Pakistan J. Sci. Ind. Res., **12**, 443–447 (1970)

STUDIES IN MERCERIZATION OF JUTE, COTTON AND SOME OTHER VEGETABLE FIBRES UNDER DIFFERENT TREATMENTS

ABDUL HAMEED KHAN, KHALIL AHMAD KHAN and PARVEZ MAHMUD HASHMI

West Pakistan Agricultural University, Lyallpur

(Received May 18, 1968; revised September 7, 1968)

Studies in mercerization of jute, cotton and other vegetabe fibres were conducted at Lyallpur during the two years 1965-66 and 1966-67 and the range of values was found to be 4.173–19.750%. The highest value was recorded by kenaf$_2$ followed by kenaf$_1$, patwa, jute, sunhemp, ramie flax, bombax cotton and calotropis, whereas the lowest value was observed in case of L.S.S., followed by other cotton varieties AC307, AC134 and 4F. The varietal differences were highly significant at all the stages of maturity and spacing effects were significant at seed maturity stage only and non-significant at pre-flowering and flowering stages. The manurial effects were found to be significant at preflowering stage and highly significant at flowering and seed maturity stages during both the years. There was a general fall in values of mercerization percentage from preflowering stage to seed maturity stage in all types of vegetable fibres during both the years. Preflowering stage of the plant is therefore the best for obtaining high quality fibres and desirable effects.

Introduction

Mercerization is the swelling or dispersion reaction of certain reagents like sodium hydroxide on cellulose. It was first discovered by Mercer and this name has been given to the well known industrial process for production of mercerized cotton. On immersion of cellulose fibre in sodium hydroxide of approximately 17.5% concentration, maximum swelling occurs transverse to the fibre axis. It is accompanied by shrinkage in length, increased tensile strength and lustre and conversion of hydroxyl groups to ONa groups on the chains to a certain degree. Mercerized fibres show enhanced activity even after the alkali is completely removed and the most significant change is the absorption of water vapour, of alkalies, or of dyes, which is increased from 10 to 300%; depending upon the concentration of alkali used for mercerization.

The great industrial value of mercerization prompted initiation of regular studies in jute, cotton and some other vegetable fibres under different treatments. The interesting results obtained are given in this paper.

Review of Literature

The researches pertaining to the mercerization of seed hair and bast fibres have been reported by a number of workers from various countries and a brief review of only the relavant literature is given here: Matthews and Mauersberger[1] reported that the mercerization values of kenaf, patwa, sunhemp, ramie and flax were 16.0,11.0, 9.6,11.3, 11.0, and 8.4%, respectively.

Materials and Methods

The present studies were carried out at the West Pakistan Agricultural University, Lyallpur, during the years 1965–66 and 1966–67. The experiment was arranged in a split plot design with three replications, two manurial treatments, three spacings and six varieties of bast fibres. The details of the experiment are given here:

Varieties.—Jute=J_1 (*Corchorus olitorius* L.); Jute=J_2 (*Corchorus Capsularis* L.); Kenaf=K_1 (*Hibiscus cannabinus* L. Var. viridis); Kenaf=K_2 (*Hibiscus cannabinus* L. Var vulgaris); Patwa=P (*Hibiscus subdariffa* L.); Sunhemp=S.H. (*Crotalaria juncea* L.).

Spacings.—

Row to row distance	Plant to plant distance
S_1= 9 in	4–6 in
S_2=12 in	4–6 in
S_3=15 in	4–6 in

Fertilizer rate per Acre.—

Mo=Control
M1=50 lbs of nitrogen/acre.

The samples of flax, ramie, calotropis and bombax cotton were collected from different sources for the present studies.

Pure seed of all the varieties was taken from the Department of Plant Breeding and Genetics, West Pakistan Agricultural University, Lyallpur. The seed was sown on the 15th of April during both the years according to the well designed experimental plan. The experimental crops received normal and uniform agricultural operations during the growing period. Nitrogen was applied as ammonium sulphate 1½ month after sowing when the seedlings were 9–12in. The condition of crop during both the years was normal.

Sampling.—Five lb sample from each plot was taken at the following three stages of maturity; (1) Preflowering; (2) Flowering and (3) Seed maturity.

Retting.—The samples thus taken were subjected to water retting under closed tank system for the separation of the fibres from the woody core of the stem. The fibres were separated by manual labour, dried under shade and were studied in the laboratory to see the effect of fertilizer, spacing and varieties on the quality of fibres.

Method Used.—The method used for the estimation of mercerization of jute, cotton and other vegetable fibres were the same as suggested by Matthews.[2]

Mercerization is represented by the loss in wt sustained by the fibres after treatment for 1 hr in the 33% cold caustic potash solution. The fibres were cut into small pieces and freed from foreign matter. Sample of 2–3 g was taken, oven-dried at 105–110°C and put into a beaker. 20 cc of caustic potash solution (KoH) was added in the beaker containing fibres with the help of a pipette. The fibres were agitated by a glass rod until the whole sample become wet and settle down. After 1 hr, the sample was filtered through Wattman filter paper No. 44. Washings were given to the beaker as well as the filter paper by distilled water to free the sample from excess alkali. The sample was dried and weighed. Percent loss in wt is calculated on the basis of oven dry weight of the sample.

Statistical Analysis.—The data thus collected were analysed statistically by the method of analysis of variance as described by Snedecor.[3] The treatment means were compared using L.S.D. test method of significance Leclerg *et al.*[4]

Results and Discussion

The results of the present studies relating to mercerization% of jute, cotton and other vegetable fibres conducted at Lyallpur, during the years 1965–66 and 1966–67, are presented in Tables 1–4 discussed here.

It will be seen from the data given in Table 1–2 that the varietal effects were significant at all the stages during both the years. It will be observed that the highest values of 19.750 and 19.700% were recorded in case of kenaf$_2$ at the preflowering stage during the 1st and 2nd year respectively, whereas the lowest values of 10.236 and 10.459% were recorded by jute$_1$ at seed maturity stage in 1965–66 and by sunhemp at the seed maturity stage in 1966–67. The range of values at the preflowering stage was 12.300–19.750% it was 12.450–16.600% at flowering stage; 10.236–14.205% at the seed maturity stage and similar trends were recorded during the 2nd year. The actual values of kenaf$_2$, kenaf$_1$, patwa, jute$_1$, jute$_2$, and sunhemp at preflowering stage in 1965–66 were 19.750,19.740,14.816,14.195,14.185,14.185 and 12.300% respectively. More or less similar were the values at other stages during both the years, although there was a progressive decline in the values recorded with the advancement of maturity.

It will be observed from Table 3 that the effect of types or varieties on mercerization was significant. The highest value of 10.243% was recorded by ramie followed by 9.703,7.245 and 6.443% in case of flax, bombax and calotropis respectively.

The varietal effects on mercerization were found to be significant as is further clear from the analysis of variance given in Table 4. It was further observed that manurial effects were non-significant in cotton the highest value of 4.508% was recorded by 4F followed by 2.226,4.205 and 4.173% in the case of AC-134,AC-307 and L.S.S. respectively.

It will be clear from Tables 1–2 that the spacing effects were non-significant at preflowering and flowering stages, but significant at seed maturity stage during both the years. The Nitrogen application affected mercerization significantly at preflowering and seed maturity stages during both the years.

TABLE 1.—SHOWING ANALYSIS OF VARIANCE OF MERCERIZATION.

Variation due to	F. Ratios					
	1965 66			1966 67		
	Preflowering	Flowering	Seed maturity	Preflowering	Flowering	Seed maturity
Manures	63.471*	109.672**	105.368**	72.411*	127.074**	119.752**
Spacings	3.633NS	3.291NS	5.590*	3.879NS	2.358NS	5.614*
Varieties	516.96**	947.39**	620.89**	698.404**	573.613**	705.010**

** Highly significant. * Significant. N.S.=Non-significant.

TABLE 2.—SHOWING STATISTICAL SUMMARY OF THE MAIN TREATMENTS.

Treatment	Means					
	1965–66			1966–67		
	Preflowering	Flowering	Seed maturity	Preflowering	Flowering	Seed maturity
Varieties						
K_1	19.740	16.600	14.205	19.672	16.366	14.407
K_2	19.750	16.583	14.204	19.700	16.379	14.409
J_1	14.195	13.422	10.236	14.283	12.564	10.572
J_2	14.185	13.433	10.252	14.278	12.553	10.564
P	14.816	13.294	13.156	14.683	13.234	13.281
S.H.	12.300	12.450	10.486	12.754	11.128	10.459
Spacings						
S_1	15.834	14.222	12.108	15.900	13.711	12.304
S_2	15.832	14.197	12.095	15.896	13.705	12.280
S_3	15.827	15.194	12.075	15.891	13.696	12.261
Manures						
M_0	15.791	14.169	12.083	15.760	13.669	12.210
M_1	15.871	14.241	12.102	16.030	13.739	12.354
Spacings C.D.						
5%	0.037	0.007	0.021	0.015	0.010	0.036
1%	0.072	0.014	0.041	0.029	0.020	0.070
Varieties C.D.						
5%	0.044	0.052	0.038	0.083	0.016	0.093
1%	0.063	0.073	0.054	0.117	0.023	0.131

TABLE 3.—SHOWING ANALYSIS OF VARIANCE OF FIBRE MERCERIZATION.

Variation due to	D.F.	S.S.	M.S.	F. ratio	t. value
Samples	3	1.5803	0.5267		
Varieties	3	41.0275	13.6758	8.2918	*
Error	9	14.8436	1.6493		
Total	15	57.4514			

* = Significant

Statistical summary of the main treatments

Varieties

S.E. = 0.642
S.E.D.M. = 0.9079
Cd1 = 3.505
Cd2 = 6.346

Ramie	*Flax*	*Bombax Cotton*	*Calotropis*
10.243	9.703	7.245	6.443

TABLE 4.—SHOWING ANALYSIS OF VARIANCE OF FIBRE MERCERIZATION.

Variation due to	D.F.	S.S.	M.S.	F. Ratio	t. value
Samples	3	0.2984	0.0994		
Varieties	3	0.5510	0.1836	4.062	*
Manures	1	0.0001	0.0001	0.002	NS
V×M	3	0.0115	0.0038		
Error	21	0.9495	0.0452		
Total	31	1.8105			

* = Significant
NS = Non-significant

Statistical summary of the main treatments

Varieties

S.E. = 0.0752
S.E.D.M. = 0.1064
Cd1 = 0.327
Cd2 = 0.518

4F	AC134	AC307	L.S.S.
4.508	4.266	4.205	4.173

Matthews and Mauersberger[1] reported that the mercerization% in the case of kenaf, jute, patwa, sunhemp ramie and flax was 16.0,11.0, 9.6,11.3,11.0 and 8.3%, respectively as compared to the values ranging from 14.205 to 19.740 19.740% in the case of $kenaf_1$ and 14.204–19.750 % for $kenaf_2$; 10.236–14.283% for $jute_1$ and 10.252–14.278% in the case of $jute_2$; 13.156–14.816% for patwa, 10.457–12.754% for sunhemp; 10.243% for ramie and 9.703% in the case of flax in the present studies, which were found to indicate a wider range than reported by the earlier workers.

The results of the present investigations have clearly shown that all vegetable fibres kenaf, jute, patwa and sunhemp have recorded fall in mercerization percentage or shrinkage from a range of 12.30% to 19.74% at preflowering stage to 11.128 to 16.60% at flowering stage and 10.459 to 14.205% at the seed maturity stage during the two years and therefore for obtaining the maximum shrinkage or mercerization effects i.e., increase in strength, sorptive power and dyeing capacity and enhansing of lustre for commercial ends, fibre must be obtained from crop Kenaf, jute, patwa and sunhemp at the preflowering stage.

The same will hold good for flax and ramie. Moreover maximum mercerization effects can be obtained in the case of kenaf followed by jute, patwa, sunhemp, ramie, flax, bombax cotton, calotropis, 4F, AC-134, AC-307 and L.S.S.

Higher and significant value of mercerization was obtained only with close spacing at seed maturity stage whereas higher and significant differences in values were recorded at preflowering and seed maturity stages with application of nitrogen.

Summary

Studies in mercerization of jute, cotton and other vegetable fibres were conducted at Lyallpur, during the years 1965–66 and 1966–67.

The varietal differences were highly significant at all the stages of maturity and spacing effects were significant only at seed maturity stage and were non-significant at preflowering and flowering stages, whereas the manurial effects were significant at preflowering stage and highly significant at flowering and seed maturity stage during both the years.

The values of mercerization ranged from 4.173 –19.750% the lowest value was shown by L.S.S. and the highest by kenaf$_2$, followed by Kenaf$_1$, Patwa (roselle) and jute, with actual values of 19.740, 14.683 and 14.288% respectively during both the years.

References

1. J.M. Matthews and H.R. Mauersberger, *Textile Fibres, Their Physical, Chemical and Microscopic Properties* (John Wiley and Sons, Inc., New York 1954).
2. J.M. Matthews, *Textile Fibres, Their Physical, Chemical and Microscopic Properties* (John Wiley and Sons, Inc., New York, 1953).
3. G.W. Snedecor, *Statistical Methods* (The Iowa State University Press. Inc. Ames. Iowa, U.S.A., 1962), fifth edition, 4th reprint.
4. E.L. Leclerg, W.H. Leonard and A.G. Clark, *Field Plot Techniques* (Burgess Pub. Co. Minnesota 1962), second edition, pp. 144–146.