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The Influence of Phosphorus and Potassium Fertilization on the Quality of Sugar of Two Sugarcane Varieties Grown on Three Soil Series of Sudan

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Abstract: A filed experiment was conducted at the Farm of Northwest Sennar Sugar Company, Sudan (latitude 13° 33'N and longitude 33° 37'E) to examine the effects of potassium and phosphorous fertilization on the quality of two sugarcane (*Saccharum officinarum*) varieties (Co 6806 and Co 527) and their first ratoons grown on three soil series (Dinder, Hagu and Nasr) of Sudan. Three levels of both potassium (0, 86 and 172 kg K_2O ha^{-1}) and phosphorous (TSP) (0, 64.5 and 129 kg P_2O_5 ha^{-1}) were used. The quality parameters of both plant cane and ratoons were evaluated in terms of contents of fiber, moisture, sugar content (polarization %), purity of the juice and brix (TSS). The results revealed that potassium and phosphorous fertilizers did not significantly affect the fiber content of the plant cane and the moisture content was significantly affected by potassium fertilization. Phosphorus treatments significantly affected the sugar content (polarization %) and purity of the juice (%). The brix percent of cane decreased by the end of the season as a response to phosphorus treatment, while the ratoon was slightly affected. On the other hand, the effect of potassium application on brix percent was insignificant in both plant cane and ratoon. The effect of variety on brix percent was noted to be significant in both plant cane and ratoon before harvest.

Key words: Phosphorus, potassium, fertilization, sugar, quality

INTRODUCTION

Sugarcane production and industry are of growing importance since it is the world's major source of sucrose sugar. It is grown mainly in the tropics and subtropics between latitude 35°N and 35°S but it can also be grown under irrigation in dry lower latitudes. The yield and quality of cane tended to vary tremendously due to the variations in soil fertility, cultural practices and weather conditions (Yassin, 1985). In spite of the expansion of cane cultivation in Sudan, yield per unit area and the sucrose content are well below those obtained elsewhere. High yield and sucrose content, which are considered the major objectives of sugarcane growers, are controlled by the cultural practices that vary widely and must be adapted to the local conditions, especially fertilization. The use of nitrogen, phosphorous and potassium fertilizers play an important role in increasing cane and sugar yields, because sugarcane is known as a heavy feeder crop that depletes the soil of essential nutrients and therefore, adequate nutrient addition is of utmost importance (Korndorfer, 1990). It was estimated that 100 tons of cane yield remove 200 kg nitrogen, 80 kg phosphorus and 420 kg potassium from the soil. This emphasizes the importance of chemical fertilizers in relatively large quantities for profitable sugarcane production. An adequate supply of nitrogen is required to stimulate vigorous vegetative growth, which will positively affect cane yield. Phosphorus was found indispensable for a healthy root system and necessary for life processes. Potassium is essential for healthy growth of sugarcane and intimately connected with the formation of carbohydrates in leaves and the subsequent translocation of sucrose to the parenchyma of the stem (Blackburn, 1984). Therefore, it is necessary to supply sugarcane crop with the big three (N, P and K) to secure good cane quantity and quality. Fertilization of cane fields in Sudan was geared towards using nitrogen fertilizers and phosphorous to small extent. Very meager research work was assigned for the response of cane to the added phosphorous and potassium fertilizers (El-Tilib *et al*., 2004). This investigation was, therefore, conducted to study the influence of soil type, sugarcane variety, phosphorous and potassium fertilizers on quality parameters of plant cane and ratoons.

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MATERIALS AND METHODS

Location, soil and treatments: A field experiment was conducted at Sennar Sugar Company in the Blue Nile State, Sudan (latitude 13° 33' N and longitude 33° 37' E.) during the season 2000/2001. The experimental site was disc ploughed, finely harrowed, leveled and ridged at 1.5 m. The area was divided into plots 1.5 m apart and the size of each plot was 7.5×5 m, with 5 rows. The experiment was carried out on three soil types (series) using two sugarcane varieties and different levels of potassium and phosphorus fertilizers and their combinations. The soil types were namely, Dinder series, Hago and Nasr series. Detailed soil classification and properties were given by El-Tilib *et al.* (2004). The cane varieties used were the most commonly grown in the scheme, namely, Co 6806 and Co527. Triple superphosphate fertilizer (TSP) was applied at three levels (0, 64.5 and 129-kg P_2O_5 ha^{-1}) designated as P0, P1 and P2, respectively. The TSP was added in bands along the furrow at the time of planting. The rates of the added potassium were 0, 86 and 172 kg K_2O ha^{-1} designated as K0, K1 and K2, respectively. The recommended basal dressing of nitrogen was applied at the rate of 219 kg N ha^{-1} as urea. Both potassium and nitrogen fertilizers were broadcast by hand in continuous band in the furrow and mixed thoroughly, buried and irrigated immediately two months after planting. Four months after planting, the ridges were split to cover the base of the growing stools (hilling up). Weeding was done by Gezapax and Gezaprim herbicides prior to the second irrigation and thereafter, hand weeding was practiced when necessary.

Sampling: Five stalks were selected randomly from the three inner rows in each plot and marked.

The parameters were measured at bimonthly intervals starting from the 4th month after planting and continued to the 10th month. Leaf samples were collected from four most recently mature leaves (i.e., leaf number 3, 4, 5 and 6 from the top, counting the rolled up spindle leaf as number 1) and pooled to constitute one sample. The leaves were cut into small pieces and oven-dried at 70°C for 48 H. The dried leaf samples were ground separately using a grinder mill and then thoroughly mixed prior taking representative sub-samples for chemical analysis. Juice samples were collected at the plant ages of 9, 11 and 12 months. Cane stalks were taken from plant cane, cut into small pieces and juice was extracted using a Jeffco machine.

Parameters estimation: The juice quality was assessed in terms of polarization, brix and purity. Polarization (refers to the sucrose content) was determined as described by Blackburn (1984). Brix (total soluble solids, TSS) was determined by a hydrometer that gives the specific gravity as percentage of the total juice (Clements, 1980). The purity of the juice was calculated as follows:

$$\text{Purity} = \frac{\text{Percent sucrose}}{\text{Percent solids}} \times 100 = \frac{\text{Polarization (\%)}}{\text{Brix (\%)}} \times 100$$

The estimated recovery percentage of sugar was calculated according to the following equation adopted by El-Guneid Sugar Research Centre, Sudan:

$$\text{Estimated recovery \%} = [(\text{Pol\% X } 0.75) - 3]$$

The ratoons received similar doses of nitrogen, potassium and phosphorus fertilizers as that of the plant cane. Procedures employed for measurements, sampling and analysis were similar to those carried on the plant cane. The fibre and moisture contents were determined according to AOAC (1993).

The treatments were arranged in a randomized complete block design and replicated thrice. Statistical analysis was performed and the means were separated using Duncan Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

Application of potassium and phosphorous fertilizers had no significant effect on the fiber content of both cane varieties investigated (Table 1). This indicates that fiber content might be a varietal character as reported by Sundara (1985). Variety Co 527 contained slightly higher fiber content than Co 6806 when the varieties were planted for 12 months. Generally, fiber content was ranged from 15 to 17% with highest values obtained before harvest. The moisture content of the plant cane at the age of 9 months (72%) tended to increase significantly due to potassium application and then declined to a minimum (63%) when the plant was 12 months old (Table 1). The significant effect of potassium fertilizer on moisture content might be due to the specific role of potassium in the mechanism of osmotic adjustments as reported by Cerda *et al.* (1995) on maize. High sugar recoveries were associated with the moisture content of 60-65% and a moisture content below 50% resulted in a reduced juice quality (Nelson, 1980). A slight increase in moisture content was noted in the plant cane treated with phosphorous fertilizer. This might be due to the fact that phosphorous stimulates the production of fibrous roots, which utilize more soil moisture. Both fiber and moisture

Table 1: Effect of phosphorus and potassium fertilization on fibre and moisture contents (%) of sugarcane varieties

	Fertilizer rate		Fibre content (%)								Moisture content (%)							
			9 months from planting				12 months from planting				9 months from planting				12 months from planting			
			Soil series				Soil series				Soil series				Soil series			
Variety	K	P	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE
		P0	15.00	13.43	13.03		15.80	17.07	16.87		64.50	75.25	74.20		64.36	63.73	62.53	
	K0	P1	13.47	14.47	14.17		14.67	15.20	17.20		67.76	71.86	71.63		62.70	62.90	62.20	
		P2	13.57	12.80	13.53		16.30	16.23	15.70		70.26	72.50	69.60		61.66	62.90	63.13	
		P0	13.87	14.70	13.00		16.03	16.83	16.77		68.63	71.10	73.33		64.70	63.53	63.56	
Co 6806	K1	P1	14.17	13.25	13.20	13.55a	16.00	17.17	17.17	16.37a	68.03	73.55	73.86	71.91a	63.46	62.46	61.80	63.38a
		P2	13.40	12.40	13.03		15.77	16.90	15.70		71.16	74.13	72.90		64.00	63.70	63.36	
		P0	14.73	12.80	13.45		16.50	15.03	17.10		69.33	73.20	73.80		64.86	61.86	62.83	
	K2	P1	14.57	13.90	12.20		16.77	16.37	16.70		71.66	72.60	74.33		64.26	63.66	64.00	
		P2	14.27	12.73	12.67		17.30	16.35	16.37		69.76	74.46	75.10		63.70	64.43	64.53	
		P0	14.37	12.77	12.90		15.57	17.27	16.20		67.93	74.53	72.53		63.86	62.16	62.96	
	K0	P1	15.53	13.13	13.83		16.73	16.57	15.33		66.70	73.66	73.36		63.16	64.23	63.70	
		P2	13.53	12.83	13.20		15.73	15.80	16.97		69.66	71.83	74.23		64.20	62.43	63.56	
		P0	13.57	13.43	14.50		17.20	16.43	16.27		68.86	73.60	73.46		63.83	61.93	62.86	
Co 527	K1	P1	14.20	13.30	12.67	13.40a	17.90	16.07	16.60	16.51a	68.30	73.60	74.43	71.85a	63.76	62.70	63.23	63.34a
		P2	12.98	13.97	13.90		17.70	17.65	16.17		69.13	72.43	73.13		63.96	62.40	63.43	
		P0	14.28	12.30	12.60		17.50	17.00	16.57		69.33	73.20	74.31		64.30	61.53	63.13	
	K2	P1	14.87	11.90	11.97		16.47	15.87	15.80		67.03	73.53	73.00		63.83	62.80	64.33	
		P2	13.23	13.33	12.80		15.40	16.37	16.50		71.30	72.10	74.76		64.16	63.90	63.86	
MSE			14.09a	13.19b	13.15b		16.41a	16.45a	16.44a		68.85b	73.17a	73.44a		63.82a	62.96b	63.28a	
			Main K effect				Main K effect				Main K effect				Main K effect			
			K0	K1	K2		K0	K1	K2		K0	K1	K2		K0	K1	K2	
			13.64a	13.53a	13.23a		16.28a	16.69a	16.44a		71.22b	72.04a	72.38a		63.16a	63.26a	63.67a	
			Main P effect				Main P effect				Main P effect				Main P effect			
			P0	P1	P2		P0	P1	P2		P0	P1	P2		P0	P1	P2	
			13.61a	13.63a	13.23a		16.56a	16.37a	16.38a		71.73a	71.77a	72.14a		63.28a	63.29a	63.52a	
			Variety SE = ±0.17				Variety SE = ±0.14				Variety SE = ±0.22				Variety SE = ±0.19			
			Soil, K and P SE = ±0.21				Soil, K and P SE = ±0.17				Soil, K and P SE = ±0.27				Soil, K and P SE = ±0.23			
			CV = 11.38%				CV = 7.40%				CV = 2.74%				CV = 2.46%			

Symbols used in this table and the following tables are explained as follows: K = Potassium; P = Phosphorus; MVE = Main Variety Effect; MSE = Main Soil Effect, Means followed by the same letter do not differ significantly using Duncan's Multiple Range Test at 1 and 5%

contents were significantly affected by the soil type. However, the Dinder type was noted to be superior over the other two soil types, indicating that it might be of a good potential in supplying nutrients. Polarization percent tended to increase with age in both plant cane and ratoon (Table 2) and it was noted to be positively affected by potassium fertilizer at 12 months age of plant cane and of all sampling dates of ratoon. The increment in polarization percent may be attributed to the physiological effect of potassium during sugar synthesis due to its role in synthesis and translocation of protein and carbohydrates and thus accumulation of sucrose rather than reducing sugars. This was in line with the results obtained by Korndorfer (1990) and Kumar and Verma (1997). Polarization percent was insignificantly affected by phosphorous application in plant cane before harvest and the reverse was true for ratoon crop. The response of polarization percent to phosphorous application may be due to the low level of available soil phosphorous as well as the negative effect of phosphorous and potassium which resulted in nutrient imbalance as reported by Kumar and Verma (1997). The varieties examined were significantly differed in polarization percent of the plant cane and ratoon before harvest.

Towards the end of the growing season, brix percent (TSS) of the plant cane tended to decrease due to phosphorous application while that of the ratoon was slightly affected (Table 3). On the other hand, the effect of potassium application on brix percent was mostly insignificant for both plant cane and ratoon. The effect of variety on brix percent was noted to be significant for both plant cane and ratoon before harvest.

Application of high rates of potassium (K2) adversely affected the purity (%) of juice in both plant cane and ratoon, particularly late in the season (Table 4). This might be due to the absorption of considerable amounts of potassium, which might decrease the amounts of the other elements due to antagonistic effect. Although there was a response to phosphorous application in plant cane, but it was insignificant in the last two measurements, which was not the case for ratoon. The results obtained agreed with that reported by Singh and Reddy (1980).

Table 2: Polarization (%) in juice of plant cane and ratoon as affected by phosphorus and potassium fertilization

	Fertilizer rate		Plant cane								Ratoon							
			9 months from planting				12 months from planting				9 months from planting				12 months from planting			
			Soil series				Soil series				Soil series				Soil series			
Variety	K	P	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE
		P0	14.29	11.30	11.75		18.91	18.61	18.29		16.65	15.18	17.20		19.61	18.81	18.84	
	K0	P1	13.32	12.18	11.99		18.43	19.92	18.65		18.16	15.57	16.88		19.87	20.05	18.96	
		P2	14.10	11.65	11.34		18.76	18.42	18.32		17.94	15.51	16.80		19.91	20.24	20.57	
		P0	13.74	11.30	11.20		18.49	19.58	18.40		17.66	15.98	17.41		19.59	19.86	18.99	
Co 6806	K1	P1	13.97	11.72	11.57	12.41b	18.01	18.58	18.63	18.73a	17.75	15.35	17.62	16.78a	20.04	19.65	19.66	19.56a
		P2	14.27	12.03	11.99		18.66	19.08	18.81		17.10	16.36	16.82		20.08	19.83	19.13	
		P0	14.36	11.72	10.87		18.72	19.12	18.47		17.31	15.95	17.29		19.66	19.59	19.60	
	K2	P1	13.84	11.56	11.93		19.02	18.57	18.12		17.57	15.57	17.73		20.09	19.42	19.96	
		P2	13.87	11.52	11.68		19.05	19.22	18.95		17.22	16.47	17.18		19.55	19.50	19.69	
		P0	16.24	10.62	10.55		18.50	18.47	18.21		17.45	14.60	16.58		19.45	18.73	18.90	
	K0	P1	15.84	12.16	10.75		18.18	18.69	18.55		17.53	15.59	17.14		19.73	19.09	18.86	
		P2	16.48	11.41	11.42		18.30	18.49	17.65		17.85	14.71	17.25		19.70	19.10	18.59	
		P0	16.40	11.55	10.02		18.54	18.00	17.71		17.10	15.61	16.78		19.77	19.53	18.98	
Co 527	K1	P1	16.63	10.77	10.31	12.79a	18.21	18.61	18.45	18.40b	18.13	15.43	15.90	16.67a	19.91	19.18	19.88	19.38b
		P2	15.06	11.39	10.51		18.67	18.71	18.71		17.85	14.88	17.63		19.80	18.96	19.21	
		P0	16.57	11.50	11.10		17.93	19.08	18.02		17.70	15.21	15.94		18.88	19.86	19.23	
	K2	P1	15.85	11.65	11.53		18.16	18.63	17.76		18.15	15.12	18.30		20.01	18.84	19.18	
		P2	15.37	11.45	11.19		18.49	18.86	18.46		17.93	15.04	17.32		19.48	19.15	18.86	
MSE			15.01a	11.53b	11.26b		18.50b	18.81a	18.34b		17.60a	15.48c	17.10b		19.73a	19.41b	19.27b	
			Main K effect				Main K effect				Main K effect				Main K effect			
			K0	K1	K2		K0	K1	K2		K0	K1	K2		K0	K1	K2	
			12.63a	12.52a	12.64a		18.52a	18.59a	18.59a		16.58b	16.74a	16.86a		19.38a	19.56a	19.48a	
			Main P effect				Main P effect				Main P effect				Main P effect			
			P0	P1	P2		P0	P1	P2		P0	P1	P2		P0	P1	P2	
			12.56a	12.64a	12.60a		18.54a	18.51a	18.65a		16.54b	16.85a	16.79a		19.31b	19.58a	19.52a	
			Variety SE = ±0.11				Variety SE = ±0.09				Variety SE = ±0.05				Variety SE = ±0.06			
			Soil, K and P SE = ±0.13				Soil, K and P SE = ±0.11				Soil, K and P SE = ±0.065				Soil, K and P SE = ±0.07			
			CV = 7.23%				CV = 4.31%				CV = 2.86%				CV = 2.56%			

Symbols as defined in Table 1

Table 3: Brix (%) in juice of plant cane and ratoon as affected by phosphorus and potassium fertilization

	Fertilizer rate		Plant cane								Ratoon							
			9 months from planting				12 months from planting				9 months from planting				12 months from planting			
			Soil series				Soil series				Soil series				Soil series			
Variety	K	P	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE
		P0	16.46	14.62	14.82		21.22	20.71	20.11		20.38	17.76	19.45		21.80	20.90	20.70	
	K0	P1	15.84	15.92	14.82		21.06	21.91	20.21		21.11	17.94	18.87		22.10	22.00	20.45	
		P2	16.30	15.39	14.58		21.31	20.95	20.35		21.36	17.69	18.70		22.35	22.67	22.43	
		P0	15.88	15.60	14.26		21.39	22.10	20.28		20.27	18.25	19.79		21.68	22.30	20.88	
Co 6806	K1	P1	16.07	15.69	14.66	15.47b	20.33	20.54	20.62	20.91a	20.58	17.78	19.67	19.30a	21.91	21.39	21.54	21.57a
		P2	16.63	15.79	14.79		20.24	21.03	20.66		20.28	18.34	19.64		22.04	21.48	20.89	
		P0	16.83	15.50	14.10		20.91	21.35	21.19		20.74	18.35	19.45		21.88	21.65	21.81	
	K2	P1	16.40	15.47	14.84		21.62	20.98	19.95		20.73	17.98	19.78		22.31	21.83	21.92	
		P2	16.43	15.53	14.49		21.46	21.00	21.00		20.70	18.31	19.67		21.85	21.50	21.75	
		P0	18.51	14.34	13.90		20.80	20.70	20.09		20.31	16.70	19.12		21.63	21.00	20.76	
	K0	P1	18.26	15.41	14.24		20.61	20.85	20.17		20.76	17.91	19.41		22.01	21.20	20.50	
		P2	18.69	14.66	14.64		20.58	20.48	19.55		20.99	17.21	19.19		21.46	21.05	20.49	
		P0	18.64	14.83	14.39		21.19	20.34	19.69		20.37	17.82	19.26		22.02	21.93	20.71	
Co 527	K1	P1	19.19	14.15	13.79	15.77a	20.25	20.43	19.91	20.44b	21.10	17.77	18.36	19.28a	21.56	20.89	21.37	21.34b
		P2	18.06	14.45	13.09		20.65	20.56	19.97		20.77	17.40	19.87		21.80	20.77	20.38	
		P0	18.68	14.81	14.56		20.76	20.95	20.29		20.18	17.37	19.21		21.13	21.65	21.49	
	K2	P1	18.58	14.88	15.13		20.88	20.83	19.15		21.20	17.66	20.18		22.14	20.91	20.54	
		P2	17.40	14.33	14.30		20.99	20.57	20.70		20.86	17.34	19.49		21.58	20.69	20.96	
MSE			17.38a	15.08b	14.41c		20.90a	20.90a	20.22b		20.73a	17.75c	19.38b		21.85a	21.43b	21.09c	

Table 3: Continued

			Plant cane								Ratoon							
			9 months from planting				12 months from planting				9 months from planting				12 months from planting			
	Fertilizer rate		Soil series				Soil series				Soil series				Soil series			
Variety	K	P	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE
			Main K effect				Main K effect				Main K effect				Main K effect			
			K0	K1	K2		K0	K1	K2		K0	K1	K2		K0	K1	K2	
			15.63a	15.55a	15.68a		20.65a	20.57a	20.81a		19.16b	19.32a	19.39a		21.42a	21.42a	21.53a	
			Main P effect				Main P effect				Main P effect				Main P effect			
			P0	P1	P2		P0	P1	P2		P0	P1	P2		P0	P1	P2	
			15.60a	15.74a	15.53a		20.78a	20.57a	20.67a		19.17b	19.38a	19.32a		21.44a	21.48a	21.45a	
			Variety SE = ±0.10				Variety SE = ±0.11				Variety SE = ±0.043				Variety SE = ±0.056			
			Soil, K and P SE = ±0.12				Soil, K and P SE = ±0.13				Soil, K and P SE = ±0.052				Soil, K and P SE = ±0.069			
			CV = 5.71%				CV = 4.71%				CV = 1.99%				CV = 2.35%			

Symbols as defined in Table 1

Table 4: Purity (%) of juice of plant cane and ratoon as affected by phosphorus and potassium fertilization

			Plant cane								Ratoon							
			9 months from planting				12 months from planting				9 months from planting				12 months from planting			
	Fertilizer rate		Soil series				Soil series				Soil series				Soil series			
Variety	K	P	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE	Dinder	Nasr	Hagu	MVE
		P0	85.65	75.32	79.15		89.22	89.84	90.97		81.69	85.47	88.43		89.95	90.00	91.49	
	K0	P1	83.94	79.39	80.90		87.54	90.91	92.42		86.02	86.78	89.45		89.90	91.13	92.71	
		P2	86.40	76.08	80.34		88.20	88.00	90.06		83.98	87.67	89.83		89.08	89.28	91.70	
		P0	86.32	73.03	78.51		86.43	88.63	90.62		87.12	87.56	87.97		90.35	89.05	90.94	
Co 6806	K1	P1	85.15	76.33	78.93	80.36a	88.76	90.46	90.28	89.57a	86.24	86.33	89.57	86.60a	91.46	91.86	91.27	90.75a
		P2	85.48	76.22	81.11		88.97	90.73	91.02		84.31	89.20	85.64		91.10	92.31	91.57	
		P0	85.33	77.86	76.92		89.52	89.58	89.50		83.46	86.92	88.89		89.85	90.48	89.86	
	K2	P1	84.58	74.75	80.40		88.01	88.54	90.85		84.75	86.59	89.63		90.04	88.96	91.05	
		P2	84.43	76.48	80.64		88.84	90.30	90.26		83.18	89.95	87.34		89.47	90.69	90.52	
		P0	87.63	73.99	75.81		88.97	88.93	90.63		85.91	87.42	86.71		89.92	89.19	91.04	
	K0	P1	86.34	78.72	75.38		88.20	89.62	91.95		84.44	87.04	88.30		89.64	90.04	92.00	
		P2	88.16	78.50	80.02		88.93	90.28	90.43		85.04	85.47	89.89		91.79	90.73	90.72	
		P0	88.14	77.86	76.49		87.51	88.56	89.93		83.94	87.59	87.12		89.78	89.05	91.64	
Co 527	K1	P1	86.60	76.23	74.77	80.58a	89.92	91.09	92.63	89.92a	85.92	86.83	86.60	86.52a	92.34	91.81	93.02	90.86a
		P2	83.37	78.81	80.37		90.41	91.03	93.69		85.94	85.51	88.72		90.82	91.28	94.25	
		P0	88.83	77.58	76.30		86.33	91.05	88.75		87.71	87.56	82.97		89.35	91.73	89.48	
	K2	P1	85.31	77.88	76.20		86.97	89.48	92.73		85.61	85.61	90.68		90.37	90.10	93.37	
		P2	88.33	79.81	78.13		88.20	92.36	89.14		85.95	86.73	88.86		90.26	92.55	89.98	
MSE			86.11a	76.94c	78.36b		88.39c	89.97b	90.88a		84.51c	87.01b	88.14a		90.31b	90.62b	91.48a	
			Main K effect				Main K effect				Main K effect				Main K effect			
			K0	K1	K2		K0	K1	K2		K0	K1	K2		K0	K1	K2	
			80.65a	80.21a	80.54a		20.65a	20.57a	20.81a		86.09a	86.78a	86.80a		90.63b	91.33a	90.45b	
			Main P effect				Main P effect				Main P effect				Main P effect			
			P0	P1	P2		P0	P1	P2		P0	P1	P2		P0	P1	P2	
			80.04b	80.10b	81.26a		20.78a	20.57a	20.67a		86.35a	87.02a	86.85a		90.18b	91.23a	91.01a	
			Variety SE = ±0.26				Variety SE = ±0.11				Variety SE = ±0.32				Variety SE = ±0.10			
			Soil, K and P SE = ±0.31				Soil, K and P SE = ±0.13				Soil, K and P SE = ±0.39				Soil, K and P SE = ±0.13			
			CV = 2.85%				CV = 4.71%				CV = 3.36%				CV = 1.03%			

Symbols as defined in Table 1

CONCLUSION

Both fiber and moisture contents were significantly affected by the soil type. However, application of potassium and phosphorous fertilizers had no significant effect on fiber content for both varieties investigated. Brix, polarization and purity were varied depend on soil type and fertilizer applied.

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