International Journal of Agricultural Sciences
Volume **10** | Issue 1| January, 2014 | 225-229

RESEARCH PAPER

Effect of various mulches on soil moisture content, soil properties, growth and yield of kinnow under rainfed condition

VIJAY KUMAR*, V.B. SINGH, PRIYANKA SOHAN[1] AND SHALINI KHAJURIA[2]
Rainfed Research Sub-station for Sub-tropical Fruits (S.K.U.A.S.T.), RAYA(J&K) INDIA
(Email : vijaykumaar1144@yahoo.com)

Abstract : An experiment was conducted during 2009-2011 to assess the response of various mulches (Bajra straw, maize straw, Ficas leaf, brankad (adhotada vassica), farm yard manure and black polyethylene) on moisture content, soil properties, growth and yield in Kinnow. Different organic and inorganic mulches significantly increased the soil moisture status in various soil depths. Black polyethylene mulch recorded the maximum moisture percentage followed by farm yard manure and brankad. Black polyethylene, farm yard manure and brankad (adhotada vassica) had given favorable results with regards to soil moisture content of the soil. The black polyethylene and farm yard manure were found to be more effective in producing maximum growth extension than rest of the treatments although the difference were non significant among the treatments. Plant treated with black polyethylene mulch recorded highest yield (3.62) followed by farm yard manure (3.45) and brankad (adhotada vassica) (3.36) while minimum in control plant. The poor aeration, non decomposable nature and high cost are the constraints of using black polyethylene as mulch material. Organic mulch of farm yard manure is decomposable nature and high costs are the constraints of using mulches material (Bajra straw, maize straw, grasses, brankad). Fruit yield/plant and fruit size and total soluble solids were highest with black polyethylene mulch, followed by farm yard manure and brankad. Among the organic mulches evaluated, brankad better responses are low cost, easily available local areas followed by bajra straw, maize straw and grasses.

Key Words : Soil moisture, Mulching, Kinnow, Black polyethylene, Rainfed condition

View Point Article : Kumar, Vijay, Singh, V.B., Sohan, Priyanka and Khajuria, Shalini (2014). Effect of various mulches on soil moisture content, soil properties, growth and yield of kinnow under rainfed condition. *Internat. J. agric. Sci.*, **10** (1): 225-229.

Article History : Received : 01.06.2013**; Revised :** 14.10.2013**; Accepted :** 13.11.2013

INTRODUCTION

Kinnow is well-known commercial citrus cultivar in the world. Citrus (Citrus sp) tree generally require good amount of water compared to the other subtropical fruits because sap circulation never entirely ceases and transpiration take place throughout the year as it is evergreen. In Kinnow has become the important fruit crop of rainfed condition of arid, semi arid region of the country because of its precocity, thornlessness and heavy bearing nature, it becomes an important Citrus cultivar all over the world. The Kinnow is a variety of citrus fruit cultivated extensively in Indian Punjab Province. Among these, Kinnow mandarin bears highest place in production, productivity, juice content and fruit quality. In India, Kinnow is being grown in Punjab, Rajasthan, Haryana, Himachal Pradesh, Jammu & Kashmir and Utter Pradesh. The Kinnow grows year-round and abundantly. This is the common supermarket Kinnow. In these soils the major constraints are moisture stress and inherently poor soil fertility. The conservation of soil moisture by application of mulches becomes essential for portable cultivation under rainfed condition of semi arid ecosystem. In spite no assured irrigation in these regions, the moisture

*** Author for correspondence**
[1]Department of Food Science and Technology Govt, Gandhi Nagar, JAMMU (J&K) INDIA
[2]Krishi Vigyan Kendra, (S.K.U.A.S.T.), KATHUA (J&K) INDIA

conservation technique is not in practice. Mulches not only conserve soil moisture but also impart manifold beneficial effect, like suppression of extreme fluctuation of soil temperature, reduce water loss through evaporation, resulting more stored soil moisture (Shirugure *et al.*, 2003), maintenance of soil fertility (Thakur *et al.*,1997), improvement in growth and yield (Shukla *et al.*, 2000). Under water scarcity conditions, irrigation is the most suitable option for water management. The requirement of water through mulch can further be reduced by using locally available organic materials as mulches which not only saves 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 (Jayantkumar *et al.*, 1999, Reddy *et al.*,1998, Shirugure *et al.*, 2005). 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 month (Jiang Ping *et al*., 1997). Continuous use of organic mulches are helpful in improving the physico-chemical properties microbial flora and soil aeration which ultimately resulted into better growth and yield of plant (Rao and Pathak, 1998). Moreover, mulching by plastic polyethylene has proved its effectiveness in conserving the soil moisture and increasing the growth, yield and quality in different citrus cultivars (Lal *et at*., 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 properties, growth and yield of Kinnow in rainfed condition.

MATERIAL AND METHODS

A study was carried out on 2 years old plants of virus free Kinnow which were planted in 2007 at distances of 6m x 6m was treated with different types of mulches at Rainfed Research Sub-station for sub-tropical fruits Raya, SKUAST-J during 2009-10 to 2010-11. The treatments were: T_1= Bajra straw, T_2= maize straw, T_3= Ficas leaf, T_4= Brankad, T_5= Farm yard manure, T_6= black polyethylene and T_7= control (no mulch). The experiment was laid out in Randomized Block Design with 7 treatments and four replications. Ten centimeter thick mulches *viz*., bajra straw, maize straw, Ficas leaf, brankad, farm yard manure all in quantity were imposed uniformly on the basin over a surface during April. For inorganic mulching 400 gauge black polyethylene was spread on plant basin covering the soil surface around the plant basin. In control no mulch was applied. Other cultural practices adopted were similar for all treatments. The soil samples were analysed for the properties *i.e.* soil reaction by pH metre, EC by EC metre, Organic carbon in soil was determined by Walkley and Black's rapid titration methods as suggested by Piper. Available N was estimated by using alkaline $KMnO_4$ method as suggested by Subbiah and Asija, (1956). Available P content of the soil was extracted with Sodium bicarbonate by Olsen *et al.* (1954). It was determined in the neutral normal ammonium acetate extract of soil through Flame photometer.

The manure, fertilizer and another horticultural operation were carried out as per standard practices under rainfed conditions. The observation regarding growth parameters *i.e.* plant height and plant spread (north-south) and (east-west) was measured with the help of meter scale. However, plant girth was observed with the help of measuring tape 5 cm above ground level.

$$\text{The soil moisture content (\%)} = \frac{\text{Fresh soil weight (g)} - \text{Soil dry weight (g)}}{\text{Soil dry weight (g)}} \times 100$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Soil moisture:

Increase in soil moisture content from after mulching treatment was significant at both the depth of soil (0-15 cm and 15-30 cm). The higher soil moisture content was observed in black polyethylene at (0-15 cm and 15-30 cm) during the year 2009 and 2011 after days of mulching at both depths and minimum in soil moisture content was recorded in the basins of rainfed control trees (Table 1). These findings are with the agreement of the results of Rao and Pathak (1998) and Singh *et al*. (2008). The higher soil moisture content below the mulches in various mulching treatments may be owing to reduction of water erosion, reduction in soil surface evaporation, suppression in extreme fluctuation of soil temperature, resulting more stored soil moisture and the minimum soil moisture in control plot due to higher evaporation from the bare soil surface of the basin (Pande *et al*., 2005). In general, in the months of low or no rainfall, the black polyethylene resulted better soil moisture retention followed by other mulching materials at both the depths. It is apparent that the black polyethylene soil covering was very efficient due to its moisture vapour proof nature (Justice and Bass, 1978). The characteristics of polythene film prevented the loss of evaporable water proof from the surface of the underneath and condensed it on its under surface on cooling. Ficas leaf was relatively less efficient in retaining soil moisture which may be attributed to its 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 its surface layer into the surrounding atmosphere. The organic and inorganic mulching provided consistently improved available soil

moisture in plant basin due to which the plant roots remained probably active throughout the irrigation season resulting in optimum availability of nutrient and proper translocation of food materials which accelerate the fruit growth and development in kinnow.

Soil properties:

All the organic mulches exhibited significant improvement in soil properties as compared to back polyethylene and control (Table 2). Amongst the organic mulches, Farm yard manure showed better response, followed by brankad, maize straw, bajra straw and Ficas leaf. Considerable improvement was also observed in chemical properties of soil after application of mulches. The soil pH and EC of the plant basin showed some reduction in their values, but the difference were non significant. This might be due to addition of organic matter after decomposition of mulches; which releases organic acids and reacts with major cations and dissolve them from their soluble form (Rao and Pathak, 1996).Organic carbon, available N, available P and available K recorded were highest in farm yard manure closely followed by brankad, maize straw, bajra straw and Ficas leaf, while lowest was observed with black polyethylene mulch even lesser than control. It was observed that farm yard manure, brankad, maize straw, bajra straw and Ficas leaf decomposed after rainy season and added lot of humus to the soil. Kinnow is deciduous plant and lot of litter is also decomposed from foliage. These findings are with the agreement of the results of Borathakur and Bhattacharya (1992) Shirugure *et al.* (2003), Pande *et al.* (2005), Kamal *et al.* (2006) and Singh *et al.* (2008).

Vegetative parameters:

The data pertaining to vegetative growth of plant presented in Table 3 indicate that these parameters significantly influenced by the various mulching treatments over control except plant girth. The increase in plant height, spread and girth size was recorded highest in black polyethylene, followed by farm yard manure and brankad. The increase in growth of plant was possible due to increase in availability of soil moisture, nutrients and moderate evaporation from soil surface Shirugure *et al.* (2003). The lowest growth of plant was recorded under control (no mulch), followed by Ficas leaf owing to high evaporation and less nutrient availability. Mulching with maize straw, bajra straw, ficas leaf 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

Table 1 : Effect of moisture content (%) (0-15 and 15-30 cm) below soil surface (2009-2010)

Treatments	80 DAM				110 DAM				170 DAM			
	2009		2010		2009		2010		2009		2010	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Control	6.11	7.74	7.12	8.24	9.12	11.37	10.12	12.32	10.12	12.35	12.67	13.57
Bajra straw	7.65	9.08	8.65	10.08	11.91	12.83	13.93	14.58	12.93	13.83	14.76	15.83
Maize straw	7.27	8.81	8.25	9.81	11.50	12.32	13.50	14.32	12.50	13.32	14.22	15.32
Ficas leaf	7.11	8.31	8.12	9.31	11.04	12.04	13.04	14.04	12.04	13.04	13.95	15.04
Brankad (adhotada vassica)	8.13	9.22	9.13	10.22	13.51	13.51	14.10	15.50	13.10	14.51	15.51	16.51
FYM	8.63	9.96	9.63	10.71	14.14	14.14	15.09	15.94	14.09	15.14	16.14	17.14
Black polyethylene	9.52	10.98	10.52	11.98	15.52	15.52	16.04	16.52	15.03	16.22	17.52	18.52
S.E. (m)±	0.18	0.21	0.27	0.22	0.16	0.22	0.22	0.24	0.16	0.22	0.23	0.23
C.D. (P=0.05)	0.54	0.65	0.83	0.68	0.50	0.66	0.68	0.73	0.48	0.67	0.70	0.71

Table 2 : Effect of mulches on vegetative growth of Kinnow (2009-2010)

Treatments	Plant height (cm)		Plant girth (cm)		Plant spread (east west) cm		Plant spread (North-South) cm	
	2009	2010	2009	2010	2009	2010	2009	2010
Control	115.75	145.00	6.67	8.00	81.75	120.00	91.75	125.00
Bajra straw	139.00	170.00	6.88	8.10	84.75	125.00	94.75	130.00
Maize straw	145.00	185.00	6.90	8.50	86.50	130.00	96.50	135.00
Ficas leaf	134.00	174.00	7.20	8.20	83.00	122.00	93.00	127.00
Brankad (adhotada vassica)	149.00	180.00	7.45	8.75	88.00	134.00	98.00	139.00
FYM	156.00	196.00	7.40	9.20	89.25	138.00	99.25	143.00
Black polyethylene	162.00	210.00	7.52	9.50	91.50	142.00	101.50	147.00
S.E. (m) ±	3.78	3.92	0.16	0.18	1.99	2.02	2.05	2.12
C.D. (P=0.05)	11.32	11.73	NS	NS	5.96	6.04	6.13	6.34

NS=Non-significant

attributed to improved. 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 mulches can be attributed to higher extension of 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).

Yield:

The fruit yield and quality parameters were influenced by different mulches (Table 4). Plants treated with various mulches were more pronounced on fruit yield compared with control. Influence of various mulches on fruit yield was found significant. The increase in yield was mainly attributed to increase in availability of soil moisture for longer duration. Mulching with black polyethylene and farm yard manure recorded highest growth (Table 4) resulting in increased yield. The highest fruit yield was recorded with black polyethylene (3.62 kg/plant) followed by farm yard manure (3.45 kg/ plant), brankad (3.36 kg/plant). Yield with mulch by using maize straw, bajra straw and ficas leaf were found to be intermediate, but superior to control (no mulch). Similar results of increased yield due to mulch were reported in citrus and other crops Shirugure *et al.* (2003), Singh *et al.* (2008) and Neilsen *et al.* (2006). They described that black polyethylene mulch increased 56-60 % fruit yield as compared to un-mulched control which was due to better conservation of soil moisture, regulating temperature and suppressing weed growth. The beneficial effect of mulching was found to be through increase in individual weight and size (length and diameter) of fruit.

Economics of technology:

The economics of different mulching treatments was worked out and presented in Table 4. To calculate the cost of each treatment, price of mulch material for each tree per treatment was calculated separately and time of its application was converted into man days at the rate of Rs. 110/- per day (8 hours). To calculate the income, saleable price of the fruits was taken to be Rs.30 kg^{-1}. The highest net income of Rs. 98.80 $tree^{-1}$ was obtained from the organic mulch which gave an additional income of Rs 11.80 $tree^{-1}$ as compared to control.

Conclusion:

Considering the economics of the treatment and biodegradable nature, mulching of Kinnow plant with locally available organic waste like brankad (adhotada vassica) is enhance under rainfed condition for higher moisture storage,

Table 3 : Effect of mulches on soil properties of Kinnow (2009-2010)

Treatments	pH (1:2.5)		EC (dSm^{-1})		O.C. ($g\ kg^{-1}$)		Avail. N kg/ha		Avail. P kg/ha		Avail K kg/ha	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control	7.10	7.08	0.26	0.27	4.26	4.46	224.50	225.50	16.31	17.43	157.52	154.52
Bajra straw	6.55	6.52	0.18	0.22	5.36	5.56	235.25	236.75	16.90	17.96	163.69	160.94
Maize straw	6.36	6.28	0.19	0.20	5.90	6.10	239.50	241.00	17.03	18.27	168.18	164.31
Ficas leaf	6.68	6.42	0.16	0.18	5.16	5.36	232.00	234.25	16.48	17.02	160.33	158.45
Brankad (adhotada vassica)	6.62	6.68	0.20	0.21	6.16	6.30	243.00	244.50	17.31	18.31	170.99	167.11
FYM	6.70	6.75	0.24	0.25	6.66	6.85	248.00	249.50	18.00	19.06	174.92	176.48
Black polyethylene	6.77	6.58	0.22	0.24	4.20	4.22	222.50	224.00	16.48	17.21	156.40	153.96
S.E.(m) ±	0.14	0.18	0.01	0.01	0.02	0.03	1.84	2.16	0.28	0.32	1.03	1.05
C.D. (P=0.05)	NS	NS	NS	NS	0.08	0.08	5.53	6.47	0.83	0.95	3.11	3.17

NS=Non-significant

Table 4 : Effect of mulching on income in Kinnow (2010)

Treatments	Yield /plant (kg)	Cost of treatment /ha) (Rs)	Cost of fruit $plant^{-1}$ (Rs)	Cost of treatment $plant^{-1}$ (Rs)	Net return $plant^{-1}$ (Rs)
Control	2.90	-	87.00	-	87.00
Bajra straw	3.25	3336.00	97.50	12.00	85.50
Maize straw	3.30	3336.00	99.00	12.00	87.00
Ficas leaf	3.20	1668.00	96.00	6.00	90.00
Brankad (adhotada vassica)	3.36	556.00	100.80	2.00	98.80
FYM	3.45	4170.00	103.50	15.00	88.50
Black polyethylene	3.62	10008.00	108.60	36.00	72.60
S.E.(m) ±	0.02	-	-	-	-
C.D. (P=0.05)	0.08	-	-	-	-

improve soil properties, growth and production fruits.

REFERENCES

Borathakur, P.K. and Bhattacharya, R.K. (1992). Organic mulches in guava orchards. *Indian Hort.,* **37**: 43-44.

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

Justice, L.O. and Bass, L.N. (1978). Principles and production of seed storage. Agric. Hand Book No. 506, USDA, Washington D.C., U.S.A.

Jayantkumar, Rehalia, AS., Rana, S.S and Verma, H.S. (1999). Long term effect of orchard management practices on growth, yield and fruit quality of apple (*Malus domestica*). *Indian J. Agric. Sci.,* **69** (5):355-358.

Kamal, K.K., Dimn, D.C. and Singh, S.C. (2006). Effect of mulching on soil and leaf nutrient status of apple (*Malus domestica* Borkh). *Prog. Hort.,* **38** (1): 91-95.

Lal, H., Samra, J.S. and Arora, Y.K. (2003). Kinnow mandarin in Doon Valley. 2. Effect of irrigation and mulching on water use, soil temperature, weed population and nutrient losses. *Indian J. Soil Conservation,* **31** (3): 281-6.

Neilsen, G.H., Hogue, E.J., Forge, T. and Neilsen, D. (2003). Mulches and biosolids affect vigour, yield and leaf nutrition of fertigated high density apple. *Hort. Sci.,* **38** (11): 41-45.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus by extraction with sodium bicarbonate. U.S.D.A. Circular. 939:19.

Piper, C.S. (1966). *Soil and plant analysis*. Hans Publishers, Bombay, 40-51 pp.

Pande, K.K., Dimn, D.C and Kamboj, Prashant (2005). Effect of various mulches on growth, yield and quality of apple. *Indian J. Hort.,* **62** : 145-147.

Reddy, Y.T.N. and Khan, M.M. (1998). Effect of mulching treatment on growth and water relation and fruit yield of Sapota (*Achras sapota*). *Indian J. Agri. Sci.,* **68**: 657-660.

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

Rao, V.K. and Pathak, R.K. (1996). Effect of mulches on soil properties Aonla (*Emblica Officinalies Gaertn*) orchards established on sodic soil. *Indian J. Hort.,* **53** : 251-254.

Subbiah, B.V. and Asija, J.S. (1956). A rapid procedure for the estimation of available nitrogen in the soil. *Curr. Sci*., **25**: 259-260.

Shirugure, P.S., Sonkar, R.K., 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 J. Agric. Sci.,* **73** : 148-152.

Shirugure, P.S., Singh, S., Panighrah, P. and Sonkar, R.K. (2003). Evaluation of mulches for improving bearing acid lime. *Indian J. Soil Conservation,* **33**(1) : 62-66.

Shukla, A.K., Pathak, R.K., Tiwari, R.P. and Nath, Vishai (2000). Influence of irrigation and mulching on plant growth and leaf nutrient status of aonla under sodic soil. *J. Appl. Hort.,* **2** : 37-38.

Singh, A.K., Singh, S., Apparao, V.V. and Meshram, D.T. (2008). Effect of mulching on soil properties, growth and yield of 'NA-7' aonla (*Emblica Officinalies*) in semi arid ecosystem. *Indian J. Agric. Sci.,* **78** (3):193-197.

Thakur, G. C., Chadha, T.R., .Kumar, J. and Verma, H.S. (1997). Effect of clean cultivation, mulching and sod culture on mineral nutrition and root growth of apple cv. Red Delicious. *Indian J. Hort.,* **54** : 53-57.