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Influence of different moisture conservation materials on soil moisture content, nutrient uptake and economics of FCV tobacco (*Nicotiana tabacum* L.)

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Abstract
A field experiment was carried out to know the effect of different moisture conservation materials on the performance of FCV Tobacco (*Nicotiana tabacum* L.) on sandy loam soil at AINP (T), Navile, Shivamogga, Karnataka during *kharif* season of 2019. The investigation included eight treatments consisting of soil application of hydrogel around the plant @ 3 g per plant hole before planting, covering the ridges with gunny bag (whole bag with two layers), gunny bag (Single layer), transparent polyethylene film, HDPE weed mat, mulch sheet and dry areca husk as a crop residue @10 t ha^{-1} on ridge. Treatments were examined in a Randomized Complete Block Design (RCBD) and replicated thrice. Results revealed that application of areca husk as a crop residue @10 t ha^{-1} on ridge recorded higher soil moisture content at three days after cessation of rainfall (13.6 %) throughout crop period, higher green leaf yield (13434 kg ha^{-1}), cured leaf yield (2039 kg ha^{-1}) top grade equivalent yield (1002 kg ha^{-1}), nutrient uptake N, P_2O_5 and K_2O (38.76, 5.69 and 97.29 kg ha^{-1}, respectively). Further, higher net return (Rs.199898 ha^{-1}) and B:C (2.20) were recorded by areca husk as a crop residue mulch and was on par with the application of mulching sheet.

Keywords: leutron moisture meter, soil moisture content, hydrogel, areca husk, HDPE weed mat, mulching sheet, FCV tobacco

Introduction
Adequate soil moisture with optimum soil temperature throughout the crop season is essential for successful crop production under rainfed conditions. Mulches are applied to create a favorable effect on soil moisture and temperature, reduce weed growth and competition and thereby, increase crop yield. Mulching in rainfed areas has been reported to reduce soil moisture losses by over 50 percent (Umrani *et al.*, 1973) [1] and increase tobacco yield (Murthy and Rao, 1969). A growing concern is that, plastic mulches are never completely removed from a field (non-biodegradable), leaving remnants which remain in soil for decades (Briassoulis *et al.*, 2015) [2]. Biodegradable materials have been developed as substitutes to polyethylene (PE) mulch films and are designed to be tilled into soil after use where resident microorganisms degrade the materials.
Areca husk is readily available in the southern transition zone of Karnataka where the areca crop is grown. It has become a menace due to its improper disposal and underutilization. It increases the soil moisture content, protects the soil from being eroded and reduces the evaporation of soil moisture and adds organic matter (Bhale and Wanjari, 2009) [3]. In Karnataka FCV tobacco is grown in Karnataka light soils theses soil have low water retention capacity hence necessity to conserve soil moisture. With this background, the present field experiment was conducted to know the influence of different moisture conservation materials on soil moisture content, yield, nutrient uptake and economics of FCV tobacco.

Material and Methods
A field experiment was conducted at D-7 plot of Zonal Agricultural and Horticultural Research Station, Navile Shivamogga during *Kharif* season of 2019. The location was situated at 13° 58' to 14° 1' North latitude and 75° 34' to 75° 42' East longitude with an altitude of 650 m above the mean sea level. The study site located at Southern Transition Zone (Zone-7) of Karnataka. The soil of the experimental site was sandy loam in texture and classified as *Typic Haplustalf* as per USDA system of soil classification. The soil of the experimental site was slightly acidic in reaction (pH 6.19) with normal EC (0.70 dS m^{-1}) and low in organic carbon content (4.56 g kg^{-1}).

The available nutrient status indicated low N, high P_2O_5 and medium K_2O (240.32 kg ha^{-1}, 76.09 kg ha^{-1} and 136.73 kg ha^{-1}, respectively). During crop period the actual rainfall received was 1088.8 mm which was high compared to normal rainfall of 583.8 mm, highest monthly rainfall of 446.8 mm was received in August and the lowest was in September (140.8 mm). The highest mean maximum air temperature of 29.8 °C was recorded in the month of October second week. The lowest mean minimum air temperature of 20.3 °C was recorded in the month of October.

Experiment consists of eight treatment laid out in Completely Randomized Design and replicated thrice. Treatments considered of different mulch materials, *viz.*, T_1: Control (No cover), T_2: Soil application of Hydrogel @ 3 g plant $hole^{-1}$ before planting, T_3: Covering the ridges with gunny bag (Whole bag with two layers), T_4: Covering the ridges with gunny bag (Single layer), T_5: Covering the ridges with transparent polyethylene film, T_6: Covering the ridges with HDPE weed mat, T_7: Covering the ridges with mulching sheet, T_8: Application of areca husk (dry) as crop residue @ 10 t ha^{-1} on ridge. Seeds of KST -28 variety of FCV tobacco was sown on 30-04-2019 following soil solarization. Main field was thoroughly ploughed and ridges were raised. Mulch materials *viz.*, weed mat, transparent polyethylene film, gunny bag and black mulch sheets were laid on ridges. A hole 15 cm diameter on these materials were made for planting. While for areca husk, hydrogel and control treatment planting point was marked. Care has been taken to cover 60 cm width of ridge by mulch materials uniformly for all treatments.

Soil moisture was measured by Leutron moisture meter. The moisture content was determined by measuring the electrical conductivity of the material which always is proportional to the content of the moisture. The percentage of soil moisture was measured three days after cessation of rainfall at a depth of 10 cm from five spots in a treatment. Then average per cent moisture content was expressed, yield, Nutrient uptake by crop and B:C was worked out.

Results and Discussion

Effect of different moisture conservation materials on soil moisture content

At three days after cessation of rainfall, soil moisture content varied based on the type of moisture conservation material used. The related data are presented in table 1. The moisture content was significantly higher in the treatment with application of areca husk as crop residue @ 10 t ha^{-1} on the ridge and it varied from 9.41 to 13.67 percent on different dates of observation, as compared to the control (6.23 to 7.68 %) and it was on par with covering the ridges with mulching sheets (7.99 to 11.76 %). The magnitude of increase in moisture content was ranged from 32.89 to 79.25 %. It might be due to mulches reduced the evaporation of moisture from soil surface, making more water available for crop, which is benefit in water limited conditions and plant water status is maintained. These results are in line with Chakraborty *et al.* (2008) [4] where, straw mulching was regarded as one of the best ways of improving water retention in the soil and reducing soil evaporation. Erenstein (2002) [5] reported higher moisture content in the range of 33 to 100 percent by mulching with paddy straw and green leaves compared to unmulched plots.

Table 1: Effect of moisture conservation materials on moisture content (Percent on volume basis) of soil at three days after cessation of rainfall during crop growth stage

Treatment	Soil moisture content (Percent)							
	23/08	28/08	12/09	16/09	26/09	05/10	09/10	31/10
T_1: Control (No cover)	7.60	7.68	7.09	6.82	6.31	6.18	6.23	6.53
T_2: Soil application of Hydrogel @ 3 g plant $hole^{-1}$ before planting	11.43	10.82	8.16	8.00	8.25	7.82	7.50	6.95
T_3: Covering the ridges with gunny bag (Whole bag with two layers)	9.35	9.83	7.58	7.65	8.03	7.58	7.40	6.77
T_4: Covering the ridges with gunny bag (Single layer)	8.56	9.07	7.32	7.51	7.53	7.37	6.77	6.77
T_5: Covering the ridges with transparent polyethylene film	10.73	10.15	7.86	7.87	8.08	7.64	6.84	6.87
T_6: Covering the ridges with HDPE weed mat	12.89	12.04	9.89	8.41	8.35	7.89	8.97	8.03
T_7: Covering the ridges with mulching sheet	11.61	11.76	9.46	8.10	9.31	7.99	9.00	8.04
T_8: Application of areca husk (dry) as crop residue @ 10t ha^{-1} on ridge	13.67	13.22	9.95	9.89	9.41	11.34	10.63	10.26
S.Em±	0.87	0.85	0.64	0.47	1.71	0.57	0.52	0.54
C.D. (p=0.05)	2.64	2.58	1.94	1.44	1.94	1.74	1.59	1.63

Note: Readings were taken in *kharif* 2019

Effect of moisture conservation materials green leaf and cured leaf yield and TGE of FCV tobacco

Yield performance of FCV tobacco was influenced significantly with the application of different moisture conservation materials. The data revealed (Table 2) that among different treatments, significantly higher green leaf yield, cured leaf yield and top grade equivalent yield were observed with application of areca husk as crop residue @ 10 t ha^{-1} on the ridge (13434, 2039 and 1002 kg ha^{-1}, respectively) and percentage increase over control (36.12, 38.42 and 36.62 %, respectively). Enhanced growth and greater yield with organic mulch may be attributed to its favourable effect on the edaphic environment. Mulching reduced weed competition and the soil temperature by several degrees Rathore *et al.*, 2010 (4.7 ^oC), favouring the soil microbes which feeds on organic matter and adds nutrient to soil. Addition of nutrients to soil might be congenial environment for good growth of yield attributing characters like leaf. Similarly, Shah *et al.* (1980) [7] reported that average yield of tobacco was significantly higher with wheat straw and bajra stover and superior to polyethylene mulch.

Table 2: Effect of moisture conservation materials green leaf and cured leaf yield and TGE of FCV tobacco

Treatment	Green leaf yield (kg ha^{-1})	Cured leaf yield (kg ha^{-1})	TGE (kg ha^{-1})	Increase of cured leaf yield over control (%)
T_1: Control (No cover)	9656	1473	767	-
T_2: Soil application of Hydrogel @ 3 g plant hole^{-1} before planting	10017	1562	773	6.04
T_3: Covering the ridge with gunny bag (Whole bag with two layers)	10857	1730	874	17.43
T_4: Covering the ridge with gunny bag (Single layer)	10538	1598	798	8.48
T_5: Covering the ridge with transparent polyethylene film	10546	1613	822	9.50
T_6: Covering the ridge with HDPE weed mat	10921	1764	838	19.75
T_7: Covering the ridges with mulching sheets	11951	1838	914	24.77
T_8: Application of areca husk (dry) as crop residue @ 10 t ha^{-1} on ridge	13434	2039	1002	38.42
SEm±	719.92	83.46	45.36	-
CD (p=0.05)	2183.66	253.16	137.57	-

Note: Top-grade equivalent

Effect of different moisture conservation materials on nutrient uptake

Application of areca husk as crop residue @ 10 t ha^{-1} on the ridge resulted in significantly higher nitrogen, phosphorous and potassium uptake (Table 3) (38.76, 5.69 and 97.29 kg ha^{-1}, respectively) over the control, followed by covering the ridges with mulching sheets (34.84, 5.18 and 97.00 kg ha^{-1}, respectively). The improvement in nutrient content under residue applied treatments could be ascribed to favourable moisture condition in the soil maintained for relatively longer period leading to dissolution of more plant nutrients. In addition, the utilization of available nutrients in soil by weeds might have reduced due mulching materials. These made the nutrients more available to the plants. Thus, the favourable moisture condition and improved nutritional environment led to higher translocation and assimilation of nutrients in leaves and stem. These results were in line with Tetarwal and Rana (2006) [8] who reported that application of stover mulch recorded significantly higher nutrient uptake.

Table 3: Effect of moisture conservation materials on nutrient and uptake (kg ha^{-1}) of FCV tobacco

Treatment	Nutrient content in leaf (%)			Nutrient content in stem (%)			Total uptake (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K
T_1: Control (No cover)	1.31	0.19	3.55	0.50	0.13	1.67	26.28	3.61	59.03
T_2: Soil application of Hydrogel @ 3 g plant hole^{-1} before planting	1.66	0.23	4.33	0.62	0.15	1.75	30.14	4.73	82.61
T_3: Covering the ridges with gunny bag (Whole bag with two layers)	1.79	0.22	3.64	0.58	0.17	1.65	35.45	5.17	75.39
T_4: Covering the ridges with gunny bag (Single layer)	1.80	0.22	3.64	0.55	0.14	1.69	32.83	4.58	72.03
T_5: Covering the ridges with transparent polyethylene film	1.72	0.20	3.29	0.64	0.16	1.80	30.47	4.32	64.19
T_6: Covering the ridges with HDPE weed mat	1.78	0.21	3.67	0.62	0.18	1.94	35.79	5.00	78.44
T_7: Covering the ridges with mulching sheet	1.81	0.22	4.51	0.57	0.16	1.90	34.84	5.18	97.00
T_8: Application of areca husk (dry) as crop residue @ 10 t ha^{-1} on ridge	1.79	0.22	4.16	0.61	0.16	1.88	38.76	5.69	97.29
S.Em±	0.10	0.01	0.26	0.05	0.01	0.10	2.35	0.32	5.13
C.D. (p=0.05)	0.29	NS	0.78	NS	NS	NS	7.13	0.98	15.56

Note: NS-Non significant

Effect of different moisture conservation materials on economics

The data on cost of cultivation, gross return, net return and benefit cost ratio as influenced by application of different moisture conservation materials is presented in the Table 4. Higher gross return, net return and B:C ratio were obtained in the treatment areca husk as crop residue @ 10 t ha^{-1} on the ridge (Rs. 3,67,020 1,99,898 and 2.20, respectively) followed by the treatment receiving covering the ridges with mulching sheets (Rs. 3,30,840, 1,40,371 and 1.74, respectively). The variable gross returns among different treatments were due to variation in tobacco yield and cost of material used. Areca husk mulch brought reasonable yield at minimum additional cost and recorded the maximum benefit: cost ratio (2.20). Similar results were akin with Verma (2002) [9] in pearl millet for paddy straw.

Table 4: Economics and net returns of each treatment as influenced by different moisture conservation materials

Treatment	Total cost of cultivation Rs ha^{-1}	Gross return Rs ha^{-1}	Net return Rs ha^{-1}	B:C
T_1: Control (No cover)	155905	265140	109235	1.70
T_2: Soil application of Hydrogel @ 3 g plant hole^{-1} before planting	225907	281160	55253	1.24
T_3: Covering the ridge with gunny bag (Whole bag with two layers)	223309	311400	88091	1.39
T_4: Covering the ridge with gunny bag (Single layer)	191665	287640	95975	1.50
T_5: Covering the ridge with transparent polyethylene film	172627	290340	117713	1.68
T_6: Covering the ridge with HDPE weed mat	235552	317520	81968	1.35
T_7: Covering the ridges with mulching sheets	190469	330840	140371	1.74
T_8: Application of areca husk (dry) as crop residue @ 10 t ha^{-1} on ridge	167122	367020	199898	2.20

*Selling price of tobacco 180 Rs kg^{-1}

Conclusion

The beneficial effects of organic mulches for crop production have been widely discussed that mulch provides b protecting the roots of the plant from heat and cold, creating congenial condition for the plant growth by reducing water requirement and suppressing the weeds thereby improving the yield and quality of the crop. Therefore farmers will make use these locally available materials (areca husk) that help them conserve moisture. This will also go long way in achieving food security sustainably.

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