 3), air mean temperatures fluctuated between 20° and 22°C, indicating that the cultivation was carried out under favorable conditions of soil humidity.

Chemical Analysis

Gel and juice samples were homogenized for each plant, and nitrates and potassium concentrations were measured (ppm) using a Compact Ion Meter Cardy, Honda 1999 (Honda LDT, Kyoto Japan). P concentration was measured using the technique reported by Hanna Instruments (1999).

Estimation of Leaf Fresh Weight

Leaf volume was calculated using leaf length (L), width (W), and thickness (T). Leaf geometry was considered to be a cone with elliptical rather than circular cross section (Fig. 2). Volume was calculated as $V = (L/12) \pi W T$. Leaf volume was regressed on fresh weight using the MSTAT software (MSTAT-C 1990).

Table 1. Irrigation timing for *Aloe vera* grown under mulch and bare soil treatments.

2001 irrigation dates	Interval (days)	Water depth (cm)
Apr. 18		5
May 08	20	5
June 05	29	5
June 17	12	5
June 29	12	5
July 11	12	5
July 28	18	5
Aug. 04	28	5
Total water depth		40

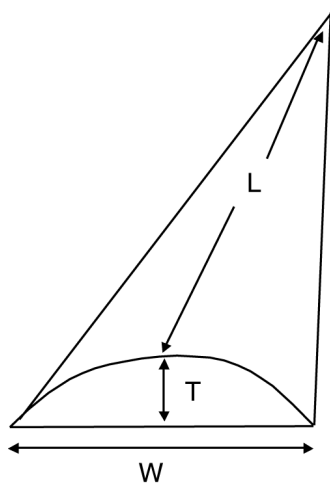


Fig. 2. Diagram of the approximate geometry of *Aloe vera* leaves and definition of parameters for volume calculation. L = length; W = width; T = Thickness.

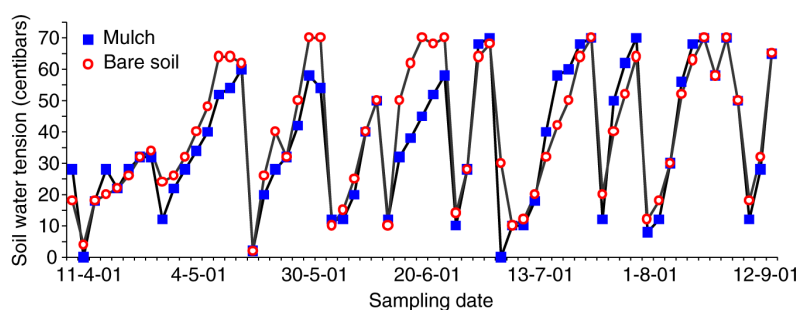


Fig. 1. Evolution soil water tension in the treatment with and without mulching during the development of the experiment.

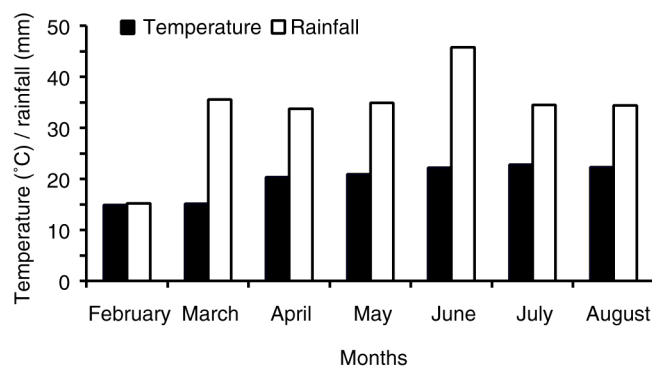


Fig. 3. Air mean temperature and precipitation during the months the experiment was developed.

RESULTS

Growth Analysis

Variance analyses (data not shown) indicates that mulch or nitrogen treatments were significant only for gel content. At the beginning of the experiment in May, leaf weight was 200 g/plant, and in August it was 1400 g/plant (Fig. 4). The average growth rate was 412 g/month; juice content increased by 116 g/month, gel by 84 g/month, and bagasse by 164 g/month (Fig. 4).

In May, plants averaged 4 leaves and in August 9 leaves per plant (Fig. 5); average growth rate was 1.8 leaves/month. The increase in leaf weight of a plant is a function of the number of leaves (Fig. 6). Leaf weight increased by an average of 228 g/leaf; juice and bagasse increased by 90 g/leaf and gel increased by 50 g/leaf. Juice represents 40% and gel 20% of total leaf weight. These results indicate that treatments to increase yield should focus on leaf development.

Chemical Analysis

Average nitrate concentration in gel and juice diminishes as the number of leaves increases (Fig. 7). When the plant has 4 leaves nitrogen concentration was 1049 ppm in juice and 524 ppm in gel; when the plant

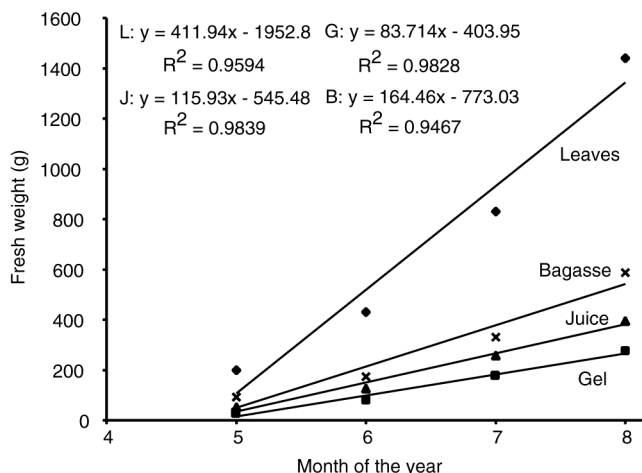


Fig. 4. Leaves, gel and bagasse weight increments of *Aloe*, regarding the month of the year. L = leaves; J = juice; G = gel; B= bagasse.

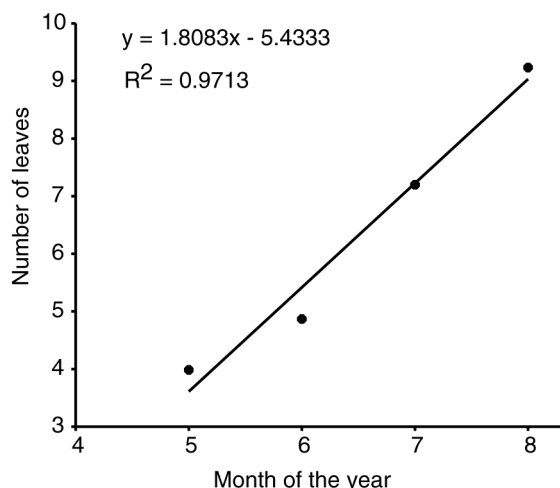


Fig. 5. Increment of the number of leaves regarding the month of the year.

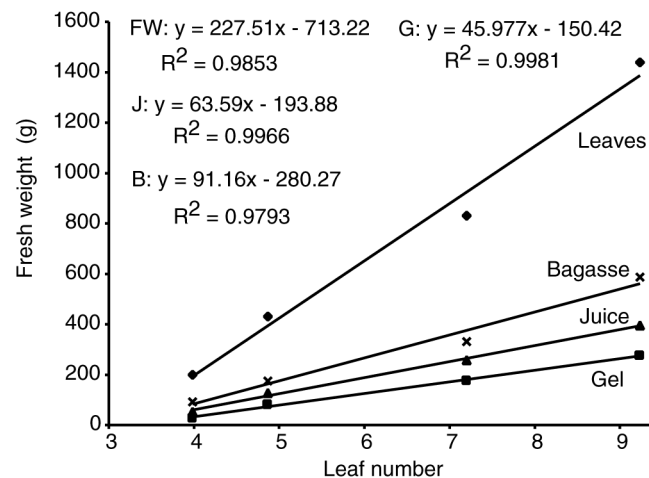


Fig. 6. Leaves, gel, juice and bagasse weight increments in a plant of *Aloe*, regarding the number of leaves. L = leaves; J = juice; G = gel; B= bagasse.

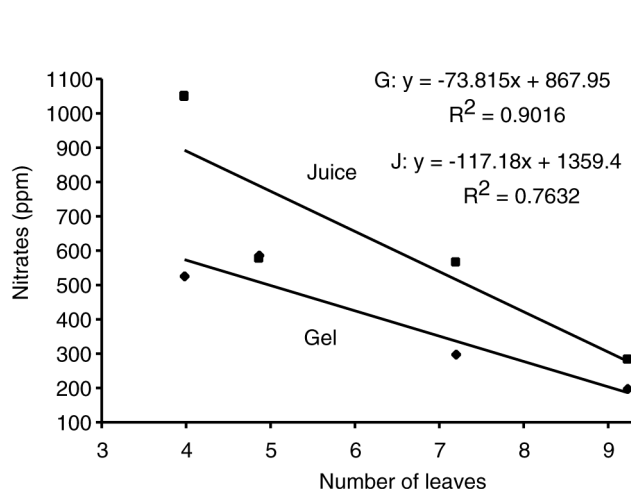


Fig. 7. Juice and gel nitrates concentration regarding the number of leaves G = gel; J = juice

had 9 leaves, nitrogen concentration diminished to 280 ppm in juice and 197 ppm in gel. A similar tendency was found for P, concentration was reduced from 87 to 32 ppm in juice, and from 70 to 45 ppm in gel (Fig. 8). There was no defined tendency for K which varied from 500 to 700 ppm (Fig. 9).

Yield

Leaf yield was 18.0 tonnes (t)/ha for the mulched treatment and 20.6 t/ha for bare soil (Table 2) but this difference was not significant. These results may be explained by abundant natural precipitation. However, gel content was significantly higher in the mulched treatment. There was no affect of N on yield, agreeing with results obtained by Yépez et al. (1993).

There was a significant difference in gel nitrate and phosphorus concentration between the mulch and the bare soil treatments. Average concentrations were 249 ppm nitrates, 35.4 ppm P, and 514 ppm K.

Predicting Leaf Weight

The relationship between calculated volume and fresh weight of leaves is shown in Fig. 10. Apparent volume is a good parameter to estimate leaf fresh weight ($R^2 = 0.935$).

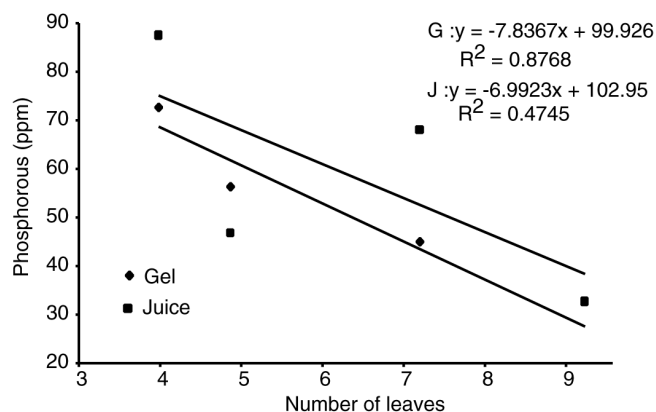


Fig. 8. Juice and gel phosphorus concentration regarding the number of leaves G = gel; J = juice.

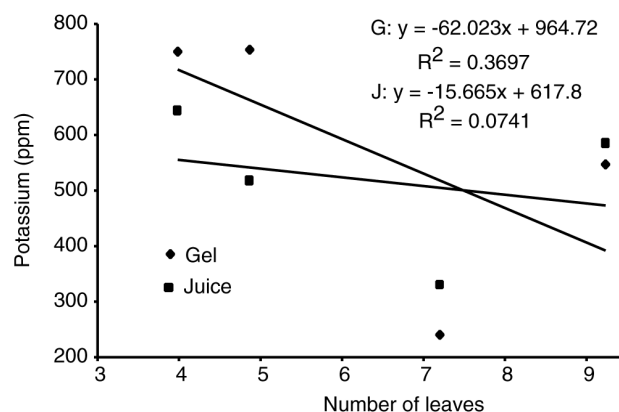


Fig. 9. Juice and gel potassium concentration regarding the number of leaves G = gel; J = juice.

Table 2. Means test for mulch and bare soil treatments at different fertilization doses for leaves, gel, juice and bagasse yields in *Aloe vera* at harvest.

Treatment	Leaf fresh weight (t/ha)	Gel (t/ha)	Juice (t/ha)	Bagasse (t/ha)
Mulching	18.00 a	3.32 b	6.99 a	7.59 a
Bare soil	20.67 a	4.17 a	8.39 a	8.10 a
Doses N (kg/ha)				
150	20.81 a	3.92 a	7.97 a	8.92 a
100	18.21 a	3.53 a	7.59 a	7.07 a
00	18.84 a	3.77 a	7.51 a	7.55 a

LSD 0.05

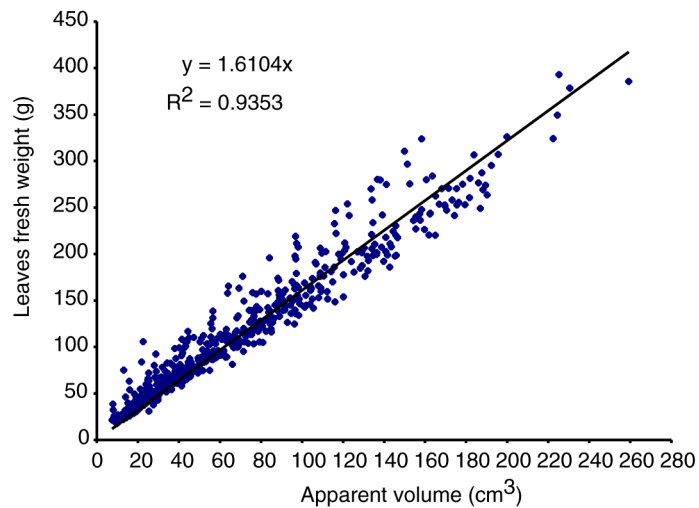


Fig. 10. Leaves weight regarding apparent volume.

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