Seasonal variations in crop indices of sugar cane*1/

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COMPENDIO

Se condujo un experimento en Coimbatore, India (11° N y 77° E, 498 m sobre NM) por dos años, realizando cuatro cultivos de caña en diferentes fechas. El objetivo era encontrar el efecto de los parámetros climáticos sobre los índices de cultivo de la caña de azúcar. Los resultados indicaron que cuando el cultivo era sometido a una temperatura baja severa durante la fase de crecimiento tardío, el nitrógeno foliar era bajo. Una cantidad más alta de lluvia aumentó el contenido de nitrógeno. El clima afecta la tasa máxima de absorción en relación con la edad del cultivo. Similarmente, el contenido de fósforo era muy afectado también por la lluvia y la temperatura. El contenido de fósforo se redujo con la edad avanzada. Las lluvias más intensas tuvieron un efecto adverso sobre el contenido de potasio de la vaina foliar, mientras que fue el reverso con el índice primario

Introduction

AMONG the factors that influence the stepping up of crop production mineral nutrition plays a major role. In recent years, tissue or foliar analysis of the plant to assess the adequacy of its nutritional needs is gaining importance. The final yield alone may not give a true measure of limiting conditions of any one period during the growth cycle. Hence, logging or periodical studies of the plant, throughout its life, was found most appropriate. This gives a correct insight into the relative effects of different factors individually or in combination on the ultimate crop performance. In this regard, the utilisation of foliar analysis has been found to be practically successful in sugarcane.

Based on the foliar diagnosis, optimum values of nitrogen index have been fixed for various stages of growth for maximum yield of cane. However, it is not the only nitrogen index alone that has to be considered. The moisture index, phosphorus, potassium as well as primary index (total sugars) also contribute to the final yield. These indices are inter-related to each other and variation in any one will affect the other. A detailed study on this aspect was carried out at the Tamil Nadu Agricultural University, Coimbatore and the results are presented in this paper.

Materials and Methods

The field experiment was laid out in the farm of Agricultural University, Coimbatore during the years 1971-73 by raising four plant crops (January, May, September and December '71 planting and harvesting in 1972-73). The variety was Co 419 which is a late maturing high yielding one. The soil type was clay loam, medium in available nutrients.

The experiment was laid out in split plot design replicated twice with gross and net plot sizes of 56.7 and 31.5 sq m respectively. The treatments for individual corps included three irrigation levels in main plot and 24 combinations of times of application of nitrogen, phosphorus and potassium and chemical ripeners. For crop log samples, the procedures suggested by Clements (4) and Lakshmikantham (8) were adopted. Total nitrogen in the leaves was estimated by micro kjeldhal method (6) and phosphorus and potassium by triple acid digestion method (7). The primary index (Total sugars) was estimated by the

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method suggested by Yoshida *et al* (10). Samplings were done at monthly intervals from 90th day onwards upto 240 days and threafter at fortnightly intervals. The mean of individual crops for the particular stage over all the 72 combinations of treatments has been utilised for assessing the effect of climate on the crop indices which is discussed in the present paper.

Results and Discussion

During the early growth phase, the mean nitrogen per cent was found to be the maximum for May planted crop (1.705 per cent) the lowest being 1.682 per cent for September planted crop (Table 1). The differences were found to be significant. Similarly, considerable differences in the nitrogen content at late growth and maturity phases were also observed. During the late growth phase also, May planted crop recorded the highest amount of leaf nitrogen per cent of 1.880 followed by December (1.850), January (1.820) and September crop (1.810). In the case of maturity phase, the lowest amount was recorded for December crop with highest for January crop. These differences in the leaf nitrogen content within the same age group under different seasons can be largely attributed to the seasonal conditions. The effect of fertilisers on cane crop is generally influenced by the climatic factors. Temperature particularly affects the nitrogen status of the plant. According to Baver (1) reduction in temperature from 83 to 64°F reduced the nitrogen uptake by thirty six per cent. Similarly, excess rainfall reduced the leaf nitrogen content. According to Evans, (5) this effect is mainly due to reduced uptake as a result of leaching of available nitrogen and reduced microbial activity resulting in reduced rate of nitrogen mineralisation. In the present study also, crop planted during September received very low temperature conditions during the early growth phase which would have brought down the absorption of nutrients. This was also reflected in the reduction of growth as explained in earlier paper (9).

During the late growth phase, the effect of rainfall seems to be more pronounced. May and December planted crops received 140.4 and 92.0 mm of rainfall respectively in course of 60 days as against 45.5 and 29.7 mm for January and September crops respectively. This higher quantity of rainfall may be the reason for the increased nitrogen content during the late growth phase of the crop planted in May and December. Similar trend has been observed in case of the maturity phase also.

The effect of season in relation to age of the crop on the nitrogen content in leaf was also found to be significant at all the three stages of the crop growth.

In all the four crops, the effect of age was found to be on the higher order. There was increased nitrogen per cent in the leaf upto the late growth phase after which there was considerable reduction. However, the age of the crop at which the nitrogen content was maximum differed from crop to crop (Fig. 1). In the case of crop planted in January, the maximum nitrogen content of 1.86 per cent was observed at 240 days, while for May and December crops, it was on 210 days. On the other hand, the September crop recorded maximum nitrogen content of 1.83 per cent at 180 days itself. This increased and prolonged absorption of nitrogen in case of May crop can be attributed to the adequate amount of rainfall from 90 to 240 days, the temperature also being optimum. In case of the September crop, particularly, there was no rainfall between 120 and 240 days. Further, this part of the growth phase experienced low temperature also (Mean minimum experienced low temperature also (Mean minimum temperature =17.0°C). This would have restricted the growth rate as well absorption of nitrogen from the soil. This is also seen from the reduced leaf nitrogen content. However, within certain limits of observation, in general it was observed that the nitrogen content increased upto around 195 days after which there was fall in the same. This was also confirmed by the quadratic equation being the best fit for all the crops in relation to age and leaf nitrogen content. The corresponding equations are given in Fig. 1 for all the four plant crops.

Sheath phosphorus

As in the case of nitrogen, the sheath phosphorus was also found to be influenced by the season. In general, the trend was towards reductions in the content of sheath phosphorus wtih increase in age (Table 1 and Fig. 2).

During the early growth phase, when the rainfall was maximum (430.8 mm) for May crop, the sheath phosphorus was found to be the maximum (188 mg). In the other months of planting, due to low temperature (17.0°C) the phosphorus content was found to be the lowest. During the late growth phase, the variation in sheath phosphorus was found to be altered by the rainfall pattern. Increased rainfall during late growth phase increased the rate of drop in the phosphorus content. The rainfall was moderate (84.5 mm) between 180 and 270 days for the crop planted in January in which case there was a gradual drop in the phosphorus. On the other hand, May crop received 384.2 mm of rainfall due to which there was a steep fall in the phosphorus content (140 to 88 mg). September and December crops received practically no rainfall during this part of the growth phase resulting in maintenance of the same amount.

Sheath phosphorus values were generally high in in the initial stages and thereafter gradually reduced till harvest.

Sheath Potassium

The seasonal effect on the sheath potassium content during the early growth phase was significant. The crop planted during January recorded the maximum value of 1.91 per cent followed by May crop

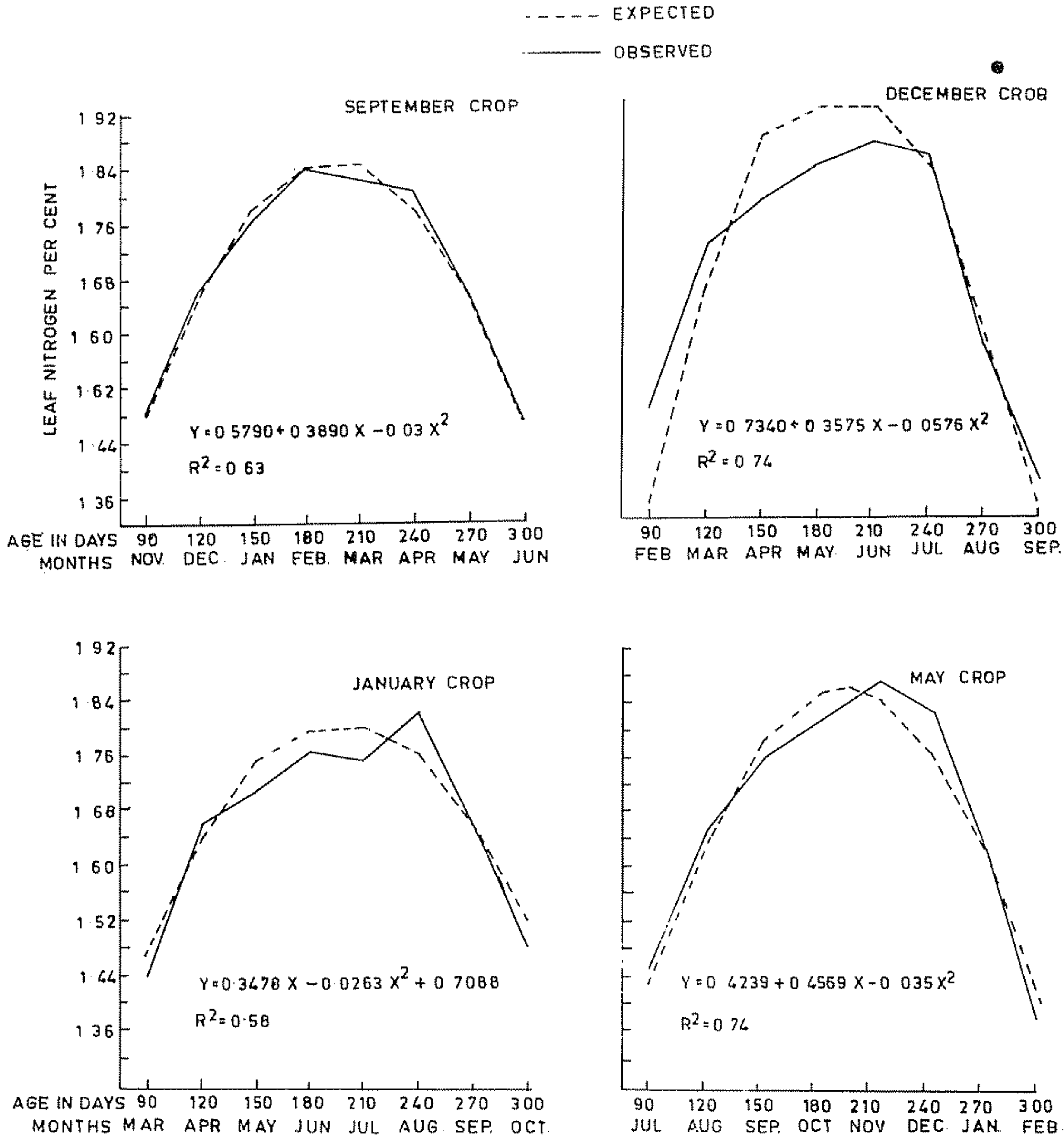

Fig. 1—*Seasonal effect in relation to age of crop on leaf nitrogen per cent.*

1.89 per cent (Table 1 and Fig. 2). There was not much difference between September and December crops (1.84 and 1.85 per cent). During late growth phase, the potassium content was maximum for September crop followed by December and May crops 2.46 and 2.45 per cent respectively. The influence of climate was found to be slightly different from that of nitrogen as seen from the above. With increasing rainfall, there seems to be reduction in the potassium content of the plant. Clements (3) and Borden (2) had reported that adverse climatic conditions like heavy rainfall did not permit the full utilisation of potassium absorbed

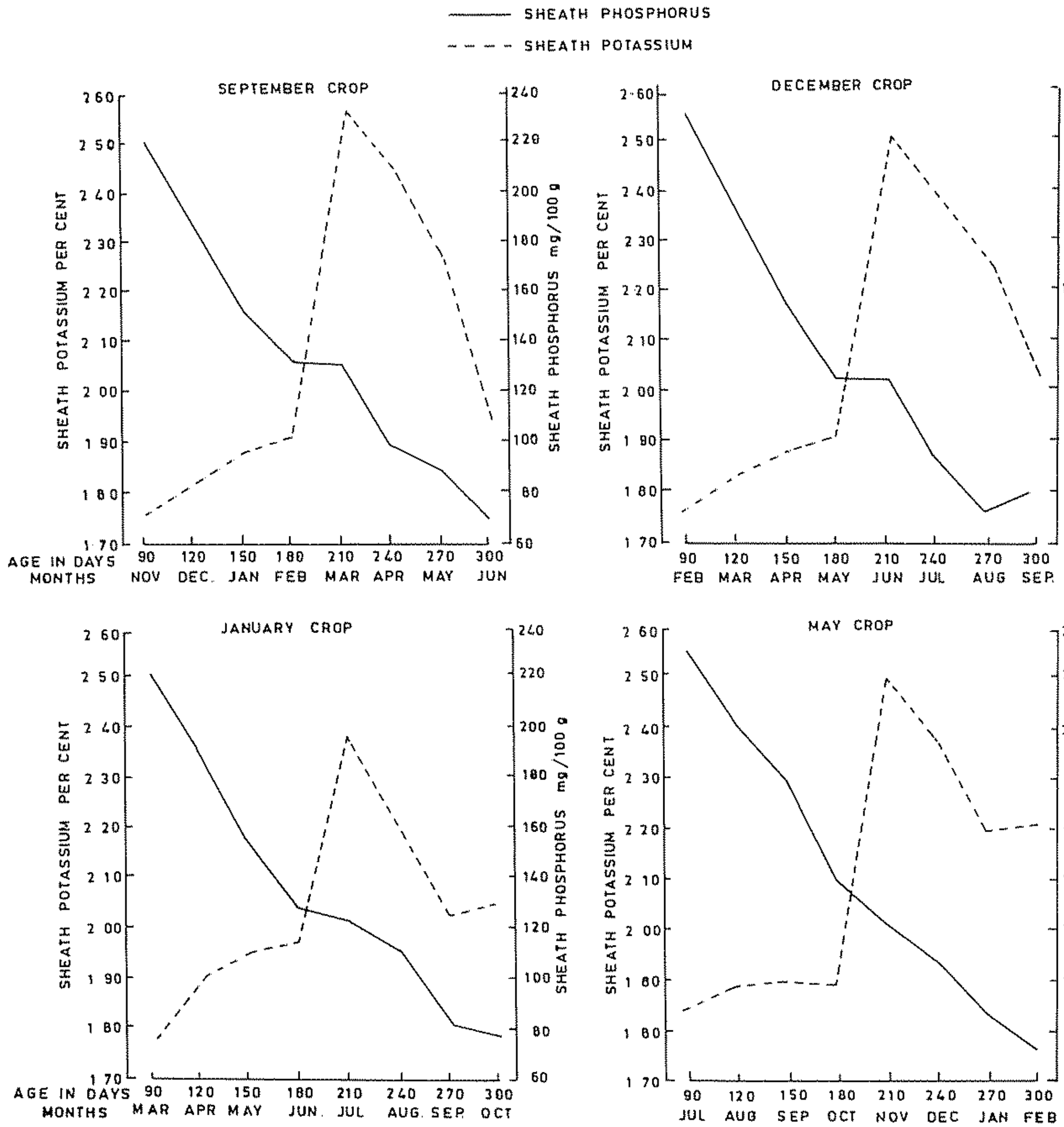

Fig. 2.—*Seasonal effect in relation to age of crop on sheath phosphorus and potassium content*

In all the crops, the maximum content of sheath potassium was seen at 210 days. The potassium values increased gradually from 90 to 180 days and thereafter, there was sudden increase. This was maintained upto 240 days. The increased absorption of potassium followed the pattern of nitrogen. Since maximum growth of crop is seen between 180 and 240 days, more of nitrogen was absorbed which would have increased the absorption of potassium also. Further, potassium is required for the translocation of sugars synthesised especially during the peak growth phase of the crop which would have warranted the absorption of the same larger quantities.

Primary Index

Production of sugars is mainly governed by solar energy in the form of heat and light while utilisation

Table 1—Effect of season on crop indices

Crop	Period of observation	Age in days	Mean climatic data				Mean value of			
			Maximum Temperature °C	Minoumum Temperature °C	Relative humidity %	Rain-fall mm	Leaf nitrogen per cent	Sheath phosphorus mg/100 gm	Sheat potassium percent	Primary index percent
January	March - June	90 - 180	32.7	22.1	75	177.6	1.688	175.41	1.91	13.93
	July - August	181 - 240	30.3	21.9	78	45.5	1.825	118.83	2.30	12.37
	Sep - Nov.	241 - 315	29.9	20.9	93	444.4	1.610	83.82	2.07	12.45
May	Nov - Dec.	90 - 180	30.4	21.8	80	430.8	1.705	188.07	1.89	13.59
	July - Oct.	181 - 240	27.4	18.7	79	140.4	1.880	116.28	2.45	12.19
	Jan - March	241 - 315	30.4	16.8	88	—	1.540	83.81	2.24	12.43
September	Nov - Feb.	90 - 180	28.8	17.9	73	141.7	1.680	170.34	1.84	14.07
	March - April	181 - 240	34.4	19.8	62	29.7	1.810	114.20	2.50	12.65
	May - July	241 - 315	31.3	22.9	86	211.3	1.550	84.20	2.15	12.09
December	Feb - May	90 - 180	33.2	20.3	66	148.3	1.698	175.08	1.85	14.10
	June - July	181 - 240	30.7	22.6	73	92.0	1.850	102.81	2.46	12.14
	Aug - Oct.	241 - 315	30.7	22.3	90	273.0	1.468	83.55	2.18	13.51
Ratoon	Feb - May.	90 - 180	33.2	20.3	66	148.3	1.656	180.34	1.95	13.94
	June - July	181 - 240	30.7	22.6	73	92.0	1.933	128.47	2.96	13.33
	Aug. - Oct.	241 - 315	30.7	22.8	88	273.0	1.678	83.00	2.10	13.43
	C. D. at 5% level						0.016	6.50	0.019	0.16

Table 2—Effect of season in relation to age of crop on primary index

Month of	Age in days										
	90	120	150	180	210	240	255	270	285	300	315
Primary index											
January	15.0	14.2	15.6	13.0	12.8	12.0	12.3	12.5	12.7	12.4	12.4
May	14.9	14.1	13.1	12.2	12.8	11.6	13.4	13.5	13.7	13.2	13.4
September	14.9	14.6	13.8	13.0	13.1	12.3	12.1	12.2	12.2	11.9	12.0
December	15.2	14.3	13.7	13.3	12.7	11.6	13.5	13.7	13.8	13.2	13.3

C. D. at 5% level = 0.06.

of sugars depends largely on moisture and growth. The balance between production and utilisation is reflected in the sugar content and is termed as primary index. When the primary index of the crop drops below a certain level, it is apparent that the growth rate is higher. As the growth was influenced significantly by the climatic parameters, it is also anticipated that these effects can also be seen in respect of primary index.

The primary index values varied with climatic variations. (Table 2). When the climatic variables are more favourable, i.e., adequate rainfall and higher temperature, more of sugars are utilised for growth which was reflected by lesser amount in the indicator tissues. Such a beneficial effect of climatic variables was seen in the presnt study also. The total rainfall was higher for May crop during the early and late growth phases which induced more growth. For the production of fresh vegetative tissues, more energy is required which has to be released by the breakdown of the photosynthetic material viz., sugars. Hence, as the growth rate is increased, there was considerable reduction in the sugars in the tissues. This was also indicated by the negative correlation between leaf nitrogen and primary index (—0 7188).

Summary

A study was conducted at Coimbatore (11.0°N and 77.0°E, 498 meter above MSL) for two years raising four crops at different times. The objetive was to find out the effect of climatic parameters on crop indices of sugarcane. The results indicated that when the crop was subjected to severe low temperature during late growth phase, leaf nitrogen was low. Higher quantity of rainfall increased the nitrogen content. Climate affect the peak rate of absorption in relation to age of the crop. Similarly, phosphorus content was also affected much by the rainfall and temperature. Phosphorus content was reduced with advancing age. Higher rainfall had adverse effect on sheath potassium content while it was reverse with primary index.

Literature cited

1. BAVER, L D. A decade of research progress 1950-59. Hawaiian Plant Research 57: 1-18. 1963.
2. BORDEN, R.J. A search for guidance in the nitrogen fertilisation of sugarcane crop. Hawaiian Plant Research 46:191-238. 1941.
3. CLEMENTS, H F. Integration of climatic and physiological factors with reference to the production of sugarcane. Hawaiian Plant Research 44:201-203. 1940.
4. CLEMENTS, H F. Crop logging of sugarcane in Hawaii. Plant Analysis and fertilizer problems. American Institute of Biological Sciences. Publications, 1961. pp. 131-141.
5. EVANS, H. Tissue diagnostic analysis and their interpretation in sugarcane. Proceedings of the International Society of Sugarcane Technologists 12: 156-180. 1965.
6. HUMPHRIS, E.C. Mineral componets and ash analysis. *In* Modern methods of plant analysis. Berten 1. Berlin, Springer, 1956. pp. 468-502.
7. JACKSON, M L. Soil chemical analysis. Madras, India, Asia Publishing House, 1956.
8. LAKSHMIKANTHAM, M. Crop logging in sugarcane around the world. *In* Proceedings of the Biennal Conference of Sugar Research and Development Workers, India 5: 306-317. 1964.
9. SRINIVASAN, T R. Effect of irrigation, nitrogen, phosphorus, potassium and chemical ripeners on cane and sugar yield of sugarcane. Indian Sugar 1978. (in press).
10. YOSHIDA, S., FORNO, D A. and COCK, J.H. Laboratory manual for physiological studies of rice. International Rice Research Institute, Los Banos, Phillippines, IRRI., 1971. 61 p.

Notas y Comentarios

Harina destoxificada de jojoba

El interés en el aceite de jojoba se ha intensificado por la escasez del aceite de cachalote *(Physeter catodon)*, que se ha vuelto más aguda porque este tipo de ballena ha sido colocado en la lista de especies en peligro. Consecuentemente, la importación de aceite de cachalote a los Estados Unidos ha sido prohibida (Cf. *Turrialba* 24: 340).

La harina de jojoba es el residuo producido cuando el aceite es separado de la semilla. Desafortunadamente, la harina de jojoba no puede ser consumida por los rumiantes y otros animales porque es tóxica. Como resultado, los animales instintivamente no comen la harina. Con el aumento de interés en el aceite de jojoba, hay una abundancia de harina de jojoba, que contiene proteína y otros nutrimentos valiosos para la alimentación animal.

C A. Elliger, A C. Waiss, Jr., y A N. Booth (U S Patent 3.919.432, asignada al U.S. Secretary of Agriculture) describen un proceso para tratar la harina de jojoba de tal manera que su toxicidad sea sustancialmente reducida, y pueda ser usada para la alimentación animal.

Según el proceso, la harina de jojoba es tratada con amoníaco para ser destoxificada. Generalmente, la harina se pone en contacto con 5 a 10 por ciento de amoniaco en peso. El contacto debe ser mantenido por 25 a 35 días. Varios métodos pueden ser usados; por ejemplo, la harina puede ser tratada con hidróxido de amonio acuoso para suministrar las cantidades correctas de amoniaco y agua, en un recipiente, que puede ser de plástico, que evite la evaporación del amoniaco. También, la harina puede ser tratada con una cantidad apropiada de agua en el recipiente; entonces, se aplica amoniaco gaseosos hasta que se obtenga el porcentaje apropiado.

Una ventaja adicional es que la harina se hace más digestible mediante la aplicación de amoniaco, lo que aumenta su valor nutritivo.

Copias de las patentes pueden obtenerse en la U.S. Patent Office, en Washington, D C., al precio de 50 centavos de dólar cada una.