International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2673-2678

Received: 01-07-2018
Accepted: 05-08-2018

Dr. Rahul Adhikary
Department of Soil Science and Agricultural chemistry, Centurion University of Technology and Management, Odisha, India

Lukalapu Ravi Sankar
Department of Soil Science and Agricultural chemistry, Centurion University of Technology and Management, Odisha, India

Correspondence
Dr. Rahul Adhikary
Department of Soil Science and Agricultural chemistry, Centurion University of Technology and Management, Odisha, India

Use of geotextiles for improving crop productivity on groundnut in inceptisols

Dr. Rahul Adhikary and Lukalapu Ravi Sankar

Abstract
A study was undertaken at the RRS at Gayeshpur under New alluvial zone, in the Nadia district of West Bengal to investigate the effect of various geotextile management on crop productivity under pre kharif groundnut crop with four geotextile treatments. Geotextile material would be collect from locally and chopped with 4-5 cm length and spread before sowing. The yield of the crop was recorded as 51.54 q/ha, 46.92 q/ha. 42.03 q/ha and 31.09 q/ha respectively in jute geotextile (T_1), coco coir geotextile (T_2), vetiver root geotextile (T_3) and farmer practice (T_4) and the response over control due to each treatment were 20.45 q/ha (65.6%), 15.83 q/ha (50.91%) and 10.94 q/ha (35.18%) respectively in jute geotextile, coco coir geotextile and vetiver root geotextile. The results also reveals that bulk density of the soil decreased by 3.8%, 2.3% and 1.5% and porosity reversely increased by 4.6%, 2.0% and 0.8% respectively in jute geo textile, coco coir geotextile and vetiver root geo textile over control plot. Crops grown with jute geotextile content more organic matter (53.3%) than control plot. The water retention capacity is more throughout the growing seasons in jute geotextile.

Keywords: geotextile, groundnut, woven, non-woven

Introduction

Geotextiles are lightly fabric made from jute, coco coir or any natural plant fibers. Geotextiles a natural product are eco-friendly and biodegradable in nature and act as useful ameliorative to eliminate the soil related constrains of crop production. The results of biodetorioration of cellulose fiber are a reduction of the polymerization degree and thus a textile strength loss. It also helps to protect the most vital natural resources of soil and water from various degradation processes soil conditioner are equally effective in erosion control, stabilization of soil slopes and increasing water retention capacity also improve crop productivity. It contains natural substances for plant growth and helps to serve and release of essential plant nutrients through lignin decomposition (Ranganathan, 1994) [24]. Among the oilseed groundnut, an important oilseed and food legume crop is being cultivated on about 25 million ha of land in about 90 countries under different agro-climatic regions, ranking 13th among the principle economic crops of the world. It covers 35% of total oilseed cover in India (8 million ha) in 260 districts, mostly as a rainfed crop and contributing 40% of total oil seed production about 8 million tons due to its low productivity and so far only about 20% area could be brought under irrigation. However, in West Bengal the cultivation of this crop in limited in few pockets only and mostly followed in kharif season and pre kharif. The productivity is also far below than average productivity of southern states. So considering varied agro climatic condition of West Bengal there is ample scope of introduction of this crop pre kharif and kharif season. Productivity can also be improved by introducing high yielding cultivars and better agronomical management with introducing geotextile may be increase yield as well as soil health. The proposed programme, to investigate the effect of various geotextites management on productivity and physico-chemical properties of soil under pre kharif ground nut crop.

Materials and Methods

A study was under taken at the University farm of Regional Research station, New Alluvial Zone under Bidhan Chandra Krishi Viswavidyalaya of Gayespur, in the Nadia district of West Bengal is situated at 22^0 58' N latitude, 88^0 30' E longitude, with an altitude at 10.9 m above the mean sea level. The climate at this region is sub-humid tropic. The selected area represents new alluvial agro-climatic zone and consists dominantly with illiates as mixed clay mineral. The soils of present site belong to the order of inceptisol and the great groups of haplaqupts.

The experiment was conducted during 2008 – 2010. Four treatments combinations were taken viz. T_1 -non woven jute geotextile (5 tons + NPK=20:40:40 kg/ha), T_2 - non woven coco coir geotextile (5 tons + NPK=20:40:40 kg/ha),T_3 - non woven vetiver root geotextile (5 ton + NPK=20:40:40 kg/ha) and T_4 - farmers practices (i.e. control) (NPK=20:40:40 kg/ha), using rabi-summer ground nut as test crop in RBD design with 3 replication. The recommended dose of fertilizer consisting N @ 20 kg/ha, P_2O_5 @ 40 kg/ha and K_2O @ 40 kg/ha were applied as basal at the time of final land preparation and mixed with soil. Geotextile material would be collect from locally and chopped with 4-5 cm length and spread before sowing. The yield and yield components (number of pods per plant, pod yield (kg/ha), 100 pod weight (g), shelling percentage, 100 kernel weight) for each plot was recorded. Soil moisture was determined periodically at 7 days intervals from 0-15 cm soil depth during seeding to harvesting from each plot. Initial and final soil samples also analyzed for relevant physical (soil texture Bulk density water holding capacity porosity Soil aggregates like water stable aggregates mean weight diameter geometric mean diameter) and chemical properties (organic carbon, pH, electrical conductivity, available nitrogen, phosphorus, potassium) by following standard methods (Jackson 1973 & Piper, 1966) [16, 22]. Water Use Efficiency also determined by the ratio of crop yield and total water use by the crop. Randomized complete block design with three replications was followed in the field experiment.

Results and Discussion

Yields and yield components

The yield of the crop were recorded as 51.54 q/ha, 46.92 q/ha, 42.03 q/ha and 31.09 q/ha respectively in non-woven Jute fibre geotextile, coco coir geotextile, vetiver geotextile and control (farmer's practice) under pre kharif condition (Table 1). The maximum pod yield was recorded in non-woven Jute fibre geotextile. The response over control due to each treatment were 20.45q/ha (65.6%), 15.83 q/ha (50.91%), 10.94 q/ha (35.18%) respectively in non-woven jute geotextile, coco-coir geotextile and vetiver root geotextile. The pod yield of groundnut significantly increased with the application of various types of non-woven geotrxtiles. The kernel yield of groundnut also showed similar result i.e. highest (34.78 q/ha) and lowest (19.28 q/ha), kernel yield were recorded jute geotextile and control respectively. The pod and kernel yield of groundnut also significantly increased with the application of various types of non-woven geotrxtiles over control. Same trend of results also found for other biological parameter like no. of kernel/pod, shelling%, and 100 kernel weight. Highest value of above parameters were recorded as, 2.12, 68%, 63.2 gm respectively for the soil treated with nonwoven jute geotextile and lowest values of such parameter were found as, 1.96, 62% and 56.8 gm respectively under control plot. Under each treatment all the above noted biological parameter of groundnut crop significantly increased over control.

The results of the physiological parameters influencing yield and growth of ground nut crop due to various parameters of geotextiles are presented in (Table 2) highest (99%) germination percentage under non-woven jute fibre Geotextile and lowest (92%) under control plot. Highest branching (9.4) and plant height (67.5cm) were also observed under jute geotextile and lowest values of 6.9 and 62.5cm were found under control. Reverse result were recorded for 50% flowering (DAS) and 50% pegging, the values become more than the plot received the treatments of geotextiles. This results highly indicative of the effect of geotextiles on the physiological growth of the groundnut crop. It was also noted that dry matter weight found highest under jute geotextile and lowest under control and crop growth rate also increased 0.31gm/day (3.6%) in jute geotextile over the control. The above result find support with the earlier observation reported by Khistaria *et al* (1994) [18] who showed that increase of crop productivity on the application of different type of mulches and geotextile on groundnut crop.

Physical properties

The result of changes of various physical properties in soil due to application of various non- woven geotextile are presented in (table 3) changes of Bulk density, Porosity and water holding capacity in soil were observed due to variation of treatment combinations. The result shows minimum bulk density under jute geotextile treatment than the other treatment. Bulk density showed to change with the following order. Jute geotextile (1.27 g/cc) < Coco coir geotextile (1.29 g/cc) < Vetiver geotextile (1.30 g/cc) < control (1.32 g/cc). The reduction of B.D. over control due to each treatment were 0.05 (3.8%), 0.03 (2.3%), 0.02 (1.5%) respectively for jute fibre, coco-coir and vetiver root. Reverse order also formed in cause of soil porosity that follows the order. Jute geotextile (52.4%) > Coco coir geotextile (51.70%) > Vetiver geotextile (50.5%) >control (50.09%). Increase porosity over control in each treatment were 2.3 (4.6%), 1.6 (2%), 0.4(0.8%) respectively jute fibre, coco-coir and vetiver root. Variations of B.D. occur non-significantly but that of porosity occurs significantly increases in Jute geotextile and coco-coir geotextile over the control.

The water holding capacity in soil also found similar results of porosity. The value of water holding capacity showed following order. Jute geotextile (49.05%) > Coco coir geotextile (46.56%) > Vetiver geotextile (46.79%) > control (41.42%) increase of the value over control were 18.4%, 13% and 12.4% respectively for jute, coco coir and vetiver geotextile. The results thus indicate the application of geotextile has influence on the reducing bulk density and inverse in porosity and WHC in soil. Similar results also evidence by Booth *et al*. (2005) [5] lowering bulk density and increasing the porosity and water holding capacity by the application of palm leaf geotextile for maintain of soil quality and soil conservation.

Soil aggregation is an important indicator of soil structure associated with various major functions in relation to soil management system. Stabilization of soil aggregates is often used as a measurement of soil structure, which mediates many important biological, chemical and physical processes in soil. The extent of aggregation within a soil acts as the controlling factor of maintenance of bulk density, porosity and water retention capacities. Many indices of soil structure are in employed to evaluate the conditions of soil structure. Changes of some of such indicates like mean weight diameter, geometric mean diameter, water stability aggregates, percent aggregates stability and structural coefficient under the influence of geotextiles are presented in (Table 4). The results clearly indicate that all the indices of soil structure and the stability of aggregation shows much variation due to variation of treatment. The mean weight diameter is an important index for characterizing the structure of whole soil by integrating the aggregate class size distribution into one number. It is also used to indicate the effect of different geotextile management practice and soil structure. It reveals no significant difference between control and vetiver geotextile but significantly difference between control and jute and coco-coir geotextile. Increase of values of MWD and GMD due to application of jute and coco coir geotextile is clearly an indicative of improvement of soil structure. Critical examination of data fertilizer reveals that among the various treatments application of vetiver root failed to show any significant changes of MWD, GMD, WAS and structural coefficients under control. Thus jute and coco coir geotextiles are more effective for improving the soil structure. The above findings corroborates with observations of several investigators who stressed the importance of organic matter in stabilization of water stable aggregates through the formation of organic mineral complex, Biswas *et al*. (1970) [4] reported that the nature of organic matter played an important role in the development soil structure owing to differential nature of by products produced during the process of decomposition.

Chemical properties

The results of the effects of various geotextiles on the changes of chemical properties and nutrient availabilities in soils are application of non-woven geotextile caused changes in the chemical properties like pH, EC, Organic Carbon and available N, P, K content in soil present in (Table 5).

The changes of chemical properties are influenced by various type of geotextile material in groundnut crop. Soil pH and EC increases with the application of jute, coco coir and vetiver root geotextile than the control. Highest value of pH and EC are 6.82 and 0.49 mmhos/cm were found in non-woven jute geotextile and lowest value i.e. 6.70 and 0.32 mmhos/cm are found in the control plot. Differences of values of pH and EC for each of the treatment ard control were found significant but no significant difference of the values occurred within the treatments.

The value of organic carbon in soils due to application of treatments followed the order i.e. jute geotextile (0.69%) > coco coir geotextile (0.67%) > Vetiver geotextile (0.62%) > control (0.45%). Increases of organic C content found highest in the plot under jute geotextile (53.3%) over the control. The results showed significant difference organic C content under each treatment over control.

The data further reviles that application of each geotextiles markedly increases the availability of N, P and K over control. Availability of N, P and K found more in the soils received jute geotextile than the application of coir geotextile and vetiver root geotextiles. The availability of K was maximum in the soils under coir geotextile treatment than others. Changes in the availability of N and P due to application of treatments found more effective than the availability of K. The above results are in arrangement with the observation report by Rajagopal and Ramakrishna, (1997) [23] to improve the organic C and soil by the application of geotextile.

The changes of chemical properties are influence by various type of geotextile material in groundnut crop. Soil pH and EC increases with the application of jute, coco coir and vetiver root geotextile than the control. Highest value of pH and EC are 6.82 and 0.49 mmhos/cm were found in non-woven jute geotextile and lowest value i.e. 6.70 and 0.32 mmhos/cm are found in the control plot. There are significant variation is found control and treatments but there are no n significant within the treatments.

The value of organic carbon shows the following order i.e. jute geotextile (0.69%) > coco coir geotextile (0.67%) > Vetiver geotextile (0.62%) > control (0.45%). Results also found that jute geotextile is more (53.3%) over the control. The results also reveals that significant variance are found control and treatments but non-significant within the treatments.

The data further reviles that the available N and P higher in jute geotextile and lower in control i.e. higher values are N-79.4 kg/ha and P- 25.0 kg/ha and lower values are 43.0 kg/ha and 10.6 kg/ha. There are significant variation are found control and treatments in case of available N and P but also significant within the treatment in case of available N. But available K was highest in coco coir geotextile. The values of available K is found in the following order i.e. coco coir geotextile (310.5 kg/ha) > jute geotextile (246.1 kg/ha) > vetiver root geotextile (176.3 kg/ha) > control (153.0 kg/ha).

Soil moisture content and water use efficiency

The results of soil moisture content 0-15 cm depth under each of the treatments 7 days interval are presented in (figure 1). The soil moisture content under each treatment showed to consistently vary with the variation of treatments during crop growing period. Highest amount of soil moisture content has been found in non-woven jute geotextile than the other geotextile and control. Results reveals that soil moisture increases with the different treatment in the following order i.e. jute geotextile (414.6 mm) > coco coir geotextile (399.4 mm) > Vetiver geotextile (394.8 mm) > control (350.8mm). The increase of soil moisture content within the treatment than the control may be different absorving capacity within the treatment material and amount of irrigation and rainfall. Variation of changes of soil moisture content as various treatments may be reflected by the variations of BD and porosity caused due to application of treatments in soil. Plant utilize more water in the different treatment and low utilize in control that means nutrients uptakes will more and yield will higher than the control. Several earlier investigations show the improvement of water retention capacity by the application of the different types of geotextile (Tiwari *et al*. 2000) [31].

Water use efficiency which is defined at the ratio between total yield and total water use during the growing period of crop also influences by various geotextile treatments (table 6). The groundnut crop which was grown under jute geotextile gives highest WUE (12.43 kg/ha/mm) and lowest was found under control (8.86 kg/ha/mm). Results also reveals that water use efficiency found in the following order i.e. jute geotextile (12.43 kg/ha/mm) > coco coir geotextile (11.74 kg/ha/mm) > Vetiver geotextile (10.68 kg/ha/mm) > control (8.86 kg/ha/mm).

Cost benefit ratio which is define at the ratio between total economic return and total cost of cultivation were also influence by various geotextile treatment (table 7). Cost benefit ratio (1:3.4) is highest in jute geotextile treatment and lowest (1:2). The above result find supported by with the earlier observation reported by Divies *et al.* (2006) [8] where it has been shown shows that effects of increases crop productivity and water use efficiency by the application of plum geotextile on different crop at the Hilton experimental site over control.

The results of present study these lead to suggest that application of each of geotextiles increased growth and yield of groundnut crop. It also helps to improve physical properties in soil particularly the structural status in soil and also enhanced the water use efficiency by the crop. Besides, each at the applied geotextile facilitated to increase soil organic C and build up soil fertility. Among the various geotextiles used

for the study jute geotextile found to be more effective for improving soil properties and building up soil fertility.
The results of the present study lead to suggest that among the various geotextiles uses but jute geotextile were found to be most efficient to keep the soil in frible condition condition that helps to improve physical condition and increase the water availability in soil influencing improvement of crop production.

Table 1: Effects of various Geotextile management on Groundnut yield and yield component

Sl No.	Treatment	Avg no. of mature pods	No. of kernel per pod	Shelling%	100 kernel weight(g)	Kernel yield(q/ha)	Pod yield (q/ha)
1.	Jute geotextile	26	2.12	68	63.2	34.78	51.54
2.	Coco-coir geotextile	24	2.10	66	62.0	30.97	46.92
3.	Vetiver geotextile	22	2.05	65	61.2	27.32	42.03
4.	Control	18	1.96	62	56.8	19.28	31.09
5.	S. Em(±)	1.33	0.025	2.12	0.35	0.032	0.032
6.	CD at 5%	3.25	0.063	0.078	1.03	0.078	0.078

Table 2: Effects of various Geotextile management on physiological parameter of groundnut crop

SL no.	Treatment	Germi-nation (%)	No. of branch at Harvesting	Height of the plant during harvesting (cm)	50% flowering (DAS)	50% Pegging (DAS)	Dry matter production at harvesting (g/m^2)	Crop growth rate (g/day)
1.	Jute geotextile	99	9.4	67.5	42	46	825.36	9.01
2.	Coco coir geotextile	98	9.1	64.6	42	46	810.35	8.98
3.	Vetiver geotextile	96	8.8	62.7	43	47	795.26	8.92
4.	Control	92	6.9	62.5	44	48	753.66	8.7
5.	S. Em(±)	1.35	0.30	1.07	1.08	0.612	2.58	0.025
6.	CD at 5%	3.30	0.73	2.62	2.64	1.499	6.31	0.063

Table 3: Effects of various geotextile management on physical properties of soil

Sl No.	Treatment	Bulk density(g/cc)	Porosity (%)	Water holding capacity (%)
1.	Jute geotextile	1.27	52.4	49.05
2.	Coco-coir geotextile	1.29	51.70	46.79
3.	Vetiver geotextile	1.30	50.5	46.56
4.	Control	1.32	50.09	41.42
5.	S. Em(±)	0.032	0.42	1.18
6.	CD at 5%	0.078	1.47	2.78

Table 4: Effects of various combinations of Geotextile on the changes of indices on soil structure and there stabilization

Treatment	Soil depth (cm)	Standard meteorological week														
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jute fibre	0-15	18.1	17.3	38.3	37.4	37.4	39.9	36.6	39.9	27.8	19.3	24.6	30.5	28.6	20.5	414.6
Coco coir	0-15	17.71	17.1	37.9	37.2	37.1	37.5	36.4	32.2	23.3	19.3	24.2	30.5	28.1	20.7	399.4
Vetiver	0-15	17.72	16.9	37.7	37	37	35.6	35.9	31.4	23.4	19.2	24	30.3	28	20.5	394.8
Control	0-15	16.7	16.2	30.4	30.5	30.6	27.6	30.3	24.9	26.8	18.6	21.8	25.1	27.5	13.8	350.8

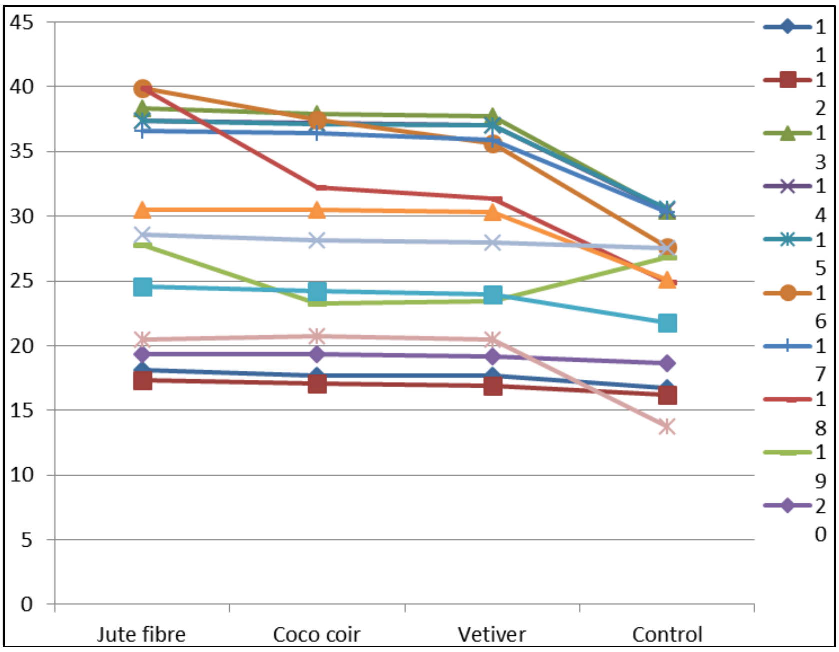


Fig 1: Water use (mm) from 0-15 cm soil depth during growing period of groundnut

Table 5: Effects of various geotextiles management on water use, water use efficiency & cost benefit ratio of Groundnut

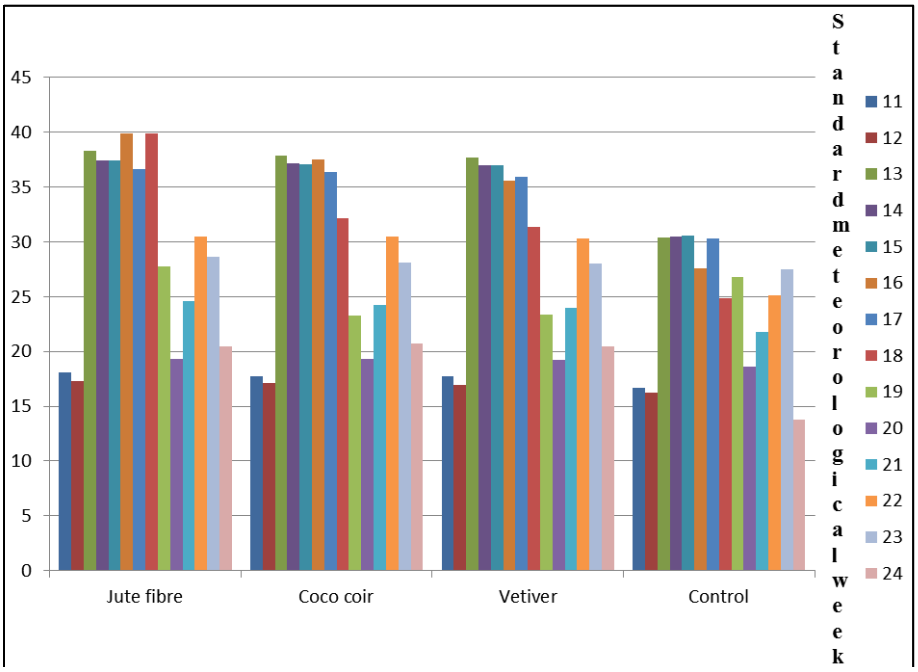
Treatment	Yield (Kg/ha)	Total water use (mm)	Water use efficiency (Kg/ha/mm)	Cost benefit ratio(B:C)
Jute geotextile	5154	414.6	12.43	1:3.4
Coco coir geotextile	4692	399.4	11.74	1:3.1
Vetiver root geotextile	4203	394.8	10.64	1:2.8
control	3109	350.8	8.86	1:2
S. Em(±)	0.032	1.08	0.040	

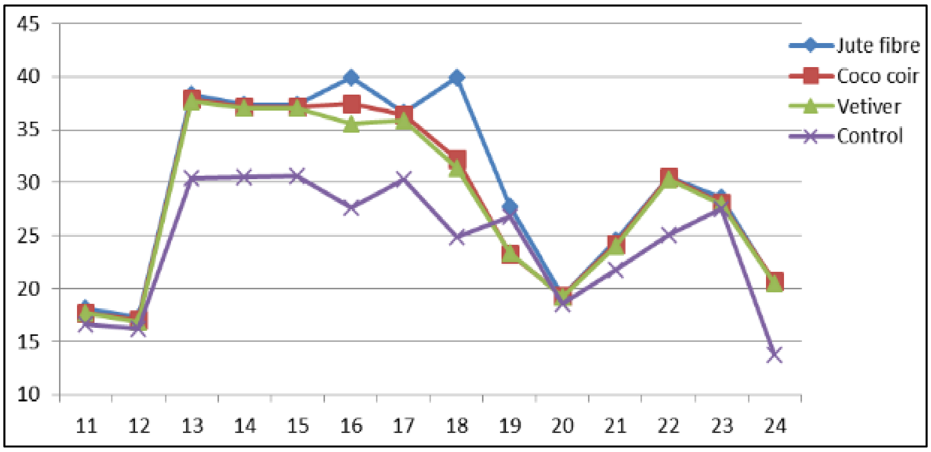
Table 6: Effects of various combinations of Geotextile on the changes of indices on soil structure and there stabilization

Treatment	MWD (mm)	Structural coefficient	GMD (mm)	WAS >0.25%	WAS<0.25%
Jute geotextile	2.970	00.831	0.705	83.99	16.01
Coco coir geotextile	1.872	0.812	0.705	82.38	17.62
Vetiver root geotextile	0.743	0.702	0.462	71.70	28.24
Control	0.706	0.514	0.426	58.47	41.53
S. Em(±)	0.03	0.01	0.03	0.99	0.99
CD at 5%	0.10	0.03	0.12	3.43	3.43

Table 7: Effects of various geotextile management on the chemical properties of soil

Treatment	pH	EC (mmhos/cm)	Organic carbon (%)	Available Nitrogen (Kg/ha)	Available phosphorus (Kg/ha)	Available Potassium (Kg/ha)
Jute geotextile	6.82	0.49	0.69	79.4	25.0	246.1
Coco-coir geotextile	6.80	0.46	0.67	73.6	24.8	310.5
Vetiver geotextile	6.73	0.39	0.62	71.3	23.2	176.3
Control	6.70	0.32	0.45	43.0	10.6	153.0
S. Em(±)	0.036	0.025	0.025	1.19	0.626	0.136
CD at 5%	0.106	0.074	0.074	2.92	1.53	0.334





References

1. Andre L, Gerard L. Mechanisms affecting long-term filtration behavior of geotextiles, Geotextiles and Geomembranes. 1988; 7(1-2):119-145.
2. Ajidkumar P. Geotextiles–new opportunities for coir, Indian Coconut Journal–Cochin. 1995; 26(3):37-40.
3. Booth CA, Davies K, Fullen MA. Environmental and socio- economic contribution of palm- leaf geotextile to sustainable development and conservation. 2005, 649-658.
4. Biswas TD, Roy MR, Sahu BN. Effect of different sources of organic manure on the physical properties of the soil growing rice, Journal of Indian society of soil science. 1970; 18:223-242.
5. Bhattacharyya R, Davies K, Fullen MA, Booth CA. Soil conservation using palm-mat geotextiles on loamy sand soils in the United Kingdom, 2005.
6. Chitodkar SS, Chaudhari PM, Patil HE, Raundal PU. Studies on irrigation regimes, mulches and anti transparent on yield and water requirement of summer groundnut (*Arachis hypogaea* L.), International-Journal-of-Agricultural-Sciences. 2006; 2(2):496-498.
7. Dayal D. Response of summer groundnut to mulching under varying irrigation regime, Journal of Groundnut-News. 1989; 2(1):5.
8. Divies K, Fullen MA. A pilot project on the potential contribution of pulm geotextile to soil conservation, Earth surface processes and landforms (In press), 2006.
9. Dutta T, Chakraborty T. Effect of organic manures and subabul (*Laucaena leucocephala*) leaf mulching under varying levels of fertility on growth and yield of potato (*Solanum tuberosum*) and weed biomass, Indian Journal of Agronomy. 1995; 40(1):140-142.
10. Gruda N. The effect of wood fiber mulch on water retention, soil temperature and growth of vegetable plants, Journal- of- Sustainable- Agriculture. 2008; 32(4):629-643.
11. Gao MZ. Mulching culture of spring-sowing groundnut with farm residues in hilly region, Journal of Guangdong-Agricultural-Sciences. 1993; (1):13-14.
12. Ghosh PK, Devi Dayal, Bandyopadhyay KK, Mohanty M. Evaluation of straw and polythene mulch for enhancing productivity of irrigated summer groundnut, Journal of Field-Crops-Research. 2006; 99(2/3):76-86
13. Huang-Jing Xiong. Experiment on different sowing dates of groundnut (Arachis hypogaea) under mulching conditions, Journal of Fujian-Agricultural-Science-and-Technology. 2001; (2):4-5.
14. Hu Li Yong, Wang Zai Qin, Peng Ding Xiang, Liao Guo Sheng. Study on the effect of jute geotextiles on ramie growth, Scientia Agricultura Sinica. 2000; 33(3):103-105.
15. Jackson ML. Soil chemical analysis, Prentice fall of India Pvt. Ltd. New Delhi, 1950.
16. Jackson ML. Soil chemical analysis, Prentice fall of India Pvt. Ltd. New Delhi, 1973.
17. Kaku T, Ito M, Ito K. Weed management issues and dynamics during establishment of phlox (*Phlox subulata* L.) ground cover using geotextile mulch, Journal-of-Weed-Science-and-Technology. 2007; 52(2):57-65.
18. Khistaria MK, Patel JS, Paida VJ, Patel JC. Effect of different mulches on the yield of groundnut under rainfed conditions, Gujarat-Agricultural-University-Research-Journal. 1994; 20(1):139-140.
19. Nag D, Choudhury TK, Debnath S, Ganguly PK, Ghosh SK. Efficient management of soil moisture with jute non-woven as mulch for cultivation of sweetlime and turmeric in red lateritic zone, Journal-of-Agricultural-Engineering-New-Delhi. 2008; 45(3):59-62.
20. Olesen Ole, Rexen Finn, Larsen Jorgen. Research in industrial application of non-food crops, I: plant fibres. Seminar of Denmark Academy of Technical Sciences, 1995, 79-86.
21. Otani I, Watanabe O, Fushimi A. Effect of mulching of plant materials on the growth of ground cover plants and emergence of weeds on levee slope. Journal-of-Weed-Science-and-Technology. 2009; 54(3):129-138.
22. Piper CS. Soil and plant analysis. Asian Reprint, Hans, Publishers, Bombay, 1966.
23. Rajagopal K, Ramakrishna S. Degradation behavior of coco geotextiles with in clay soils. Proc. Of Asian Regional Conf. on Geosynthesis, 1997, 25-29.
24. Ranganathan, S.R, Development and potential of jute geotextiles, Journal of Geotextiles and Geomembranes, 1994; 13(6-7):421-433.
25. Raschle R. Microbial influence on cellulose textile and microbiological testing, Journal of International Biodeterioration. 1989; 25(1-3):237-244.
26. Sharma VAK, Dekshinamurtic Curr. Sci. 1971; 40:35.
27. Shulga G, Betker T, Shakels V, Neiberte B, Verovkins B, Brovkina J, *et al.* Effect of the modification of lignocellulosic materials with a lignin-polymer complex on their mulching properties, Journal-of Bio Resources. 2007; 2(4):572-582.
28. Smets T, Poesen J. Impacts of soil tilth on the effectiveness of biological geotextiles in reducing runoff and interrill erosion, Soil-and-Tillage-Research. 2009; 103(2):356-363.
29. Smets T, Poesen J, Fullen MA, Booth CA. Effectiveness of palm and simulated geotextiles in reducing run-off and inter-rill erosion on medium and steep slopes. Journal-of-Soil-Use-and-Management, 2007; 23(3):306-316.
30. Singh A, Jose R Bicudo, Stephen R Runoff. And drainage water quality from geotextile and gravel pads used in livestock feeding and loafing areas, Journal of Bioresource Technology. 2008; 99:3224-3232.
31. Tiwari Journal of Indian Society of soil science. 2000; 48(2):257-268. 15 ref.
32. Unial SP, Tripathi NC, Singh RV. Effect of different locally available mulches on moisture conservation, yield of off season potato under mid hills. Potato: Present and future proceeding of the National Symposium held at Modipuram during, 1993-1994, 147-150
33. Tayel MY, Matyn MA, Wahba SA. Response of groundnut to irrigation frequency, soil mulching and heaping, Egyptian- Journal- of- Soil- Science. 1993; 33(2):163-176.
34. Thomas V, Edgar Jay, Puckett A, William F. Utilizing geotextiles in high way bridge approach embankments, Geotextiles and Geomembranes. 1987; 5(1):3-16
35. Valsangkar AJ, Holm TA. Model tests on peat-lightweight aggregate system, Geotextiles and Geomembranes. 1987; 5(4):251-260.
36. Vishnudas S, Savenige HHG, Zaag P, Balan K. The productive and attractive covering of a vegetated embankment using coir geotextiles, Hydrology and Earth system Sciences. 2006; 10(4):565-574
37. Yong Li Hu, ZaiQin Wang, Ding Xiang Peng, GuoSheng Liao. Study on the effect of jute geotextiles on ramie growth. Journal of Scientia- Agricultura- Sinica. 2000; 33(3):103-105.