A COMPARATIVE STUDY ON THE BEHAVIOR OF NUTRIENT UPTAKE BETWEEN JUTE (CORCHORUS CAPSULARIS) AND KENAF (HIBSCUS CANNABINUS) *

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Due to the limited arable land of Taiwan, jute is being considered as a crop antagonistic to paddy rice. In order to appropriate increases in staple food and fiber production, this institute began a series of experiments (4,5) on the cultivation of kenaf, which has a fiber quality similar to that of jute, but is possible to grow in a soil that is rather low in fertility. However, as specific information is lacking on the behavior of uptake of nutrients of kenaf in comparison with that of jute, this expriment was designed for getting information regarding the behavior of uptake of nutrients of kenaf and jute, and their differences in leaf composition.

Experimental procedure

This experiment was conducted in the field of Taipei clayey loam with a pH 4.7. The design of the experiment consisted of ten treatments in a randomized block with quadruplicate. Each plot was 2.25 by 7.5 meters, and separately planted with a jute trial of Hoowae blue No. 7 and a kenaf trial of Madras red. Fertilizers were added at the levels: 0-0-0, 1-1-1, 2-2-2, 3-3-3, and 4-4-4 which are indicating N-P_2O_5-K_2O applied at rate of 0-0-0, 40-40-60, 80-80-120, 120-120-180, and 160-160-240 kilogram per hectare, respectively. The nitrogen was derived from ammonium sulfate, phosphoric acid from superphosphate and potash from sulfate of potash. Two-plant samples used for chemical analysis were taken at random from plants of average height in the middle row of each plot at harvest time and during the vegetative growth. Total nitrogen was determined by semimicro-Kjeldahl method. phosphoric acid by the method of Lorenz and potash by the volumetric cobaltnitrite method.(1)

Pot culture was simultaneously conducted in the greenhouse, in order to collect all leaves fallen during growth. For this experiment soils were taken from the same field in which field experiment was being made and the similar fertilizer treatments as described in the field test were laid in duplication, and 16 kg. of soil were used per

* This experiment was included in the experiment entitled "Effect of Continuous Cultivating of Jute and Kenaf on the Yield of the Following Crop," and was conducted in cooperation with P. L. Chang and K. C. Chang, senior agronomist and junior agronomist, respectively. Here, data presented are confinded to the part of chemical study.

pot. The same varieties of jute and kenaf were separately planted in each prepared pot. After germination, the seedlings were thinned to two most vigorous plants for each pot. From the beginning to the end of the experiment, the shedded leaves were collected and stored. After harvest, the dry matter content of total shedded leaves and plant were determined. Samples of leaves were divided into two portions; petiole and blade, and were separately analyzed for determing nitrogen content by Kjeldahl method.

Results and Discussion

Effect of fertilizer on the dry matter content of jute and kenaf

As this experiment was mainly designed to get an information as to the difference in the behavior of uptake of nutrients between jute and kenaf, the data concerning the yield of fiber are not included here. Generally speaking, the yield of dry matter increased as the rate of fertilizer application was increased (Fig. 1). However, if the yield in the plot of 222 was taken as a basis for comparison, it was found that the yield did not show further significant increase, when the rate of application exceeded the level of 222. With jute, however, more yield was obtained from the plot of 222 than that of 111, the difference was significant through t-test, whereas, with kenaf, it did not occur. It seems to indicatet that the responses of kenaf to 222 fertilizer had a similar trend, but of a lesser magnitude than that of jute. Thus it may be possible to obtain a desired yield of kenaf with a lower rate of fertilizer applicaton than that for jute.

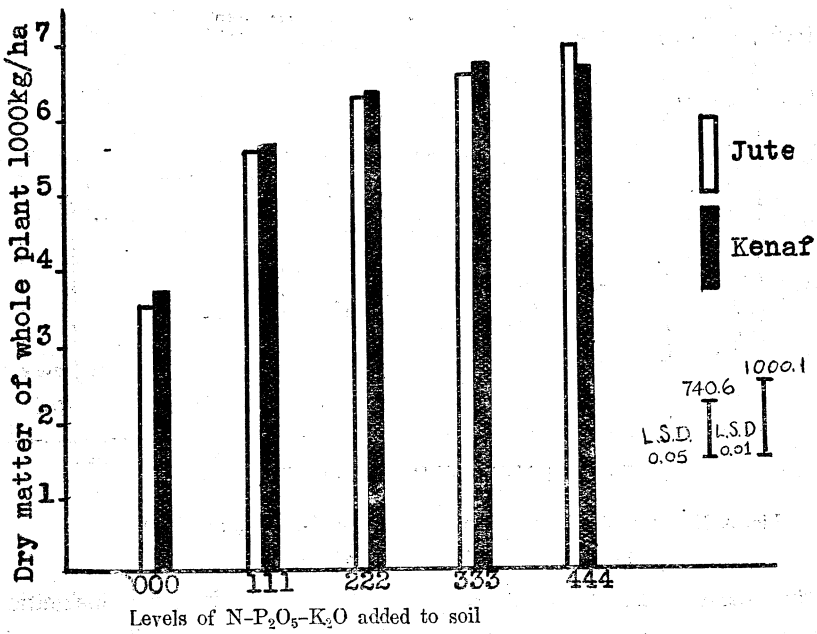


Fig. I. Effect of fertilizer on the dry matter contents of jute and kenaf
L. S. D. of the 0.05 and 0.01 is for treatment means

Effect of fertilizer on the percentages of N, P_2O_5, and K_2O in jute and kenaf

The percentages of N, P_2O_5, and K_2O in jute and kenaf at the harvest time were separately plotted in Fig. 2. It showed that the percentages of the nutrients in plants of unfertilized plots were always higher than those of fertilized plots at the level of 111. It seems to indicate that the application of fertilizer at certain level would cause a much more rapid process of photosynthesis, i.e. the rate of elaboration of dry matter was more rapid than nutrient absorption. Consequently, it induced the decreases in N, P_2O_5, K_2O contents as the percenatge in the content of dry matter increased. This may be considered as a result of dilution. Terman, Carpenter, and Cunningham (3) has acquired the same conclusion in their studies on the relation between the percentage of potash and the dry matter content of potatoes.

Generally speaking. an increase in the rate of application usually resulted in an increase in the percentages of N and K_2O in both jute and kenaf (Fig.2). But a striking difference has been found in the case of kenaf, when its results were compared for the percentages of nitrogen and potash derived from plot 222 with that from the plot 444.

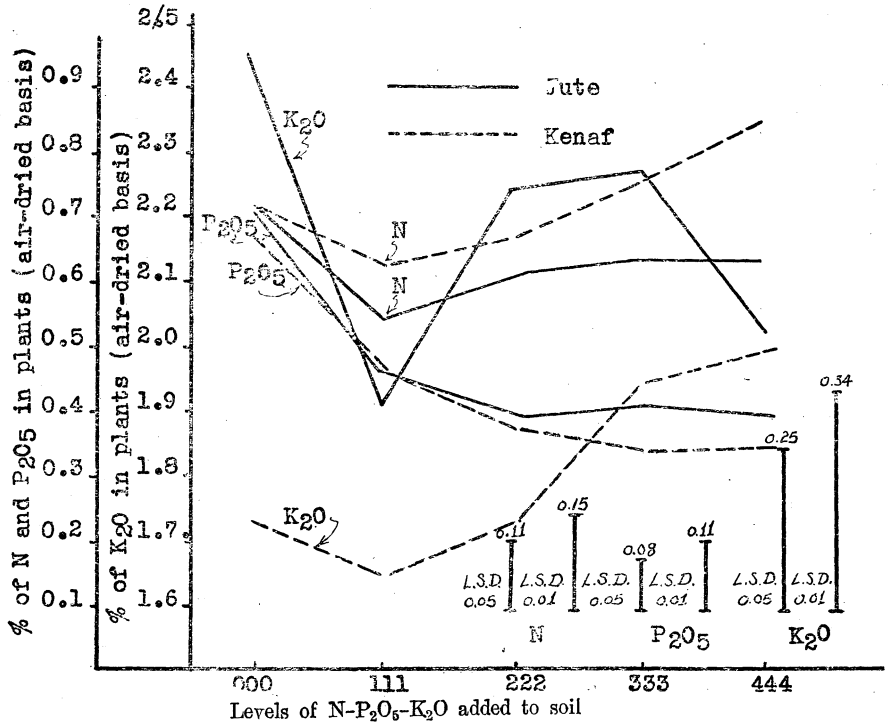


Fig. 2. Effect of fertilizer on the pecentages of N, P_2O_5, and K_2O in the plants of jute and kenaf

While, in the case of jute, the results of the similar comparison was insignificant. The effect of nitrogen was studied by Yamaguchi (6) who showed that nitrogen would cause a greater increment in fiber production in kenaf than that in jute.

The shape of the utilization curve for phosphoric acid showes that the percentage of phosphoric acid in plants gradually decreased as the rate of application increased. It is

especially true in the case of kenaf. Its phosphoric acid percentage derived from the plot 222, 333, or 444 are significantly lower than that from the plot 111, whereas, in the case of jute these comparisons are insignificant. Although this indicates that the P_2O_5-requirement of these two crops is less in amount, the response of kenaf to phosphatic fertilizer may be considered to be much lesser. Yamaguchi (6) has also pointed out that the effect of phosphatic fertilization is positive on jute and negative on kenaf.

Effect of the nutrients applied on the amount of nutrients absorbed by jute and kenaf

The amount of N and K_2O absorbed by jute and kenaf were found, in general, increased as the fertilizer applied increased (Fig.3.). However, if the amount of N and K_2O derived from the plot 222 were taken as a basis for comparison, it was found that beyond this level, in the case of kenaf, further increase in rate of application would still cause a significant increase in the amount of N and K_2O absorbed, but the same was not true for jute. Very little evidence was found regarding the amount of phosphorus absorption affected by its rate of application, so it might indicate that among the three essential elements, nitrogen and potash are the most important elements for getting the desired growth of jute and kenaf. And phosphorus was needed in the least amount. It was mentioned above that if the rate of application of fertilizer exceeded the level of 222, the dry matter content of kenaf was not significantly increased. Consequently, the continuous absorption of N and K_2O were probably largely attributed to the higher absorptive ability of kenaf.

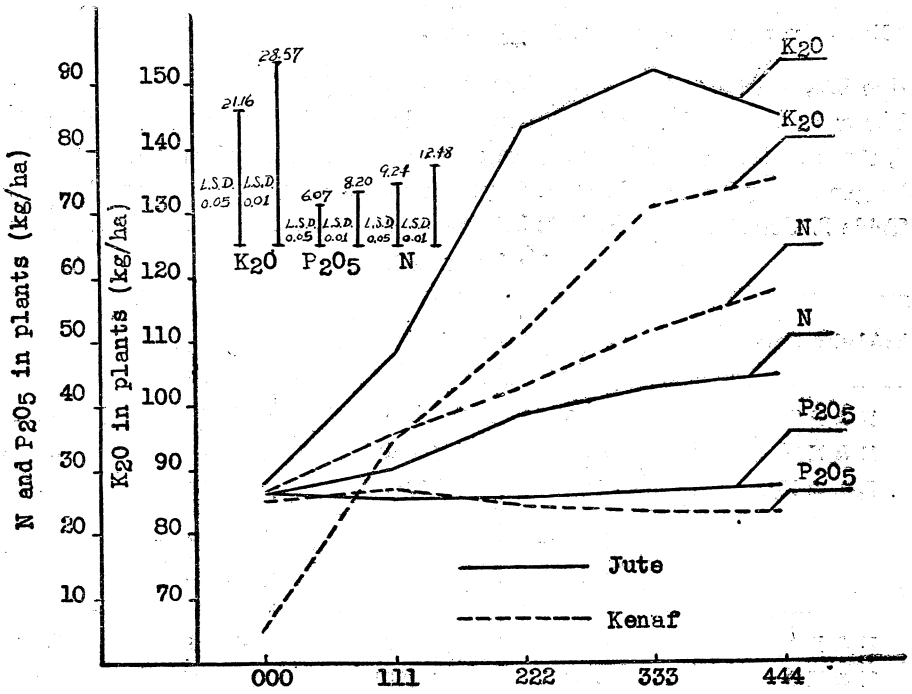


Fig. 3. Effect of fertilizer on the uptake of N, P_2O_5, and K_2O by the plants of jute and kenaf

Comparisons of the average contents of dry matter and nutrient elements between jute and kenaf

The data concerning the average contents of dry matter, and nutrient elements between jute and kenaf are given in table 1. It showes that there were little differences in the content of dry matter and P_2O_5% between jute and kenaf, but striking differences were observed in the content of nitrogen and potash between the two, i. e. the nitrogen content of kenaf was higher than that of jute, while, the reverse occurred in the potash content. In view of the experimental results, it may be concluded that nitrogen would be the limiting element for getting the desired growth of kenaf. As most soils in Taiwan are deficient in this element, nitrogen fertilization is particularly important.

Table 1. Showing the average contents* of dry matter and nutrient elements in jute and kenaf

Kind of plant	Content of dry matter	Per cent of nutrients in plant			Amount of nutrient uptake by plant		
	kg/ha	N%	P_2O_5%	K_2O%	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha
Jute	5879.3	0.63	0.47	2.18	36.35	26.06	127.19
Kenaf	5884.3	0.72	0 44	1.81	42.90	24.41	107.03
L. S. D .05	389.7	0.04	0.36	0.11	4 16	2.71	9.46
.01	526.2	0.06	0.48	0.15	5.62	3.66	12.78

*Each value represents average of 20 replications.

Relation between the individual nutrient absorbed by jute and kenaf

For clarifying the interaction between the individual nutrients absorbed by jute and kenaf, the correlation coefficients were computed and compiled in table 2. The increase in nitrogen absorption with increase in potash was highly correlated in all cases which

Table 2. Correlation coefficients between two individual nutrient elements absorbed by jute and kenaf

Correlation between	Jute		Kenaf	
	Correlation coefficient	t	Correlation coefficient	t
N & P_2O_5	0.3956	1.8275	0.0175	0.0742
N & K_2O	0 8633	7.2584**	0.6362	4.0028**
P_2O_5 & K_2O	0.4253	1.9938	0.0592	0.2517
	Partial correlation coefficient	t	Partial correlation coefficient	t
N & P_2O_5	0.0622	0.2568	-0.0319	0.1315
N & K_2O	0 8362	6.2899**	0 6365	3.8928**
P_2O_5 & K_2O	0.1808	0.7579	0.0649	0.2681

**Showing correlation coefficient of highly significant.

indicates the necessity of applying a balanced nitrogenous and potash fertilizer for the growth of jute and kenaf. It may be noted that the negative value of partial correlation coefficent between nitrogen and phosphorus was merely occurring in the case of kenaf. It would seem to indicate that from the standpoint of fiber production, the application of phosphatic fertilization on kenaf would be unnecessary except where soil is extremely low in available phosphorus. Farmers are usually applying farmyard manure which contains sufficient phosphorus for the need of kenaf.

Comparison in the contents of dry matter and nitrogen of the shedded leaves between jute and kenaf

It was believed that the jute was very hard upon the soil. This means that jute depleted the plant food elements in a soil very rapidly. However, substantial data for an elucidation of this are still lacking. For introducing kenaf in place of jute, it is necessary, of course, to know first of all, what nutrient element or elements are being deficient after these two crops have been cultivated. Unfortunately, one could not get an andequate answer to this problem by merely indicatlng the chemical analyses of soil which have been made before and after cultivation. It seems that there is a possibility of knowing the extent of depletion of plant nutrients in a soil by analyzing the nutrient element contents which plants have taken from the soil and those they have returned to the soil by shedding the leaves during their growth. Pot data indicated in table 3 and 4,

Table 3. Comparison on the contents* of dry matter in plants and shedded leaves (greenhouse condition)

Treatment	Dry matter content of							
	Plant g/pot		Leaf blade g/pot		Leaf petiole g/pot		Whole leaf g/pot	
	Jute	Kenaf	Jute	Kenaf	Jute	Kenaf	Jute	Kenaf
000	47.5	58.5	4.8761	3.7180	0.9430	1.3324	5.8191	5.0504
111	80.0	86.0	6.8520	6.7780	1.5337	2.7050	8.3857	9.4830
222	90.0	102.5	8.4295	6.3165	1.8758	2.5150	10.3053	8.8315
333	90.0	127.5	7.1538	6.0618	1.4585	2.9356	8.6122	8.9974
444	105.0	135.0	8.8026	10.7062	2.0578	4.2728	10.8604	14.9790
Mean	82.5	101.8	7.2230	6.7161	1.5738	2.5522	8.7965	9.4683
t-test	3.1618**		0.7413		3.163**		0.779	

* Each value represents average of two replicates.
** Showing the significance of difference.

may supply an information on this problem. Originally the author wished to find out a regression equation stating the relationship between the dry matter content of plant and the shedded leaves in greenhouse conditon. As shown in table 3, the dry matter content of the plant increased as the yield of the shedded leaves increased. The regression equation for jute was found as follows: $Y=0.08821x+1.5192$, $t=5.5477$, in which Y represents the estimated dry matter content of shedded leaves, x the actual dry matter content of plant;

and t, the test of significance. This equation reveals that the amount of the shedded leaves of jute may be estimated by this equation. However, due to the limited amount of shedded leaves from the kenaf, because most of its leaves remained on the stem after the harvest, the same equation was not obtained. From the t-test of the differences between means of jute and those of kenaf shown at the bottom of table 3, it may be found that the dry matter content of plant and petiole in kenaf were much higher than those in jute, while the difference in the dry matter content of whole leaf and of leaf blade were insignificant between these two crops. The data of nitrogen content in leaves of these crops are shown in table 4. It indicates that in both jute and kenaf, the per cent

Table 4. Comparison on nitrogen content in different portions of leaf

Treatment	Per cent of nitrogen in					
	Leaf blade		Leaf petiole		Whole leaf	
	Jute	Kenaf	Jute	Kenat	Jute	Kenaf
	%	%	%	%	%	%
000	1.08	1.18	0.59	0.48	0.99	1.06
111	1.19	1.18	0.58	0.50	1.08	0.91
222	1.16	1 40	0.65	0.53	1.06	1.08
333	1.28	1.48	0.65	0.50	1.18	1.17
444	1.26	1.35	0.70	0.56	1.15	1.11
Mean	1.19	1.32	0.63	0.51	1.09	1.07
t-test	7.93**		9.803**		0.0433	

* Each value represents the average of two replicates,

**Showes significance of difference.

of nitrogen in leaf blade increased with the increasing rate of application. And the per cent of nitrogen in petiole also showed an increasing tendency in jute but it remained fairly constant in the case of kenaf. By comparing the t value at the bottom of the same table, it may be known that by leaf blade, the nitrogen content of kenaf was much higher than that of jute, whereas, with leaf petiole, the reverse occurred. With whole leaf, however, there was no apparent difference. Thus these data lead us to adopt a conclusion that the amount of nitrogen returned to the soil during the growth period of these two crops related closely to the dry matter content of shedded leaves. Hence there is a possibility that nitrogen returned to a soil through the kenaf plant would be much more than that from the jute, because kenaf, on average, will produce 1.4 times dry matter yearly than jute (7) and there is a positive correlation between yield of plant and amount of leaves.

Besides, the author has noticed that the main root of kenaf was much longer and its branch roots were stretched into subsoil, whereas the roots of jute were mainly restricted in the surface soil. Thus it may be known that the nutrient elements of jute were mainly derived from the surface soil, whereas, in kenaf, from both surface and

subsoil. This may be accounted as a reason why kenaf, having had a higher absorptive ability of nutrients, was capable of thriving on a relatively poor soil. Consequently, it would be naturally that the plant food in surface soil would not be so rapidly depleted after the cultivation of kenaf as the case observed after the cultivation of jute.

Summary and Conclusion

Jute, Hoowae blue No.7 and kenaf, Madras red, were grown at the different rates of fertilization and a study was made on the different behaviors in the uptake of nutrient elements between them. Pot culture with the same treatments was also conducted so as to collect the shedded leaves during growth and the nitrogen content in leaves between jute and kenaf was compared.

The dry matter content, both of jute and kenaf, increased significantly with the increasing rate of fertilization up to a certain level, beyond which, however, an increased supply of fertilizers was unaccompanied by further striking increase in plant growth. The optimum nutrient level is likely to be less for kenaf than for jute.

Both in jute and kenaf, the percentage of nitrogen and potash increased almost consistently with the increasing rate of fertilizers application. However, the degree of increment was much more significant in the case of kenaf. Increase in fertilization had little effect on the percentage of phosphoric acid in jute, but the reduction in the percentage of phosphorus with the increase in fertilization was found in kenaf. By comparing the average percentage of nitrogen, and potash between jute and kenaf, it was found that jute was high in nitrogen and low in potash. The difference in the percentage of phosphoric acid between them were insignificant. A similar result as stated above was obtained in the amount of nutrient element taken by these two crops.

Though most of the correlation coefficients between individual nutrient element were found positive, the significant correlation was found only between nitrogen and potash in both jute and kenaf. This finding may emphasize the importance of applying balanced nitrogenous and potash fertilizer for the growth of these two crops. Similar result was obtained in partial correlation, but an exception was found on the negative value of the partial correlation between nitrogen and phosphorus of kenaf. which indicates that the response of the phosphatic fertilizer on the production of kenaf fiber is very small.

The relationship between the dry matter content of shedded leaves and that of plant was studied in greenhouse condition and the amount of nutrient compositions of shedded leaves returned to soil by jute and kenaf were determined and discussed. No apparent difference in the nitrogen content of shedded leaves was found between jute and kenaf, but there was a striking difference in root distribution throughout the soil profile.

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中 文 摘 要

黃麻與鐘麻對於肥料三要素吸收性能之比較研究

林 家 棻

本試驗之目的在比較兩種麻類對于三要素吸收之性能及其落葉中所含氮成分之差異，藉以探討該兩項作物對于三要素之需要狀況及其對于土壤養分補還作用之關係。所用之黃麻品種爲虎尾青皮7號，鐘麻爲 Madras red. 三要素施用量分爲五平準，其中包括空白區。經田間與盆栽試驗結果，獲知兩種麻類對于氮鉀的需要均甚迫切，但因麻類的不同，在需要量上則有顯著差異，一般言之，鐘麻之含氮百分率與其需要量均高于黃麻。而黃麻之含鉀百分率與其需要量則高于鐘麻。該兩種麻類對于磷肥的需要量均甚低，其中尤以鐘麻爲然。兩種麻類落葉中含氮百分率差異不顯著。但落葉收量與麻株乾物量成正比，而鐘麻的植株收量一般均高于黃麻，因而鐘麻對于土壤養分的歸還可能較黃麻爲多，同時鐘麻根群深達心土，對于表土養分的消費可能較黃麻爲少。

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