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Effect of Different Mulches on Soil Moisture, Growth and Yield of Eureka Lemon (*Citrus limon* Burm) Under Rainfed Condition

Vijay Kumar[1], A.K. Bhat[2], Vikas Sharma[3], Neeraj Gupta[4], Priyanka Sohan[5] and V.B. Singh[6]

[1, 4 & 6] RRSS, Raya, S. K. University of Agricultural Sciences & Technology, Jammu-181 143, India
[2, 3] Division of Soil Science & Agricultural Chemistry, Chatha, S.K. University of Agricultural Sciences & Technology, Jammu-180 009, India
[5] Department of food Science & technology, Govt. College Gandhi Nagar, University of Jammu, Jammu-180 004, India

Email: vijaykumar.1144@yahoo.com

ABSTRACT: An experiment was conducted during 2009-2011 to assess the effect of different mulches (bajra straw, maize straw, grasses, brankad (*Adhotada vassica*), farmyard manure and black polyethylene) on soil moisture, weed reduction, growth and yield in Eureka lemon (*Citrus limon* Burm). Different organic and inorganic mulches significantly increased the soil moisture status in various soil depths. Black polyethylene mulch recorded the maximum moisture content followed by farmyard manure and brankad. The black polyethylene and farmyard manure were found to be more effective in producing maximum growth extension than rest of the treatments although the differences were non-significant among the treatments. Plots treated with black polyethylene mulch recorded highest yield (1848 kg/ha) followed by farmyard manure (1780 kg/ha) and brankad (1744 kg/ha). Poor aeration, non-decomposable nature and high cost are the constraints of using black polyethylene as mulch material. Among the organic mulches, the cost of brankad was less as the material is easily available in local areas followed by bajra straw, maize straw and grasses.

Key words: Soil moisture, mulching, Eureka lemon, black polyethylene, rainfed condition

Citrus (*Citrus* sp) generally requires good amount of water compared to other subtropical fruits because sap circulation never entirely ceases and transpiration takes place throughout the year as the crop is evergreen. Eureka lemon (*Citrus limon* Burm) has become the important fruit crop of arid and semi-arid region of the country because of its precocity, thornlessness and heavy bearing nature. In semi-arid soils the major constraints are moisture stress and inherently poor soil fertility. Conservation of soil moisture by application of mulches becomes essential for profitable cultivation of the crop under rainfed condition of semi-arid ecosystem. In spite of no assured irrigation in these regions, the moisture conservation technique is not in practice. Mulches not only conserve soil moisture but also impart manifold beneficial effects, like suppression of extreme fluctuation of soil temperature and reduction of water loss through evaporation, resulting in more stored soil moisture (Shirugure *et al.,* 2003), maintenance of soil fertility (Slathia and Paul, 2012), suppression of weed growth (Ramakrishna *et al*., 2006), improvement in growth and yield (Chakraborty *et al.,* 2008; Ban *et al.,* 2009). The requirement of water through mulch can further be reduced by using locally available organic materials as mulches which not only save irrigation water but also conserves soil moisture. Various studies have indicated that in fruit crops like apple, sapota and acid lime, mulching improves soil moisture status, growth, yield and quality of these fruits, besides reducing weed growth (Shirugure *et al.,* 2005, Abouziena *et al.,* 2008). Organic mulching reduces soil temperature in summer and increases in winter season which is beneficial for proper growth during winter and fruit development during summer months (Jiang Ping *et al.,* 1997). Continuous uses of organic mulches are helpful in improving the physico-chemical properties microbial flora and soil aeration (Rao and Pathak, 1998). Moreover, mulching with plastic polyethylene is found effective in conserving the soil moisture and increasing the growth, yield and quality in different citrus cultivars (Lal *et al.,* 2003, Shirugure *et al.,* 2005). Considering the beneficial effect of mulching, this investigation was undertaken to assess the effect of organic and inorganic mulches on soil moisture, growth and yield of Eureka lemon in rainfed condition.

Materials and Methods

A study was carried out on 2 years old plants of air layered Eureka lemon which were planted in 2007 at a spacing of 5 m x 5 m these plants were treated with different mulches at Rainfed Research Sub-station for sub-tropical fruits Raya, Sher-e- Kashmir University of Agricultural Sciences and Technology Jammu during 2009-10 to 2010-11. The experiment was laid out in a randomized block design with 7 treatments and four replications. Different organic mulches viz bajra straw, maize straw, grasses, brankad (*Adhotada vassica*) and farmyard manure were imposed uniformly on the basin (10 cm thickness) during April. For inorganic mulching, 400 gauge black polyethylene was spread on plant basin. No mulch was applied in control plots. Other cultural practices adopted were similar for all treatments. Nutrient management and other horticultural operations were carried

out as per standard practices under rainfed conditions. The fruits were harvested in the month of August by three hand pickings. Moisture was determined by using gravimetric method.

Results and Discussion

Soil moisture

Increase in soil moisture content due to mulching was found significant at both depths of soil (0-15 cm and 15-30 cm). At 50 DAM, highest soil moisture content was observed with black polyethylene mulching during both the years of study upto 15 cm depth (9.14 and 10.16%, respectively). This was followed by the treatment where FYM was applied (8.52 and 9.52%, respectively) which in turn had higher moisture content than the treatment where Brankad was applied (7.84 and 8.84%, respectively) (Table 1&2). The least soil moisture content was recorded in the basins of control plots, which was significantly lower than all other treatments (Table 1&2). Similar trend was also observed for the sub-surface soil (15-30 cm). These findings are in agreement with the results of Singh *et al.* (2008). The higher soil moisture content due to mulching in various mulching treatments may be owing to reduction of water erosion, reduction in soil surface evaporation and suppression in extreme fluctuation of soil temperature (Pandey *et al.,* 2005).

The trend among the treatments with respect to soil moisture content remained consistent over the different time intervals up to 290 DAM, with black polythene treatment reporting the maximum soil moisture content followed by FYM and the least being in control (Table 1&2). In general, during the months of low or no rainfall, black polyethylene mulching resulted in better soil moisture retention followed by other mulching materials. The polythene film prevented the thin film of water from the surface of the underneath and condensed it on its inner surface on cooling. Sharma and Arora (2008) observed that application of FYM in the *kandi* areas increased soil moisture storage and enhanced crop yield. FYM was followed by *brankad* with respect to moisture storage (Table 1&2). Brankad has been observed to be a cheap alternative as it grows locally around the fields and uncultivated places in *kandi* areas.

Grasses were relatively less efficient in retaining soil moisture which may be attributed to their early decomposable nature which would have favoured the adsorption of evaporated water from the surface of the soil and in turn allowed it to get evaporated from surface layer into the surrounding atmosphere. The organic and inorganic mulching provided consistently higher available soil moisture in plant basin due to which the plant roots remained probably active throughout the irrigation season resulting in optimum availability of nutrients and proper translocation of food materials which accelerate the fruit growth and development in Eureka lemon.

Vegetative growth

The crop vegetative growth was significantly influenced by various mulching treatments maximum except plant girth (Table 3&4). The increase in plant height, spread and girth size was maximum highest (51 cm, 35 cm and 2.2 cm) in black polyethylene, followed by farmyard manure (45 cm, 31 cm and 1.9 cm) and brankad (*adhotada vassica*) (37 cm, 24 cm and 1.2 cm) respectively. The increase in growth of plant was due to increase in availability of soil moisture, nutrients and moderate evaporation from soil surface (Shirugure *et al.,* 2005). The lowest growth of plant was recorded under control (no mulch), followed by grasses owing to high evaporation and less nutrient availability. Mulching with maize straw, bajra straw, grasses were found to be intermediate in their influence on plant growth. The positive response of most of the mulches on various growth characteristics may be attributed to improve. These findings are in close conformity with the results of Rao and Pathak (1998) in aonla. The higher soil moisture availability, addition of nutrients and less weed growth associated with organic mulches can be attributed to higher extension of root growth under mulching treatment. These results are in conformity with the findings of Lal *et al.* (2003), Pande *et al.* (2005) and Singh *et al.* (2008).

Fruit yield

The fruit yield and quality parameters were influenced by different mulches (Table 5). Plants treated with various mulches produced higher fruit yield compared with control. The increase in yield was mainly attributed to increase in availability of soil moisture for longer duration. Mulching with black polyethylene and farmyard manure recorded highest growth (Table 5) resulting in increased yield. The highest fruit yield was recorded with black polyethylene (4.62 kg/plant) followed by farmyard manure (4.45 kg/plant) and brankad (*adhotada vassica*) (4.36 kg/plant). Similar results of increased yield due to mulch were reported in citrus and other crops (Shirugure *et al.,* 2003; Neilsen *et al.,* 2006 and Singh *et al.,* 2008). The beneficial effect of mulching was found to be through increase in individual weight and size (length and diameter) of fruits.

Table 1 : Soil moisture content below soil surface (0-15 cm) under different mulches

Treatment	Soil moisture content (%)																	
	50 DAM		80 DAM		110 DAM		140 DAM		170 DAM		200 DAM		230 DAM		260 DAM		290 DAM	
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
Control	5.82	6.82	6.11	7.12	9.12	10.12	13.53	14.12	12.67	13.53	9.22	10.12	8.03	9.12	6.99	7.45	6.04	7.04
Bajra straw	7.60	8.60	7.65	8.65	11.91	13.93	15.52	16.52	14.76	15.52	12.03	12.93	10.42	11.91	9.06	10.03	8.11	9.11
Maize straw	7.05	8.05	7.27	8.25	11.50	13.50	15.04	16.04	14.22	15.04	11.46	12.50	10.02	11.50	8.80	9.55	8.85	8.85
Grasses	6.58	7.58	7.11	8.12	11.04	13.04	14.61	15.92	13.95	14.61	11.03	12.04	9.93	11.04	8.03	9.02	8.08	8.08
Brankad (Adhotada vassica)	7.84	8.84	8.13	9.13	13.51	14.10	16.18	17.18	15.51	16.18	12.39	13.10	10.86	13.51	9.58	10.22	8.63	9.63
FYM	8.52	9.52	8.63	9.63	14.14	15.09	17.05	18.05	16.14	17.05	12.72	14.09	11.22	14.14	9.95	10.72	9.00	10.00
Black polyethylene	9.14	10.16	9.52	10.52	15.52	16.04	18.17	19.17	17.52	18.17	13.12	15.03	11.97	15.52	10.36	11.22	9.41	10.41
SEm±	0.11	0.21	0.18	0.27	0.16	0.22	0.15	0.22	0.23	0.12	0.14	0.16	0.12	0.15	0.12	0.14	0.11	0.12
CD (P=0.05)	0.33	0.63	0.54	0.83	0.50	0.68	0.45	0.68	0.70	0.36	0.42	0.48	0.37	0.46	0.36	0.43	0.33	0.37

DAM: Days after mulching; Y_1: 2009-10; Y_2: 2010-11

Table 2 : Soil moisture content below soil surface (15-30 cm) under different mulches

Treatment	Soil moisture content																	
	50 DAM		80 DAM		110 DAM		140 DAM		170 DAM		200 DAM		230 DAM		260 DAM		290 DAM	
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
Control	6.40	7.12	7.74	8.24	11.37	12.32	15.26	16.26	12.35	13.57	9.32	10.32	9.20	10.02	8.09	9.08	7.04	7.99
Bajra straw	9.03	10.03	9.08	10.08	12.83	14.58	17.86	18.91	13.83	15.83	12.05	13.05	11.56	12.83	10.83	11.21	9.11	10.73
Maize straw	8.72	9.78	8.81	9.81	12.32	14.32	16.92	17.77	13.32	15.32	11.61	12.63	11.11	12.40	10.43	10.92	8.85	10.33
Grasses	8.22	9.22	8.31	9.31	12.04	14.04	16.20	17.28	13.04	15.04	11.09	12.12	11.42	11.94	10.02	10.22	8.08	9.92
Brankad (Adhotada vassica)	9.12	10.12	9.22	10.22	13.51	15.50	18.04	19.04	14.51	16.51	12.22	13.22	12.02	13.00	11.12	11.22	9.63	11.02
FYM	9.83	10.83	9.96	10.71	14.14	15.94	19.32	20.32	15.14	17.14	13.74	13.94	12.43	13.99	11.72	11.62	10.00	11.62
Black polyethylene	10.83	11.83	10.98	11.98	15.52	16.52	20.52	21.50	16.22	18.52	13.74	14.74	13.22	14.93	12.22	12.17	10.41	12.12
SEm±	0.25	0.27	0.21	0.22	0.22	0.24	0.25	0.37	0.22	0.23	0.17	0.23	0.16	0.18	0.14	0.17	0.12	0.14
CD (P=0.05)	0.75	0.83	0.65	0.68	0.66	0.73	0.75	1.11	0.67	0.71	0.50	0.69	0.49	0.55	0.42	0.52	0.37	0.40

DAM: Days after mulching; Y_1: 2009-10; Y_2: 2010-11

Table 3 : Vegetative growth (plant height, plant girth) of Eureka lemon under different mulches

Treatment	Plant height (cm)						Plant girth (cm)					
	June		October		March		June		October		March	
	2009	2010	2009	2010	2010	2011	2009	2010	2009	2010	2010	2011
Control	6.40	7.12	7.74	8.24	11.37	12.32	15.26	16.26	12.35	13.57	9.32	10.32
Bajra straw	9.03	10.03	9.08	10.08	12.83	14.58	17.86	18.91	13.83	15.83	12.05	13.05
Maize straw	8.72	9.78	8.81	9.81	12.32	14.32	16.92	17.77	13.32	15.32	11.61	12.63
Grasses	8.22	9.22	8.31	9.31	12.04	14.04	16.20	17.28	13.04	15.04	11.09	12.12
Brankad (*Adhotada vassica*)	9.12	10.12	9.22	10.22	13.51	15.50	18.04	19.04	14.51	16.51	12.22	13.22
FYM	9.83	10.83	9.96	10.71	14.14	15.94	19.32	20.32	15.14	17.14	13.74	13.94
Black polyethylene	10.83	11.83	10.98	11.98	15.52	16.52	20.52	21.50	16.22	18.52	13.74	14.74
SEm±	0.25	0.27	0.21	0.22	0.22	0.24	0.25	0.37	0.22	0.23	0.17	0.23
CD (P=0.05)	0.75	0.83	0.65	0.68	0.66	0.73	0.75	1.11	0.67	0.71	0.50	0.69

NS; Non significant

Table 4 : Vegetative growth (plant spread (E-W and N-S) under different mulches

Treatment	Plant spread (East-West) (cm)						Plant spread (North-South) (cm)					
	June		October		March		June		October		March	
	2009	2010	2009	2010	2010	2011	2009	2010	2009	2010	2010	2011
Control	81	141	95	160	138	176	84	148	100	162	142	179
Bajra straw	84	146	104	171	146	190	85	150	114	175	148	193
Maize straw	86	149	108	173	150	194	87	152	116	178	152	198
Grasses	83	139	98	168	141	186	84	145	111	171	145	188
Brankad (*Adhotada vassica*)	88	155	113	177	153	200	89	157	118	181	156	204
FYM	89	163	117	180	162	207	90	163	123	183	165	210
Black polyethylene	91	170	120	184	167	211	92	168	120	185	170	215
SEm ±	1.99	1.69	3.53	3.84	3.58	4.25	1.35	1.82	3.38	3.54	3.42	3.91
CD (P=0.05)	5.96	5.06	10.58	11.52	10.73	12.72	4.06	5.47	10.13	10.62	10.24	11.71

NS; Non significant

Table 5 : Effect of mulches on fruit yield and cost of mulching (summer season-2010)

Treatment	Yield/plant (kg)	Yield (kg/ha)	Cost of mulching (₹/tree)	Cost (₹/ha)
Control	3.90	1560	-	-
Bajra straw	4.25	1700	12	4,800
Maize straw	4.30	1720	12	4,800
Grasses	4.20	1680	6	2400
Brankad (*Adhotada vassica*)	4.36	1744	2	800
FYM	4.45	1780	15	6,000
Black polyethylene	4.62	1848	36	14,400
SEm ±	0.02	11.50	-	-
CD (P=0.05)	0.08	34.4	-	-

Conclusion

The study reveals that black polythene is the best option for conserving soil moisture, followed by FYM and brankad (*Adhotada vassica*). The increase in soil moisture has resulted in increased yields. However, due to moisture stress and poor yields this is a resource poor region. Investing in black polythene sheets may not be a viable option for local farmers. Due to limited population of domestic animals in the kandi area, availability of FYM is also limited. The locally available FYM may not be sufficient for mulching. Considering the economics of the treatment, availability and biodegradable nature, mulching of Eureka lemon plant with locally available material like brankad (*Adhotada vassica*) is a viable option under rainfed condition for enhancing soil moisture storage, growth and yield of fruit crops.

References

Abouziena HF, Hafez OM, El-Metwally IM, Sharma SD & Singh M. 2008. Comparison of weed suppression and mandarin fruit yield and quality obtained with organic mulches, synthetic mulches, cultivation, and glyphosate. *Hort. Science*, 43(3), 795-799.

Ban D, Žanić K, Dumičić G, Čuljak TG and Ban SG. 2009. The type of polyethylene mulch impacts vegetative growth, yield, and aphid populations in watermelon production. J*ournal of Food Agriculture and Environment*, 7, 543-550.

Chakraborty D, Nagarajan S, Aggarwal P, Gupta VK, Tomar RK, Garg RN, Sahoo RN, Sarkar A, Chopra UK, Sundara Sarma KS and Kalra N. 2008. Effect of mulching on soil and plant water status, and the growth and yield of wheat (Triticumaestivum L.) in a semi-arid environment. *Agricultural water management*, 95(12), 1323-1334.

Jiang Ping, Zhao Xiang Xong, Zhang RenRong and Wang Yuansheng. 1997. Effect of mulching in hillside citrus orchards. South China fruits, 26(3): 7-18.

Lal H, Samra JS and Arora YK. 2003. Kinnow mandarin in Doon Valley. 2. Effect of irrigation and mulching on water use, soil temperature, weed population and nutrient losses. *Indian Journal of soil Conservation*, 31(3): 281-286.

Neilsen GH, Hogue EJ, Forge T and Neilsen D. 2006. Mulches and biosolids affect vigour, yield and leaf nutrition of fertigated high density apple. *Hort. Science*, 38(11): 41-45

Pande KK, Dimn DC and Prashant Kamboj. 2005. Effect of various mulches on growth, yield and quality of apple. *Indian Journal of Horticulture*, 62: 145-147.

Ramakrishna A, Tam HM, Wani SP, & Long TD. 2006. Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. *Field Crops Research*, 95(2), 115-125.

Rao VK and Pathak,R.K.1998. Effect of mulches on Aonla (Emblica Officinalies Gaertn) orchard in sodic soil. Indian journal of Horticulture, 55(1): 27-32.

Sharma V and Arora S. 2008. Effect of balanced fertilization on moisture storage and yield in maize-wheat system under rainfed conditions. Proceedings of National Seminar on Policy Interventions for promotion of Balanced Fertilization and Integrated Nutrient Management. April 10-11, Palampur. pp. 93-94.

Shirugure PS, Sonkar RK, Singh S and Panighrah P. 2003. Effect of different mulches on soil moisture, weed reduction, growth and yield of drip irrigated Nagpur mandarin (Citrus reticulata). Indian journal of Agricultural Sciences, 73: 148-52.

Shirugure PS, Singh S, Panighrah P and Sonkar RK. 2005. Evaluation of mulches for improving bearing acid lime. Indian journal of Soil Conservation, 33(1): 62-66.

Singh AK, Singh S, Apparao VV and Meshram DT. 2008. Effect of mulching on soil properties, growth and yield of 'NA-7' aonla (Emblica Officinalies) in semi arid ecosystem. Indian journal of Agricultural Sciences, 78(3): 193-197.

Slathia PS and Paul N. 2012. Traditional practices for sustainable livelihood in Kandi belt of Jammu. Indian Journal of Traditional Knowledge. 11(3): 548-552.

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