APPLICATION OF NATURAL FIBERS IN EROSION CONTROL

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Abstract

This research is mainly concerned with designing fabrics used in erosion control (lining of river and canal banking up). Two kinds of textile materials were used in this research, cotton and jute fibers. The woven technique was applied to produce all samples using different structures (plain weave 1/1, irregular hopsack 2/1,twill 2/1 and twill 2/2) . Different parameters were studied including, fabric structure, yarn count and weft set . Physical properties including; , water permeability and U.V resistance were evaluated according to the final product needs. Some more results were reached concerning structures and materials. Most samples have achieved the expected results.

Introduction

The erosion of river banks ,canals or shore lines of sea is a common phenomenon of transportation of soil particles by exogenous wind or water action .The erosion phenomenon starts as soon as the first particle ,detached from the rest of the soil ,gets carried away due to the impact of splash and velocity of flow ,(1) but it only became a serious problem in recent centuries because of the a accelerated erosion which caused severe instability and even destruction of the slope . (2)

Before usage of geotextiles ,the conventional method of river bank protection against erosion envisaged laying of a permeable multi –layer granular overlay on the eroded surface with armours on top, (3) such as riprap ,concrete blocks and concrete slabs .(4) But even when properly installed ,granular filters are washed away ,under the erosive forces ,leaving the soil slope unprotected . (2)

A geotextile placed between the rock layer and the underlying soil surface provide anchorage of the underlying soil and protects it from erosion and wave attack .(5)Beside this ,these aggregate filters are considerably thicker than geotextile sheets ,often by a factor of 500 to 1 . (4)

Geotextiles are permeable textiles structures used in civil engineering applications in conjunction with soil , rock or other technical materials for improving the engineering performance of the engineering works .(6) The main functions geotextiles provide are aggregate separation ,soil ,reinforcement ,filtration, drainage ,and moisture or liquid barriers .(7)

In erosion control applications ,the primary function of geotextile is as a filter by allowing free liquid flow through its plane and by retaining soil particles on the upstream side .(8)

Eco-friendly fibers and fabrics are gradually gaining importance in recent times due to environmentalist movement through out the world. [9] Biobased geotextiles are used for short term (6 months to 10 years) applications where biodegradability is a positive attribute ,such as erosion control and mulching ,and is know as soil bioengineering .Fiber options for biobased geotextiles include cereal straws, coir ,jute , kenaf ,flax ,sisal ,hemp, cotton and others ,[7]due to their better performance ,ease of installation ,availability of materials ,and they are environmentally sound. [10]

It was found that ,the surface erosion can be effectively prevented with a proper vegetation cover on such land ,as biodegradable geotextiles initially provides protection to retain the seeds until germination and developing roots deep into the soil , [6] and over time ,the geotextile will decay and add organic matter to soil which helps in speedy growth of plants .[10]

Woven fabrics are considered the most suitable construction technique in soil stabilization and erosion control ,due to their desirable properties such as porosity ,strength and elongation .In general a woven geotextile is less likely to stretch and does not let water to flow as freely as nonwoven geotextiles .[11]

The experimental work

There are no previous studies about using natural fabrics in erosion control , this research concerns with producing fabrics suitable for erosion control using natural fibers, which are cotton yarns of 10 ,14 and 20 English count and jute yarns of 9 and 12 Libra . Four different woven structures were also used in this research to produce all samples, twill weave 2/1, twill weave 2/2, irregular hopsack 2/1 and plain weave 1/1.

Table (1) the specification of the machine used for producing jute samples

No	Property	Specification
1	**Model**	One Mack
2	**Company**	Machine of jute
3	**Year of manufacturing**	1956
4	**The manufacturer country**	James Mackie & Son LMT
5	**Shedding system**	Dobby
6	**Number of healds**	16 healds
7	**Width of the machine**	90 cm

Table (٢) Specification of jute samples produced in this research

Fabric construction						
Samples No.	**Yarn type**	**Fabric structure**	**Yarn count (Libra)**		**Warp set (ends/10 cm)**	**Weft set (picks /10 cm)**
			Warp	**Weft**		
Sample No .1	**Jute**	Twill weave 2/1	6	9	32	20
Sample No. 2	**Jute**	Twill weave 2/1	6	9	32	25
Sample No. 3	**Jute**	Twill weave 2/1	6	9	32	30
Sample No .4	**Jute**	Twill weave 2/1	6	9	32	35
Sample No .5	**Jute**	Irregular hopsack 2/1	6	9	32	20
Sample No .6	**Jute**	Irregular hopsack 2/1	6	9	32	25
Sample No .7	**Jute**	Irregular hopsack 2/1	6	9	32	30
Sample No .8	**Jute**	Irregular hopsack 2/1	6	9	32	35
Sample No. 9	**Jute**	Twill weave 2/1	6	12	32	20
Sample No. 10	**Jute**	Twill weave 2/1	6	12	32	25
Sample No. 11	**Jute**	Twill weave 2/1	6	12	32	30
Sample No .12	**Jute**	Twill weave 2/1	6	12	32	35
Sample No .13	**Jute**	Irregular hopsack 2/1	6	12	32	20
Sample No .14	**Jute**	Irregular hopsack 2/1	6	12	32	25
Sample No .15	**Jute**	Irregular hopsack 2/1	6	12	32	30
Sample No .16	**Jute**	Irregular hopsack 2/1	6	12	32	35

Table (3) the specification of the machine used for producing cotton samples

No	**Property**	**Specification**
1	**Model**	Somet 93
2	**Year of manufacturing**	1987
3	**The manufacturer country**	Italy
4	**Shedding system**	Dobby
5	**Number of healds**	20 healds
6	**Width of the machine**	190 cm
7	**Machine speed**	360 picks/min

Table (4) Specification of cotton samples produced in this research

Fabric construction						
Samples No.	**Yarn type**	**Fabric structure**	**Yarn count (cotton)**		**Warp set (ends/cm)**	**Weft set (picks/cm)**
			Warp	**Weft**		
Sample No .1	**Cotton**	Plain weave 1/1	40/2	10	28	10
Sample No. 2	**Cotton**	Plain weave 1/1	40/2	16	28	14
Sample No. 3	**Cotton**	Plain weave 1/1	40/2	20	28	18
Sample No .4	**Cotton**	Twill 2/2	40/2	10	28	10
Sample No .5	**Cotton**	Twill 2/2	40/2	16	28	14
Sample No .6	**Cotton**	Twill 2/2	40/2	20	28	18
Sample No .7	**Cotton**	Plain weave 1/1	40/2	10	28	10
Sample No .8	**Cotton**	Plain weave 1/1	40/2	16	28	14
Sample No. 9	**Cotton**	Plain weave 1/1	40/2	20	28	18
Sample No. 10	**Cotton**	Twill 2/2	40/2	10	28	10
Sample No. 11	**Cotton**	Twill 2/2	40/2	16	28	14
Sample No .12	**Cotton**	Twill 2/2	40/2	20	28	18
Sample No .13	**Cotton**	Plain weave 1/1	40/2	10	28	10
Sample No .14	**Cotton**	Plain weave 1/1	40/2	16	28	14
Sample No .15	**Cotton**	Plain weave 1/1	40/2	20	28	18
Sample No .16	**Cotton**	Twill 2/2	40/2	10	28	10
Sample No .17	**Cotton**	Twill 2/2	40/2	16	28	14
Sample No .18	**Cotton**	Twill 2/2	40/2	20	28	18

Tests and analysis

Several tests were carried out in order to evaluate the produced fabrics, these tests were,
Water permeability, this test was carried out according to the ASTM-D 383 (12)
U.V. resistance, this test was carried out according to the ASTM.D -4491 using the grey scale (13)

Results and Discussion

Through this research, it was reached to the following results

Water permeability

Jute samples

Table (5) the results of water permeability test applied to samples.

Test	**Water permeability ($L^3 /m^2/ sec$)**			
	Irregular hopsack 2/1		**Twill 2/1**	
Yarn count / **Weft set**	**9**	**12**	**9**	**12**
20	1.25	1.2	1.13	1.1
25	1.15	1.1	1.09	1.05
30	1.04	1.06	1.04	1.02
35	1.04	1.03	1.00	1.03

It is clear from the diagrams from (1) to (4) that there is an inverse relationship between number of picks per cm and water permeability, this is due to that the increasing in number picks per unit area cause the fabric to be more compacted so water permeability will be decreased .

It can also be observed from the diagrams that samples produced with 9 Libra have achieved the highest rates of water permeability, whereas samples produced of 12 Libra have achieved the lowest rates. we can report that the more diameter the yarns get the less porosity the fabric become because of the decreasing in spaces between yarns, so the water permeability will be decreased.

It is obvious from the diagrams that regular hopsack 2/1 has recorded the highest rates of water permeability , whereas twill 2/2 recorded the lowest rates of water permeability . We can report that twill weave cause the produced fabric to be more compacted, so spaces in the fabric will be decreased causing decreasing in water permeability compared to fabrics of regular hopsack 2/1..

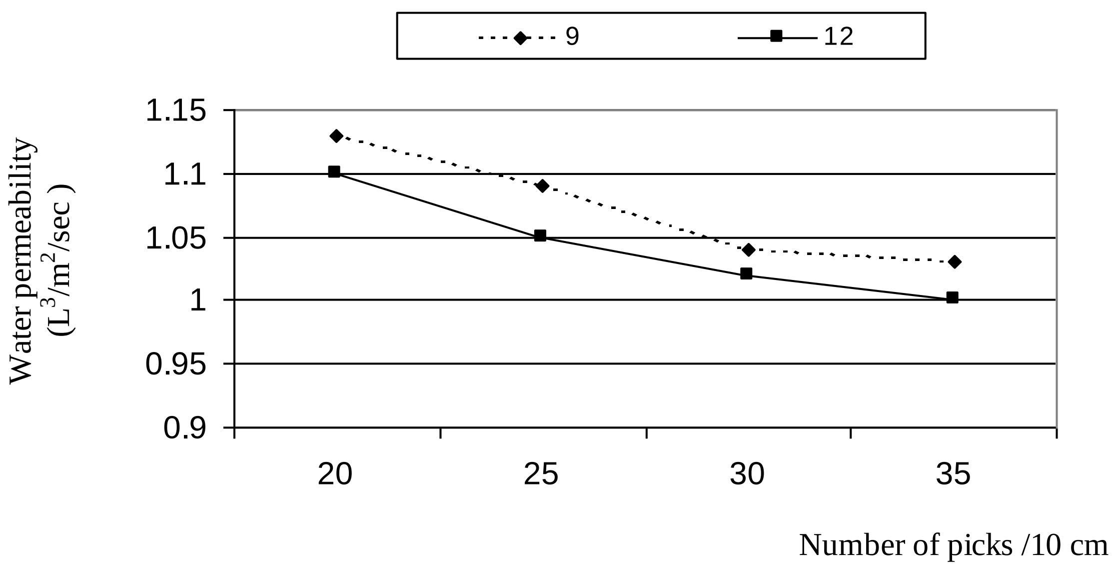

Fig (1)
Effect of number of picks /10 cm and yarn count on water permeability, using twill weave 2/1

Table (٦) regression equation and correlation coefficient for the effect of number of picks/10 cm and yarn count on water permeability , using twill weave 2/1

Yarn count	Regression equation	Correlation coefficient
9 Libra	Y =-0.00583X +1.23	-0.972598
12 Libra	Y =-0.0055X +1.191	-0.979526

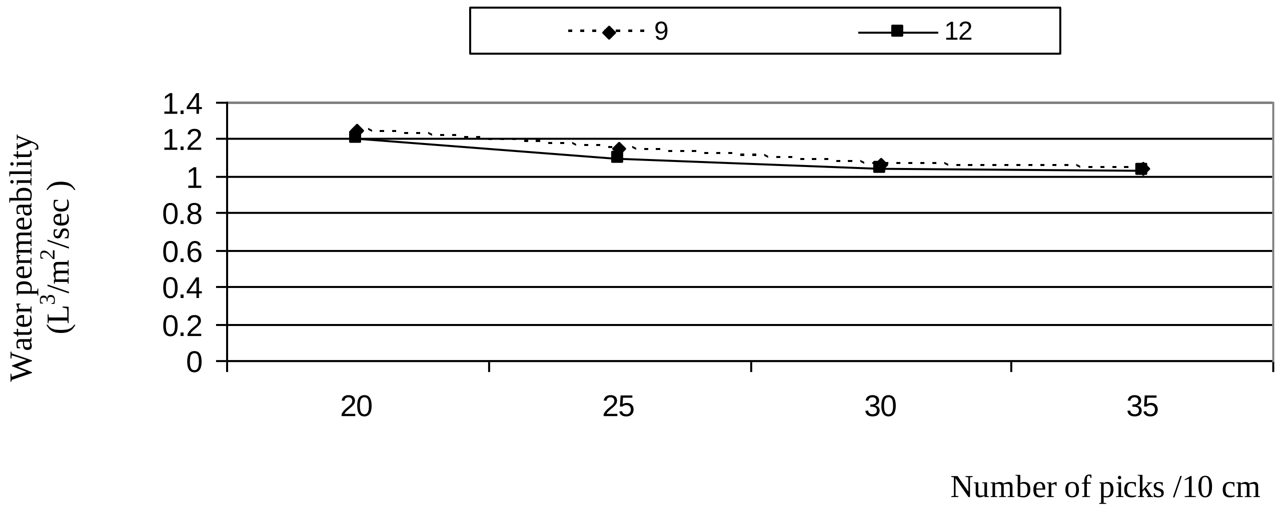

Fig (2)
Effect of number of picks /10 cm and yarn count on water permeability, using irregular 2/1 structure

Table (7) regression equation and correlation coefficient of the effect of number of picks/10 cm and yarn count on water permeability, using irregular 2/1

Yarn count	Regression equation	Correlation coefficient
9 Libra	Y =-0.012X +1.449	-0.967334
12 Libra	Y =-0.00883X +1.341	-0.958893

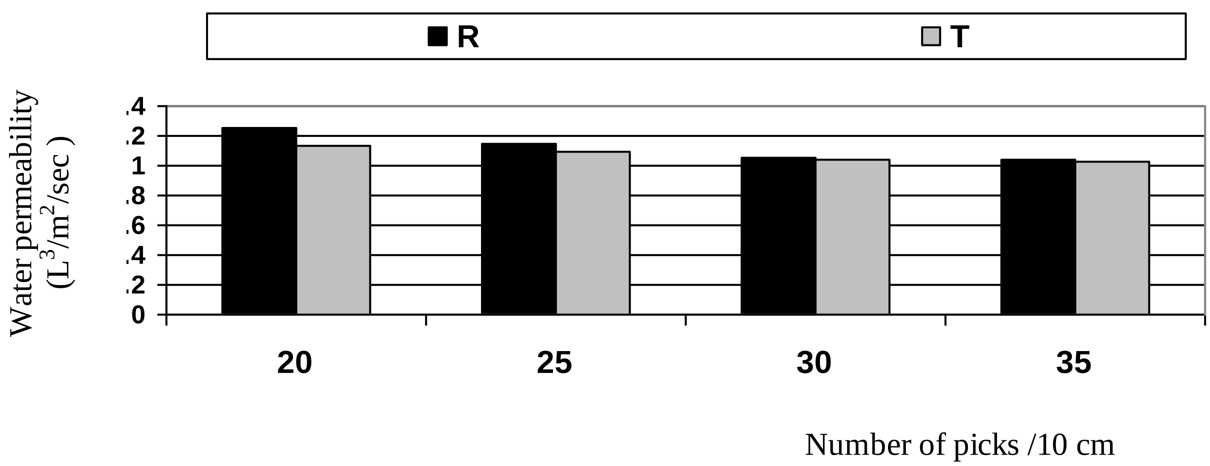

Fig (3)
Effect of number of picks /10 cm and fabric structure on water permeability, at count 9 Libra

Table (٨) regression equation and correlation coefficient for the effect of number of picks/10 cm and fabric structure on water permeability, at count 9 Libra

Fabric structure	Regression equation	Correlation coefficient
Irregular hopsack 2/1	Y =-0.012X +1.449	-0.967334
Twill weave 2/1	Y =-0.00583X +1.23	-0.972598

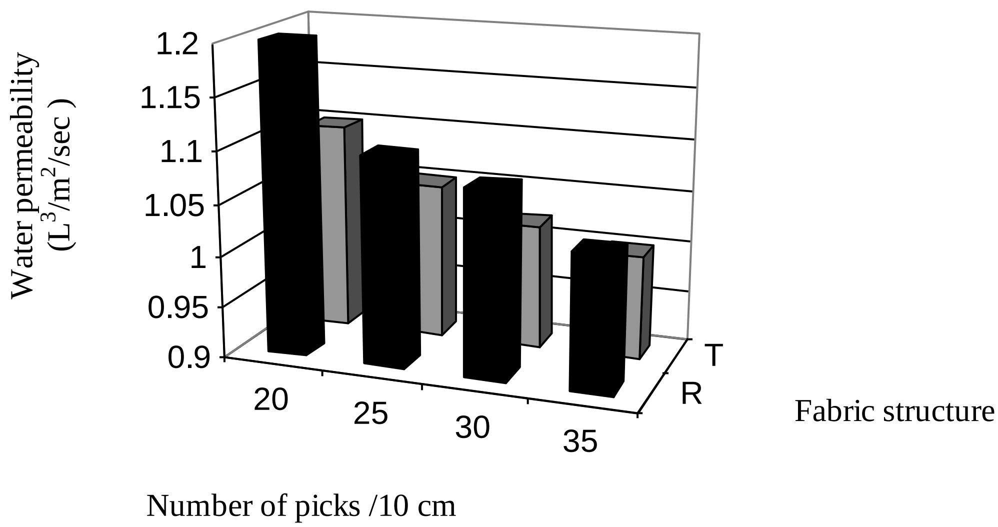

Fig (4)
Effect of number of picks / 10 cm and fabric structure on water permeability, at count 12 Libra

Table (9) regression equation and correlation coefficient for the effect of number of picks/10 cm and fabric structure on water permeability at count12 Libra

Fabric structure	Regression equation	Correlation coefficient
Irregular hopsack 2/1	Y =-0.00883X +1.341	-0.958893
Twill weave 2/1	Y =-0.0055X +1.191	-0.979526

Cotton samples

Table (10) the results of water permeability test applied to samples.

Test	**Water permeability ($L^3/m^2/sec$)**					
Fabric structure	**Plain weave 1/1**			**Twill 2/2**		
Yarn count / **Weft set**	**10**	**16**	**20**	**10**	**16**	**20**
10	0.92	0.95	1.00	0.92	0.93	0.99
14	0.83	0.90	0.94	0.82	0.89	0.95
18	0.72	0.76	0.79	0.71	0.73	0.77

It is clear from the table (10), that there is an inverse relationship between number of picks per cm and water permeability, this is due to that the increasing in picks per unit area cause the fabric to be more compacted so water permeability will be decreased .

It can also be observed from the diagrams that samples of 20 cotton have achieved the highest rates of water permeability, followed by samples of 16 and 10 cotton respectively. we can report that the more diameter the yarns get the less porosity the fabric become because of the increasing of the cover factor, so the water permeability will be decreased.

It is also clear from the figures that plain weave samples have recorded the highest rates of water permeability compared to twill weave samples but difference was insignificant . We can state that plain weave has intersection per unit area than twill weave ,which increasing spaces between yarns leading to the increase in permeability .

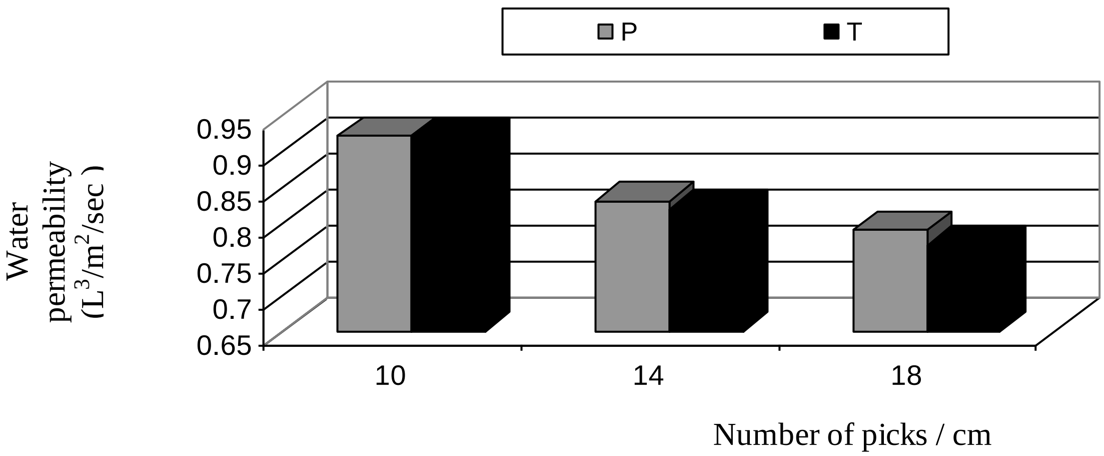

Fig (5)
effect of number of picks /cm and fabric structure on water permeability, at count 10 cotton

Table (11) regression equation and correlation coefficient for the effect of number of picks/cm and fabric structure on water permeability , at 10 cotton

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =-0.07375X +0.42583	-0.837284
Twill weave 2/2	Y =-0.01875X +1.099167	-0.981981

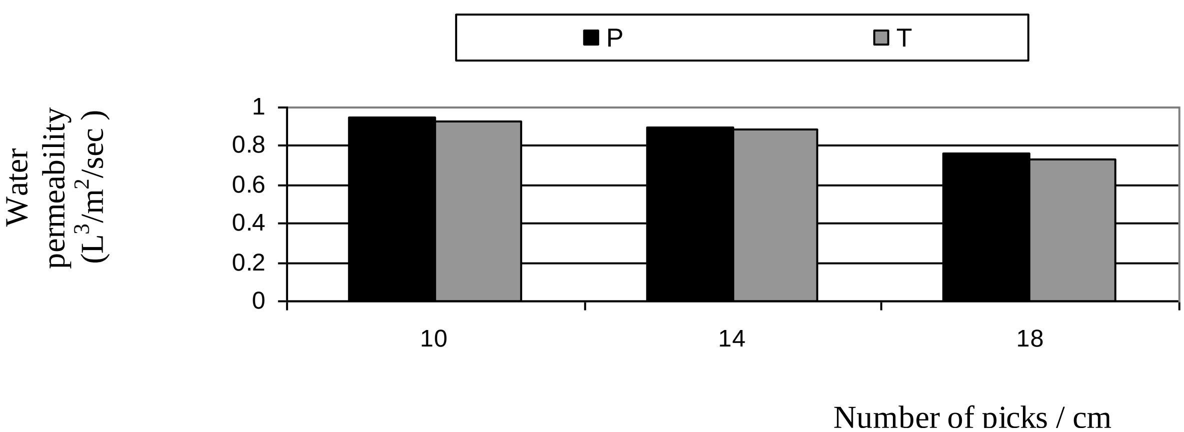

Fig (6)
Effect of number of picks /cm and fabric structure on water permeability, at count 16 cotton

Table (12) regression equation and correlation coefficient for the effect of number of picks/ cm and fabric structure on water permeability ,at count16 cotton

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =-0.02375X +1.2025	-0.964579
Twill weave 2/2	Y =-0.025X +1.2	-0.944911

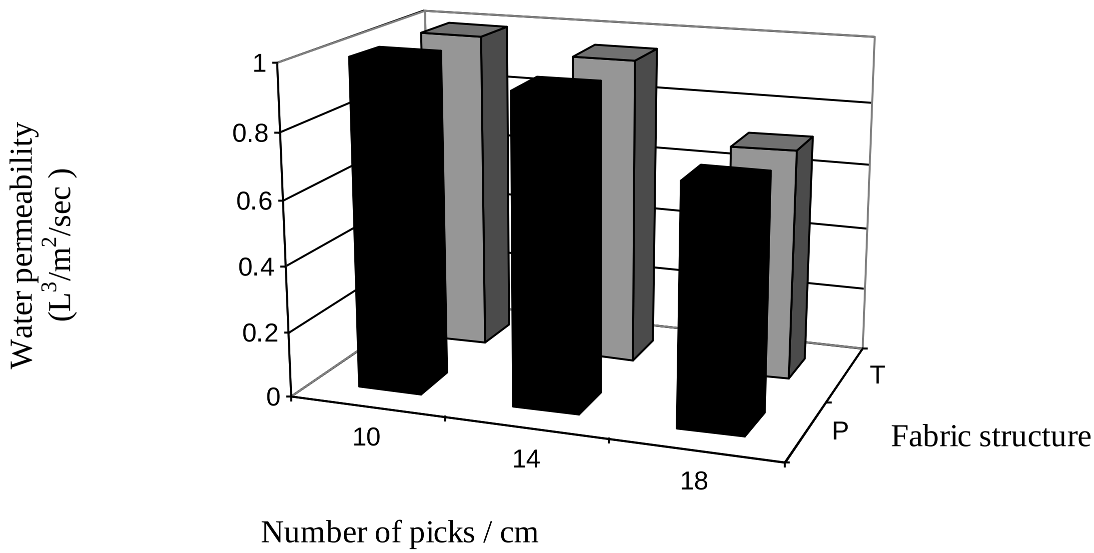

Fig (7)
Effect of number of picks /cm and fabric structure on water permeability, at count 20 cotton

Table (13) regression equation and correlation coefficient for the effect of number of picks/ cm and fabric structure on water permeability ,at count 20 cotton

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =-0.035X +1.376667	-0.949653
Twill weave 2/2	Y =-0.035X +1.373333	-0.924473

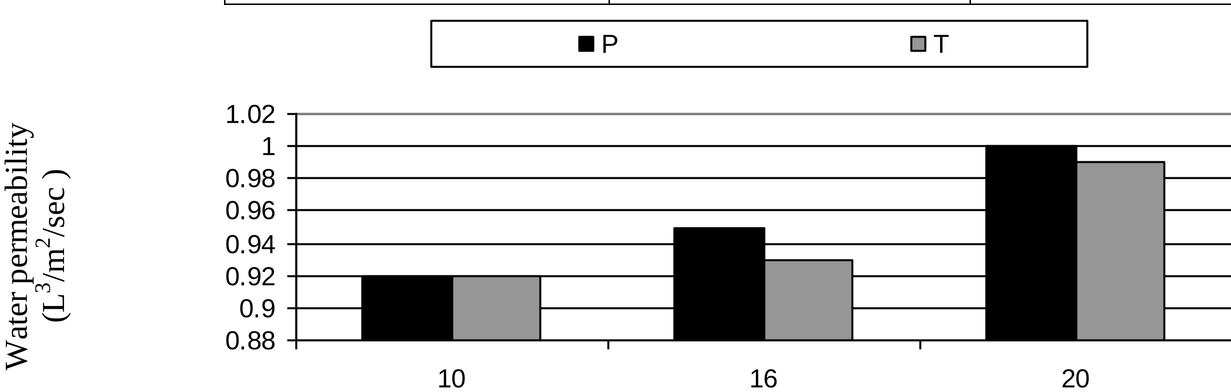

Fig (8)
Effect of yarn count and fabric structure on water permeability, of cotton samples , at 10 picks/cm

Table (14) regression equation and correlation coefficient for the effect of fabric structure and yarn count on water permeability , at 10 picks/cm

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =0.07763X +0.837632	0.966823
Twill weave 2/2	Y =0.0006579X +0.845789	0.874639

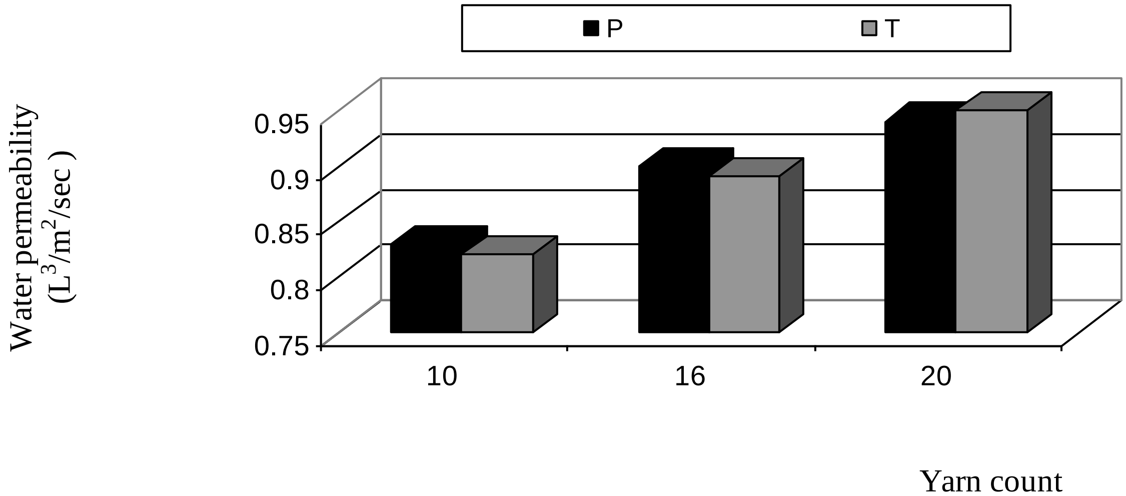

Fig (9)
Effect of yarn count and fabric structure on water permeability, of cotton samples ,at 14 picks/cm

Table (15) regression equation and correlation coefficient for the effect fabric structure and yarn count on water permeability , at 14 picks/cm

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =0.11053X +0.720526	0.999151
Twill weave 2/2	Y =0.012895X +0.688947	0.99751

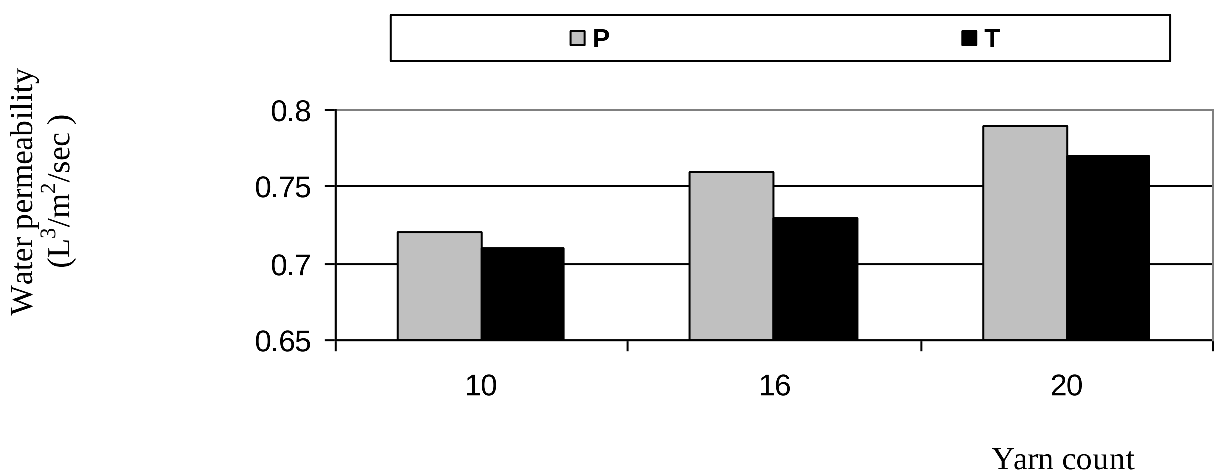

Fig (10)
Effect of yarn count and fabric structure on water permeability, at 18 picks/cm

Table (16) regression equation and correlation coefficient for the effect of fabric structure and yarn count on water permeability , at 18 picks/cm.

Fabric structure	Regression equation	Correlation coefficient
Plain weave 1/1	Y =0.00684X +0.681579	0.980609
Twill weave 2/2	Y =0.00605X +0.829474	0.997176

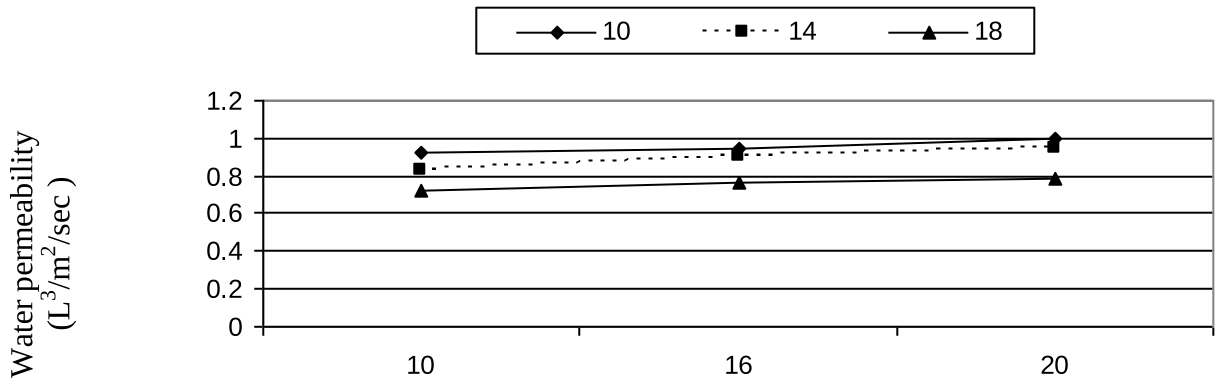

Fig (11)
Effect of yarn count and number of picks/cm on water permeability ,using plain weave 1/1

Table (17) regression equation and correlation coefficient for the effect of yarn count and number of picks/cm on water permeability, using plain weave 1/1

Yarn count	Regression equation	Correlation coefficient
10	Y =0.01625X +1.074167	0.976221
16	Y =0.02345X +1.2025	0.964579
20	Y =0.035X +1.376667	0.949653

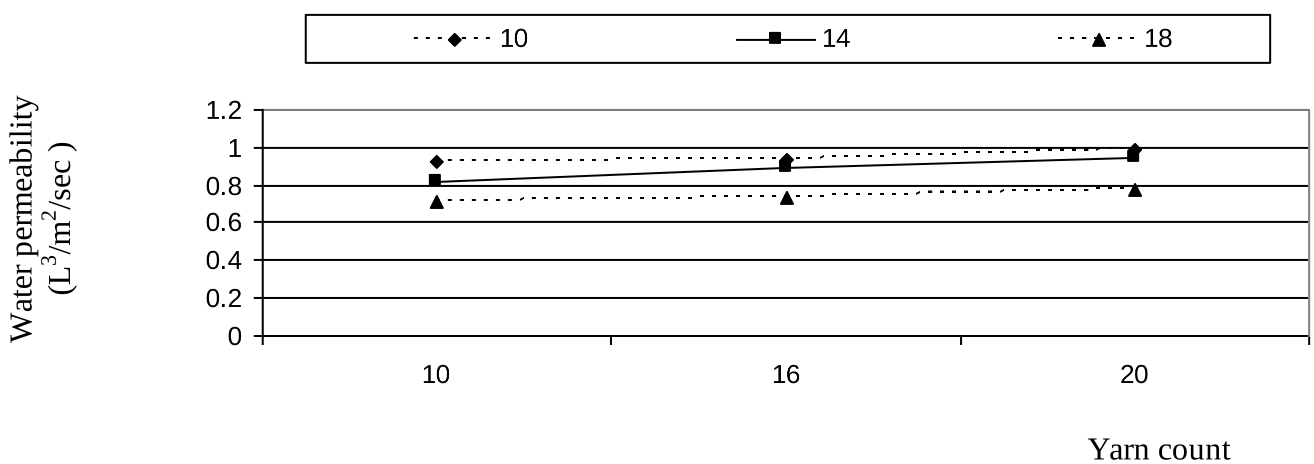

Fig (12)
Effect of yarn count and number of picks/cm on water permeability, for cotton samples , using twill weave 2/2

Table (18) regression equation and correlation coefficient for the effect of yarn count and number of picks/cm on water permeability, at plain weave 1/1

Yarn count	Regression equation	Correlation coefficient
10	Y =0.01875X +1.099167	0.981981
16	Y =0.025X +1.2	0.944911
20	Y =0.035X +1.373333	0.924473

U.V resistance test

Jute samples

Table (19) The results of the U.V resistance test applied to samples .

The test	**U.V resistance (after 100 hours exposure according to the grey scale)**			
Fabric structure	**Irregular hopsack 2/1**		**Twill weave 2/1**	
Yarn count / **Weft set**	**9**	**12**	**9**	**12**
20	3	3	3*	3
25	4	3	3	3
30	4	3	4**	4
35	4	4	5***	4

It can be seen from table (19) and figures of jute samples that there is an inverse relationship between number of picks and U.V resistance. We can state that the more picks /cm the more compacted the fabric become which cause decreasing in U.V permeability leading to the increase in its resistance to U.V effect .

We can also notice from the diagrams of jute samples that samples of 12 Libra have scored the highest rates of U.V resistance followed by 9 Libra samples . This is due to the 12 Libra yarns are thicker in diameter than 9 Libra .so they obstruct the passage of U.V rays more than 9 Libra yarns leading to the increase in its U.V resistance

It is also clear from the diagrams that twill weave structure has achieved the highest rates of U.V resistance , whereas irregular hopsack structure has achieved the lowest rates . We can report that the twill weave structure has the ability of being more compacted than irregular hopsack because of the distribution of the intersection.

*** 3 good**

**** 4 very good**

***** 5 excellent**

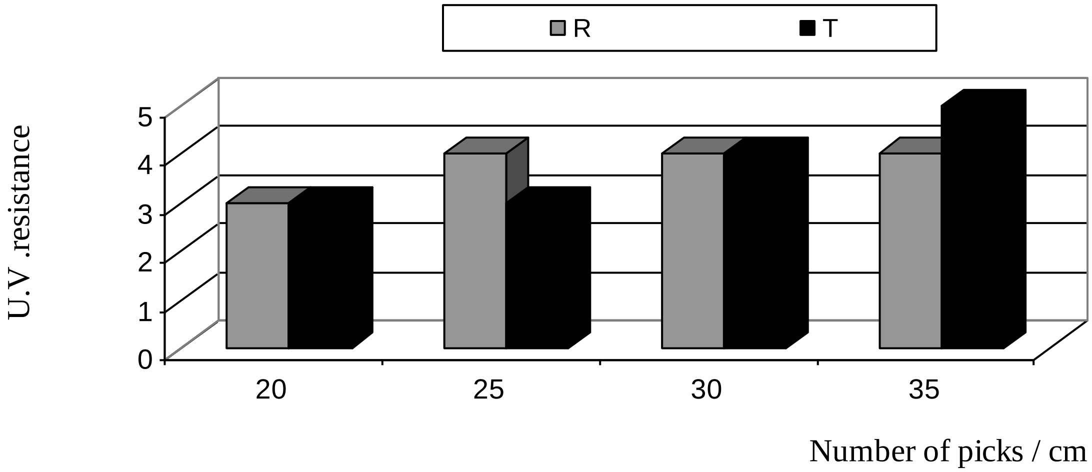

Fig (13)
Effect of fabric structure and number of picks/10 cm on fabric U.V resistance, at 9 Libra

able (20) regression equation and correlation coefficient for the effect of fabric structure and number of picks/cm on U.V resistance, at 9 Libra

Fabric structure	Regression equation	Correlation coefficient
Irregular hopsack 2/1	Y =0.05X +2.04	0.874597
Twill weave 2/1	Y =0.116667 X +0.6	0.94388

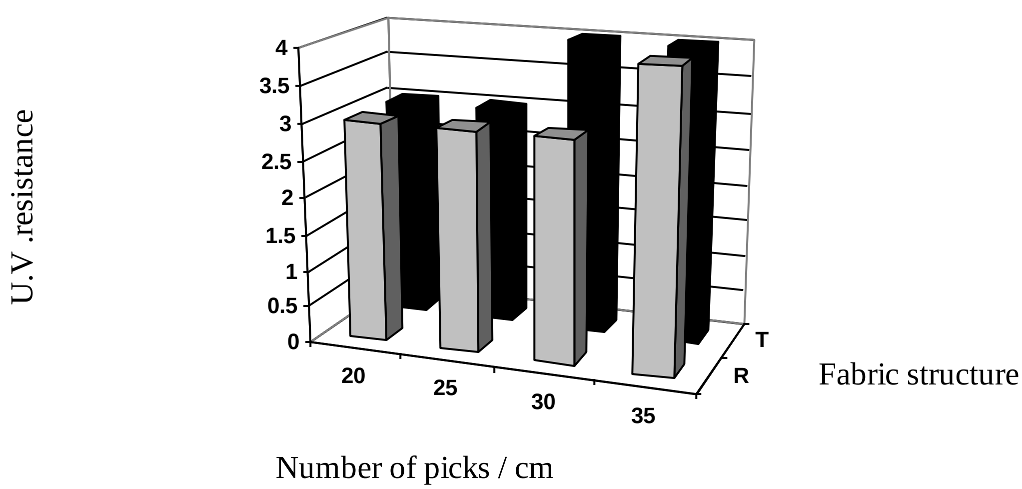

Fig (14)
Effect of fabric structure and number of picks/10 cm on fabric U.V resistance, at count 12 Libra

Table (21) regression equation and correlation coefficient for the Effect of fabric structure and number of picks/ 10 cm on U.V resistance, at 12 Libra

Fabric structure	Regression equation	Correlation coefficient
Irregular hopsack 2/1	Y =0.05X +1.9	0.874597
Twill weave 2/1	Y =0.066667 X +1.7	0.894427

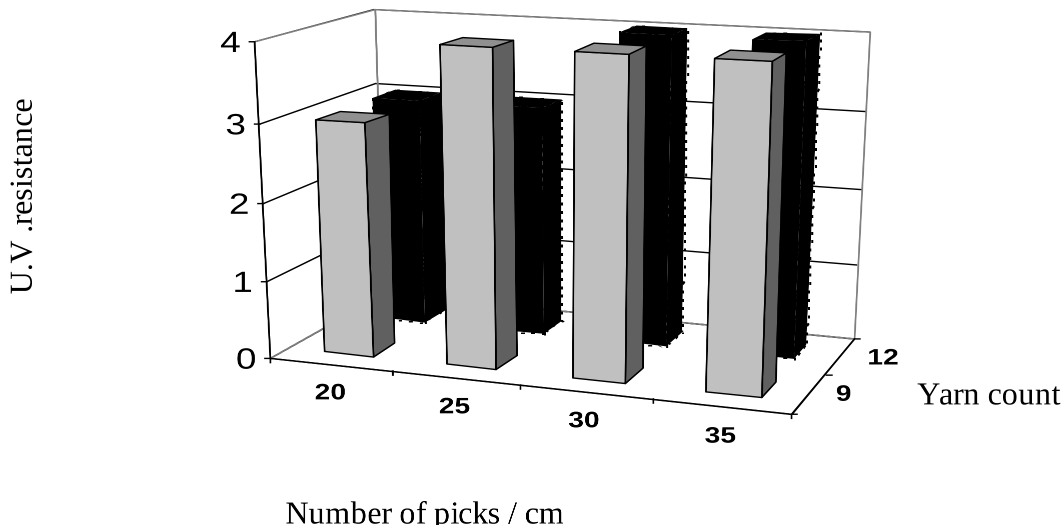

Fig (15)
Effect of yarn count and number of picks/cm on fabric U.V resistance, for Irregular hopsack 2/1

Table (22) regression equation and correlation coefficient for the Effect of yarn count and number of picks/ 10cm on U.V resistance ,at Irregular hopsack 2/1

Multi regression equation	**Correlation coefficient**
Y =0.08333 X1 +0.07 X2+2.575	0.848258

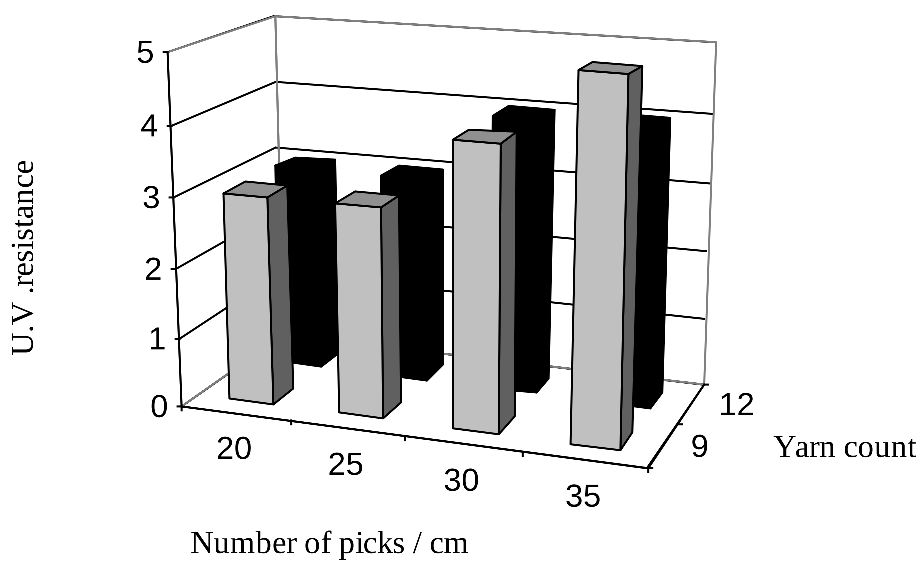

Fig (16)
Effect of yarn count and number of picks/ 10 cm on fabric U.V resistance, at twill weave 2/1

Table (23) regression equation and correlation coefficient for the Effect of yarn count and number of picks/ 10cm on U.V resistance, at twill weave 2/1.

Multi regression equation	**Correlation coefficient**
Y =0.08333 X1 +0.11X2+1.475	0.901611

Cotton samples

Table (24) The results of the U.V resistance test applied to all cotton samples .

The test	**U.V resistance (after 100 hours exposure according to the grey scale)**					
Fabric structure	**Plain weave 1/1**			**Twill weave 2/1**		
Yarn count / Weft set	**10**	**16**	**20**	**10**	**16**	**20**
10	5	5	5	5	5	5
14	5	5	5	5	5	5
18	5	5	5	5	5	5

It is clear from table (24) that all cotton samples have scored an excellent results when exposed to U.V radiation for 100 hours .

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