The Nitrogen, Phosphorus, Potassium and Ash Content Of Castor Bean Hulls

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Fertilizer Value Of Castor Bean Hulls

Castor bean hulls compare favorably with cotton burs as a low grade source of the three major fertilizer elements, nitrogen, phosphorus, and potassium. Castor bean hulls analyzed during a three-year period showed average values as follows: nitrogen, 1.64 percent; phosphorus, 0.082 percent; potassium, 3.81 percent. Cotton burs were analyzed in a previous study* as follows; nitrogen, 1.04 percent; phosphorus, 0.10 percent; and potassium, 3.39 percent.

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*Oklahoma Agricultural Experiment Station Bulletin No. B387, *Cotton Burs and Cotton Bur Ashes as Fertilizer for Cotton on a Claypan Soil.*

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Commercial production of castor beans in recent years has resulted in an accumulation of large quantities of hulls at hulling centers (Fig. I). Considerable interest has been expressed in the possible use of these hulls as fertilizer and mulching materials. In view of this interest, studies were made from 1951 to 1953, inclusive, of the percentages of nitrogen, phosphorus, potassium, and ash in hulls of castor bean varieties grown on irrigated and non-irrigated plots. This bulletin reports results of these studies.

Procedure

Samples of hulls of four representative castor bean varieties which were grown in the regional variety trials were collected and analyzed. In 1951 and 1952, the varieties selected were Cimarron, Conner, USDA 74, and USDA 101. In 1953, the varieties were Cimarron, USDA 74, W. O. Hybrid 4, and N-224A-1-6-4-3. Each of these varieties was grown with and without irrigation at several locations in Oklahoma, Texas and Arkansas.

The castor bean trials in Arkansas were grown at Clarkedale, Fayetteville, Hope, Stuttgart, and Van Buren. In Oklahoma the variety trials were located at Anadarko, Altus, McAlester, Miami, Perkins, and Stillwater. Samples were collected from plantings grown under irrigation at Altus, Oklahoma, and at Dimmit, Hereford, Littlefield, Lubbock, and Plainview in Texas.

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Chemical Methods

Two pound samples of castor bean hulls representing a composite of the various replications in a location were collected for each variety and prepared for chemical analysis. Representative portions of these samples were ground through the medium screen of the Wiley cutting mill and stored in air-tight bottles until analyzed.

Chemical procedures employed for each component were:

Nitrogen.—Samples were run according to the Gunning modification of the Kjeldahl procedure as described by the Association of Official Agricultural Chemists.

Phosphorus.—These determinations were run on the ash samples as directed in the Association of Official Agricultural Chemists under plant analyses, using the volumetric procedure.

Potassium.—These analyses were run on the same base solutions used for the phosphorus determinations. A Perkins-Elmer flame photometer was used for the actual determinations, using an internal standard.

Ash.—Five gram samples were used for these determinations. The samples were weighed in platinum and dried overnight at 110° C. The

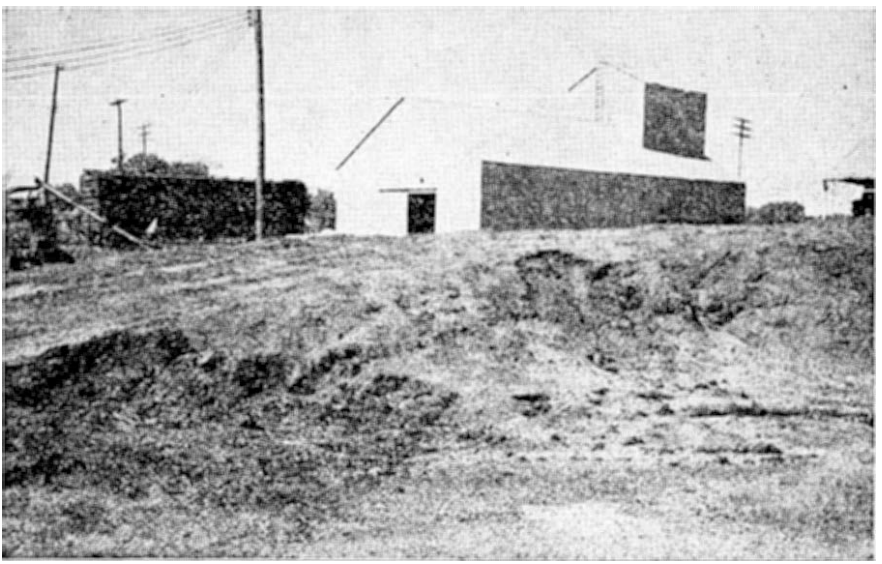


FIGURE 1

Field harvested castor beans are approximately 30 percent hull, by weight. Commercial production of castor beans has caused large accumulations of hulls at some hulling centers. Research indicates that hulls compare favorably with cotton burs in the principal fertilizer elements.

samples were then ashed at a low red heat not exceeding 600° C. The residues were calculated as ash.

Results

Results of the chemical analyses are summarized in Tables I, II and III, and Figure 2.

Nitrogen

There were no marked differences among varieties in the nitrogen content of the samples. The average nitrogen content of castor bean hulls for the three-year period at all locations was 1.68 percent.

Nitrogen content of the samples from the irrigated and non-irrigated plots differed slightly. The three-year average was 1.39 percent nitrogen for hulls produced under irrigation. The average nitrogen content for hulls grown without irrigation was 1.80 percent.

TABLE I.—Chemical Analysis of Castor Bean Hulls for the Elements N, P, K, and for Ash, for the Varieties Collected from One Irrigated Location and Six Non-Irrigated Locations in 1951.

(Percent Dry Weight)

	Non-irrigated							Irrigated
	Altus, Okla.	Perkins, Okla.	Clarkedale, Ark.	Fayetteville, Ark.	Hope, Ark.	Stuttgart, Ark.	Avg.	Hereford, Tex.
USDA 74								
N	1.99	____	1.30	1.61	1.46	1.87	1.65	1.72
P	.091	____	.128	.135	.143	.124	.124	.089
K	3.03	____	0.92	0.75	2.68	0.80	1.64	3.48
Ash	7.73	____	4.04	3.92	6.63	3.98	5.26	9.08
Cimarron								
N	1.91	1.58	1.18	1.52	1.25	2.69	1.69	1.47
P	.127	.133	.145	.132	.106	.160	.134	.100
K	2.53	1.08	1.90	1.50	1.58	1.50	1.68	3.15
Ash	7.96	4.30	5.97	4.53	4.23	5.31	5.38	8.68
USDA 101								
N	____	1.10	1.31	1.31	1.59	2.05	1.47	____
P	____	.099	.166	.111	.156	.140	.134	____
K	____	0.52	1.75	0.69	2.05	1.08	1.22	____
Ash	____	5.17	4.67	2 89	5.34	3.54	4.32	____
Conner								
N	____	1.42	1.18	1.61	1.25	2.43	1.58	____
P	____	.129	.164	.118	.078	.183	.134	____
K	____	1.20	2.20	1.60	1.63	1.53	1.63	____
Ash	____	4.43	5.94	4.76	4.49	4.46	4.82	____

TABLE II.—Chemical Analysis of Castor Bean Hulls for the Elements N, P, K, and for Ash, for the Varieties from Three Different Irrigated Locations And Seven Non-Irrigated Locations in 1952.

(Percent Dry Weight)

	Non-irrigated								Irrigated			
	McAlester, Okla.	Miami, Okla.	Perkins, Okla.	Clarkedale, Ark.	Fayetteville, Ark.	Hope, Ark.	Stuttgart, Ark.	Avg.	Hereford, Tex.	Littlefield, Tex.	Plainview, Tex.	Avg.
USDA 74												
N	2.00	1.84	1.52	1.25	1.91	2.24	1.96	1.82	.97	1.44	1.36	1.26
P	.075	.090	.069	.184	.100	.089	.099	.101	.093	.072	.105	.090
K	1.85	2.26	4.86	3.95	3.35	3.71	2.24	3.17	5.22	6.49	4.11	5.27
Ash	6.13	7.13	12.97	10.23	8.82	9.35	7.08	8.82	13.64	15.99	10.95	13.53
Cimarron												
N	2.26	1.97	1.39	1.52	2.01	2.08	1.97	1.88	.99	1.53	1.41	1.31
P	.068	.108	.078	.211	.103	.077	.130	.111	.106	.088	.124	.106
K	2.98	3.07	4.56	4.26	3.30	3.80	2.23	3.46	6.63	6.27	6.03	6.31
Ash	8.47	9.10	12.75	11.51	9.03	9.78	7.51	9.74	17.72	15.04	15.32	16.03
USDA 101												
N	2.10	1.86	1.14	1.29	2.00	2.18	2.19	1.82	1.14	2.21	1.52	1.62
P	.060	.083	.058	.177	.096	.080	.125	.097	.120	.091	.161	.124
K	1.73	1.94	3.69	3.21	2.72	3.08	1.70	2.58	6.08	6.65	4.52	5.75
Ash	4.76	5.92	9.22	8.04	7.25	7.89	5.53	6.94	15.81	15.91	12.13	14.62
Conner												
N	2.48	1.72	1.04	1.24	2.14	2.26	2.15	1.86	---	---	---	---
P	.050	.076	.059	.152	.088	.065	.123	.088	---	---	---	---
K	2.72	2.91	4.41	3.48	3.55	3.70	2.14	3.27	---	---	---	---
Ash	7.49	7.80	11.27	9.37	8.86	9.06	6.70	8.65	---	---	---	---

TABLE III.—Chemical Analysis of Castor Bean Hulls for the Elements N, P, K, and for Ash for the Varieties Collected from Four Different Irrigated Locations and Five Non-Irrigated Locations in 1953.

(Percent Dry Weight)

	Non-irrigated						Irrigated				
	Anadarko, Okla.	Miami, Okla.	Perkins, Okla.	Stillwater, Okla.	Van Buren, Ark.	Avg.	Dimmit, Tex.	Hereford, Tex.	Littlefield, Tex.	Lubbock, Tex.	Avg.
USDA 74											
N	2.33	1.88	2.07	2.13	1.88	2.06	.83	---	---	---	.83
P	.057	.025	.067	.041	.028	.044	.052	---	---	---	.052
K	7.19	3.39	3.04	4.03	2.23	3.98	2.61	---	---	---	2.61
Ash	15.22	11.59	10.58	9.11	8.01	10.90	8.81	---	---	---	8.81
Cimarron											
N	2.09	1.86	2.69	1.89	1.74	2.05	.79	.74	1.98	1.26	1.19
P	.066	.036	.060	.032	.047	.048	.091	.011	.021	.081	.038
K	6.02	6.68	4.85	4.30	2.85	4.94	2.64	2.37	3.94	4.46	3.35
Ash	13.71	18.67	11.89	10.04	8.56	12.57	10.88	11.51	11.72	14.17	11.87
N-224A-1-6-4-3											
N	2.96	1.96	2.27	2.43	2.04	2.33	.95	.79	1.89	1.38	1.25
P	.030	.003	.036	.107	.034	.042	.028	.011	.074	.072	.046
K	6.28	4.92	4.26	4.51	2.87	4.57	2.50	4.18	6.38	5.43	4.62
Ash	14.73	15.47	11.59	8.03	8.27	11.62	9.12	13.48	15.17	14.91	13.17
W. O. Hybrid 4											
N	2.71	2.24	1.59	2.36	2.19	2.22	.97	.79	2.36	1.51	1.41
P	.028	.011	.058	.046	.023	.033	.053	.006	.016	.062	.034
K	6.46	5.50	3.98	4.34	2.12	4.48	2.96	1.71	5.51	4.06	3.56
Ash	14.95	15.26	10.99	9.28	8.69	11.83	9.13	6.88	14.58	14.11	11.18

Phosphorus

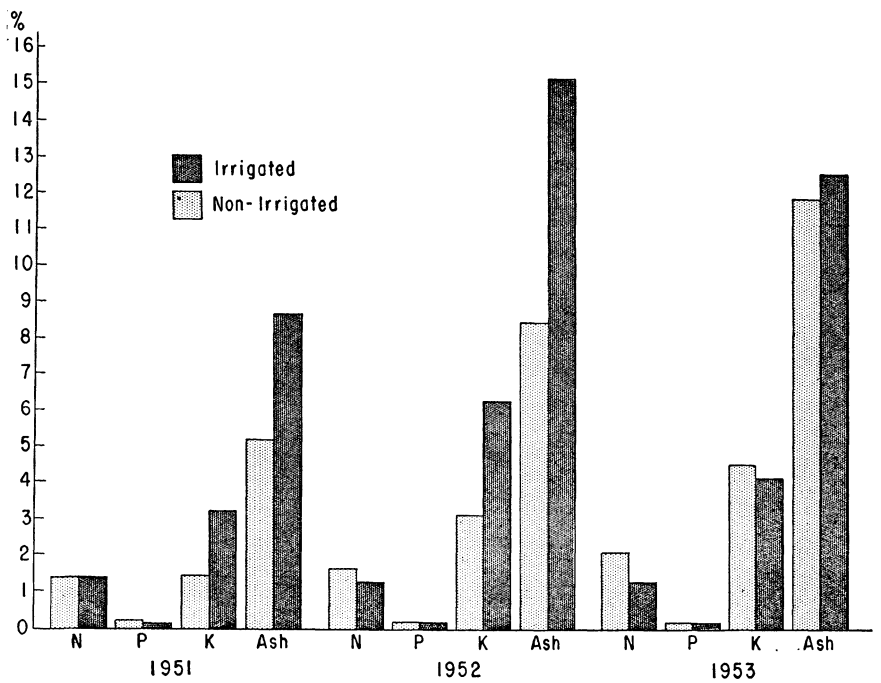
The phosphorus content of hull samples in the 1951, 1952, and 1953 seasons averaged .114, .101, and .036 percent, respectively, with a three-year average of .084 percent. The explanation for the progressive decline is not known; however it has been associated with the soil moisture available to the crop during the growing season.

Potassium

The average postassium content of castor bean hulls over the three-year period was 3.88 percent. There was considerable variation between years. The average potassium content of all varieties at all locations was 2.13, 4.26, and 4.01 percent, respectively, for 1951, 1952, and 1953.

There were no important differences in potassium content among varieties. However, there was a notable difference in potassium content between the castor bean hulls grown on irrigated plots and those from non-irrigated plots: 4.23 and 3.51 percent, respectively.

FIGURE 2



Ash

There were no apparent differences in the ash content among varieties. The average ash content for varieties at all locations was 6.25, 11.19, and 11.58 percent for 1951, 1952, and 1953, respectively. The average ash content of the samples for the three-year period was 9.56 precent. The hulls from castor beans grown without irrigation averaged 6.84 percent ash as compared to 12.25 percent for samples of hulls obtained from the same varieties grown under irrigation.

There was a progressive increase each year in the ash content of all varieties grown without irrigation. The hulls from castor beans grown under irrigation varied from a low of 8.88 percent in 1951 to a high of 14.72 percent in 1952. In 1953, the hulls from castor beans grown under irrigation averaged 11.43 percent.

Summary

The average analysis of the castor bean hulls for all varieties and locations was: nitrogen, 1.64 percent; phosphorus, 0.82 percent; potassium, 3.81 percent; and ash 10.38 percent. No important variation among varieties was noted for any of the components. The greatest variation within components occurred between years and locations. In general there were differences between samples of hulls from the irrigated and non-irrigated plots.

The percentage of ash and potassium in each of the hull samples increased progressively from 1951 to 1953. Phosphorus decreased each year from .114 percent in 1951 to .036 percent in 1953. The nitrogen content did not change greatly between years. In general, nitrogen was slightly higher in hulls from castor beans grown without irrigation than those grown with irrigation. Apparently, the environment prevailing during each of the growing seasons was an important factor governing the percentage of inorganic chemical components deposited in the hulls.