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Impact of Mulch Thickness on Enhanced Vegetative Growth of *Khirni* and Increased Microbial Populations in Soil

Mukesh Chand Bhateshwar*, Jitendra Singh* and Kamlesh Kumar Yadav**
College of Horticulture & Forestry, Jhalawar,
Agriculture University, Kota, Rajasthan 324001

ABSTRACT

A field study for the effect of mulch thickness on enhanced vegetative growth of khirni and microbial populations in soil cv. Thar Rituraj was conducted during the 2019–20 at the College of Horticulture and Forestry, Jhalawar, Rajasthan. Among different thicknesses, application of T6–12 cm of dry grass to individual plants was significantly superior to all other treatments, but it was on at par with T5–10 cm thickness of dry grass. In treatment T6, an increase in shoot and leaf parameters, such as plant height (32.61%), petiole length (6.64%), leaf length (13.45%), leaf width (18.85%), leaf area (31.03%), leaf perimeter (18.92%), chlorophyll content (29.75%) and microbial populations Bacteria (×105 cfu/g soil) (4.35) and Fungi (×103 cfu/g soil) (3.10) recorded.

Key Words: Dry Grass, Microbial Population, Thar Rituraj and Chlorophyll Content.

INTRODUCTION

Khirni (Manilkara hexandra Roxb.) is one of the important underutilized fruit crops of tropical and sub-tropical region of India. It belongs to the family Sapotaceae or mahua family. It is also known as *Rayan*. *Khirni* is a native of tropical south-east Asia. It occurs naturally in forests and common lands particularly in Central and Deccan peninsular India. Madhya Pradesh is famous for availability of large number of naturally occurring *khirni* trees and production of its best quality fruits. The major *Khirni* growing states in the country are Madhya Pradesh, Gujarat, Rajasthan, Karnataka, Maharashtra, and Tamil Nadu. The genus *Manilkara* contains about 70 genera and 800 species. However, *Manilkara achras* (sapota) is grown commercially as a fruit crop. *Khirni* is a hardy plant and performs well in wide range of soil. It is generally grown on degraded land soil having poor fertility status and low water holding capacity. It can also be cultivated on saline and sodic soil condition. The plant is well adapted to varying climate conditions. It can tolerant extreme hot during summer and extreme cold during winter.

Shah *et al* (2004) studied the effect of the flavonoid rich fraction of the stem bark of *Manilkara hexandra* (Roxb.) Dubard, on gastric ulcers in animal. Oral administration of the ethyl acetate extract (extract A3) inhibited the formation of gastric lesions induced by ethanol. *Khirni* fruits are milky, sweet, sour, cooling, aphrodisiac, appetizer, emollient and tonic. The seeds contain approximately 25 per cent oil which is used for cooking purposes. The fruit is good source of iron, sugars, minerals, protein, carbohydrate, etc. Fresh fruits are good source of vitamin A (675IU).

Mulching is an essential cultural technique which, helps to produce healthier plants. Mulch is often defined as any material applied to the soil surface as cover. It can be divided into two general groups-organic and inorganic. Organic mulches such as dry grass is usually a bi-product of farm waste and decompose readily over time. Inorganic mulches such as plastic sheet does not decompose quickly and may actually remain in the environment for an identify period of time. Both types have found use for various types in horticulture. However; the benefits provided by organic mulch may outweigh the use of inorganic

Corresponding Author's Email - mukeshchandbhateshwar@gmail.com
**Department of Horticulture H.N.B. Garhwal University, Srinagar, Uttarakhand 246174

Table 1. Effect of mulching on height of the plant (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period

Treatments	Initial value (March)	Height of the plant (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	72.80	73.25 (0.61)	74.69 (2.59)	78.68 (8.07)	79.67 (9.43)	80.10 (10.02)	80.97 (11.22)
T_1 (2 cm thickness of dry grass)	70.45	71.57 (1.58)	73.24 (3.96)	76.87 (9.11)	78.74 (11.76)	80.13 (13.74)	81.42 (15.57)
T_2 (4 cm thickness of dry grass)	71.24	72.45 (1.69)	74.31 (4.30)	77.98 (9.46)	81.12 (13.86)	82.87 (16.32)	84.51 (18.62)
T_3 (6 cm thickness of dry grass)	71.66	73.12 (2.03)	74.84 (4.43)	78.68 (9.79)	81.98 (14.40)	84.35 (17.70)	86.81 (21.14)
T_4 (8 cm thickness of dry grass)	73.54	75.13 (2.16)	77.23 (5.01)	82.26 (11.85)	85.91 (16.82)	87.75 (19.32)	90.32 (22.81)
T_5 (10 cm thickness of dry grass)	68.14	70.12 (2.90)	72.35 (6.17)	78.61 (15.36)	83.02 (21.83)	86.14 (26.41)	89.76 (31.72)
T_6 (12 cm thickness of dry grass)	72.60	74.86 (3.11)	77.32 (6.50)	85.42 (17.65)	89.12 (22.75)	93.05 (28.16)	96.28 (32.61)
SEm ±	-	0.02	0.02	0.07	0.09	0.12	0.30
CD (5%)	-	0.06	0.06	0.22	0.27	0.38	0.91

types. Organic mulch has a number of positive attributes. It conserves soil moisture by reducing water loss thorough evaporation, minimizing soil erosion, moderating soil temperature, inhibiting weed growth, encouraging the growth of beneficial soil microorganism, and reducing the spread of soil-borne pathogen by preventing soil form splashing onto plants during rainstorms and watering. Mulch can also eliminate mowing around tree and shrubs, and mechanical injury to trunk. Keeping in mind the importance of different thickness of mulching current study was planned to enhanced vegetative growth of *khirni* and increased microbial populations in soil. An experiment entitled Impact of mulch thickness on enhanced vegetative growth of *khirni* and increased microbial populations in soil.

MATERIALS AND METHODS

This field experiment was conducted at Department of Fruit Science, College of Horticulture and Forestry, Jhalarapatan, Jhalawar in the newly established orchard of *Khirni* cv. Thar Rituraj during 2019-20. It consists of six mulch treatments along with the control, T_0 (Control), T_1 (2 cm thickness of dry grass), T_2 (4 cm thickness of dry grass), T_3 (6 cm thickness of dry grass), T_4 (8 cm thickness of dry grass), T_5 (10 cm thickness of dry grass) and T_6 (12 cm thickness of dry grass) laid out in randomized block design with three replications. The treatments were applied during first week of March 2019 after recording initial (base) growth and development parameters of plants and observations were noted at 2 months interval for

Table 2. Effect of mulching on petiole length (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Petiole length (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	0.685	0.686 (0.14)	0.688 (0.43)	0.691 (0.87)	0.693 (1.16)	0.694 (1.31)	0.696 (1.60)
T_1 (2 cm thickness of dry grass)	0.625	0.627 (0.32)	0.630 (0.8)	0.636 (1.76)	0.641 (2.56)	0.644 (3.04)	0.647 (3.52)
T_2 (4 cm thickness of dry grass)	0.781	0.784 (0.38)	0.788 (0.89)	0.796 (1.92)	0.802 (2.68)	0.806 (3.20)	0.810 (3.71)
T_3 (6 cm thickness of dry grass)	0.713	0.716 (0.42)	0.721 (1.12)	0.730 (2.38)	0.740 (3.78)	0.745 (4.48)	0.749 (5.04)
T_4 (8 cm thickness of dry grass)	0.723	0.727 (0.55)	0.733 (1.38)	0.743 (2.76)	0.751 (3.87)	0.757 (4.70)	0.762 (5.39)
T_5 (10 cm thickness of dry grass)	0.699	0.704 (0.71)	0.710 (1.57)	0.721 (3.14)	0.730 (4.43)	0.737 (5.43)	0.743 (6.29)
T_6 (12 cm thickness of dry grass)	0.677	0.683 (0.88)	0.690 (1.92)	0.701 (3.54)	0.709 (4.72)	0.717 (5.90)	0.722 (6.64)
SEm ±	-	0.01	0.02	0.04	0.05	0.08	0.13
CD (5%)	-	0.03	0.07	0.12	0.17	0.25	0.39

a total period of 12 months. For the measurement of rootstock and scion girth of plant marked at a fix point with white paint and values were expressed in mm. The plant height was recorded from the base of soil to highest tip of the plant with the help of measuring scale and noted in centimeter (cm). The numbers of nodes and internodes/ shoot and number of leaves/plants were counted manually. For measuring leaf length, selected tagged leaves under various treatments of *Khirni* were measured in April, June, August, October, December and February. The average increase in leaf length was calculated on the basis of cumulative increase in initial value. The average increase in leaf area index was calculated on the basis of recorded values of leaf area and plant spread as per the given formula (Watson, 1947). The microbial population like bacterial population and fungal population in soil was determined by soil dilution and plate count method (Pramer and Schmidt, 1964).

LAI=(Leaf area)/(Ground area)

The data were statistically analyzed as per analysis of variance technique as suggested by Panse *et al* (1995). The significance of the treatments was tested through F test at 5 per cent level of significance. The critical difference CD was calculated to assess the significance of difference among the different treatments.

RESULTS AND DISCUSSION

The thickness of the dry grass mulch affected plant development. The thickest dry grass, T_6–12 cm, showed the largest increase in plant height (32.61%), whereas T_5–10 cm thick dry grass showed a comparable increase (31.72%)

Table 3. Effect of mulching on leaf length (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf length (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	3.31	3.32 (0.30)	3.33 (0.60)	3.36 (1.51)	3.38 (2.11)	3.40 (2.71)	3.42 (3.32)
T_1 (2 cm thickness of dry grass)	3.43	3.45 (0.58)	3.48 (1.45)	3.56 (3.79)	3.63 (5.83)	3.68 (7.28)	3.72 (8.45)
T_2 (4 cm thickness of dry grass)	3.55	3.58 (0.84)	3.62 (1.97)	3.72 (4.78)	3.80 (7.04)	3.88 (9.29)	3.93 (10.70)
T_3 (6 cm thickness of dry grass)	3.63	3.67 (1.10)	3.71 (2.20)	3.83 (5.50)	3.92 (7.98)	3.99 (9.91)	4.04 (11.29)
T_4 (8 cm thickness of dry grass)	4.100	4.15 (1.21)	4.20 (2.43)	4.34 (5.85)	4.44 (8.29)	4.55 (10.97)	4.61 (12.43)
T_5 (10 cm thickness of dry grass)	3.80	3.85 (1.31)	3.91 (2.89)	4.06 (6.84)	4.15 (9.21)	4.22 (11.05)	4.30 (13.15)
T_6 (12 cm thickness of dry grass)	3.27	3.33 (1.83)	3.40 (3.97)	3.55 (8.56)	3.64 (11.31)	3.65 (11.62)	3.71 (13.45)
SEm ±	-	0.02	0.04	0.08	0.11	0.14	0.17
CD (5%)	-	0.06	0.12	0.25	0.35	0.43	0.52

(Table 1). T_0-control showed the least amount of plant height increase (11.22%).

Similarly, maximum increase (6.64%) in petiole lenght was noted in T_6 followed with T_5 (6.29%) and minimum increase (1.60%) was observed in T_0 treatment (Table 2). Leaf length maximum (13.45%) application of 12 cm thickness of dry grass followed with application of 10 cm thickness of dry grass (13.15%) and minimum increase with the control (3.32%) (Table 3). From the table 4 and 5, it apparently appears that maximum increase in leaf width and leaf area (19.36 and 31.03%, respectively) was observed with treatment $T_6$and A found at par with T_5 (18.85%, 29.44%, respectively). The lowest increase in leaf width and leaf area (5.77% and 18.13%, respectively) was recorded in control (Table 4 and Table 5). The highest increase (18.92%) in leaf perimeter was observed in T_6-12 cm thickness of dry grass and found at par with T_5 - 10 cm thickness of dry grass (18.36%) (Table 6). The lowest increase (12.98%) in leaf perimeter was noted in T_0- control. Maximum increase in leaf area index and chlorophyll content (1.50% and 29.75%, respectively) was observed with treatment T_6 and found at par with T_5 (1.46, 27.73%, respectively). The lowest increase in leaf area index and chlorophyll content (0.46 and 20.20%, respectively) was recorded in control (Table 7 and Table 8). The treatment T_6- 12 cm thickness of dry grass had maximum microbial population [(Bacteria 4.35 $\times 10^5$ and Fungi 3.10 $\times 10^3$ ($\times 10^5$ cfu/g soil)] in end of the experiment during February and it is found superior over other

Table 3. Effect of mulching on leaf width (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf width (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	2.25	2.26 (0.44)	2.27 (0.88)	2.31 (2.66)	2.34 (3.99)	2.36 (4.88)	2.38 (5.77)
T_1 (2 cm thickness of dry grass)	2.15	2.17 (0.93)	2.20 (2.32)	2.28 (6.04)	2.33 (8.37)	2.37 (10.23)	2.40 (11.62)
T_2 (4 cm thickness of dry grass)	2.24	2.27 (1.33)	2.31 (3.12)	2.41 (7.58)	2.47 (10.26)	2.52 (12.50)	2.56 (14.28)
T_3 (6 cm thickness of dry grass)	2.56	2.60 (1.56)	2.65 (3.51)	2.77 (8.20)	2.84 (10.93)	2.89 (12.89)	2.95 (15.23)
T_4 (8 cm thickness of dry grass)	2.34	2.39 (2.13)	2.45 (4.70)	2.56 (9.40)	2.63 (12.39)	2.70 (15.38)	2.74 (17.09)
T_5 (10 cm thickness of dry grass)	2.28	2.33 (2.19)	2.40 (5.26)	2.52 (10.52)	2.59 (13.59)	2.63 (15.35)	2.71 (18.85)
T_6 (12 cm thickness of dry grass)	2.22	2.28 (2.70)	2.36 (6.30)	2.47 (11.26)	2.55 (14.86)	2.60 (17.11)	2.65 (19.36)
SEm ±	-	0.04	0.10	0.12	0.11	0.15	0.30
CD (5%)	-	0.13	0.30	0.37	0.34	0.46	0.92

treatments and minimum microbial count [(Bacteria 2.70 $\times 10^5$ and Fungi 1.80 $\times 10^3$ ($\times 10^5$ cfu/g soil)] observed in control (Table 9) at the time of completion of experiment.

The shoot parameters were recorded comparatively better with T_6-12 cm thickness of dry grass treatment as compared to rest of treatments. Healthier shoot attributes observed under T_6 treatment may be due to relatively more amenable effect of this treatment in modification of microclimate, better improvement in texture of soil, conservation of soil moisture, improvement of fertility and control of weeds. This treatment might also influence hydrothermal regimes by changing radiation balance, rate of heat, water vapour transfer and minimized hit of soil with sun more effectively in comparison to other treatments. Effective prevention of moisture deficit leading to improved cell division and elongation, perhaps also led to better shoot parameters in T_6 (12 cm thickness of dry grass) treatments over other treatments evaluated. Similar effect of the mulching on the plant growth was reported by Chattopdhyay and Patra (1992), Borthakur and Bhattacharyya (1996), Mal *et al* (2006). Ali and Gaur (2013).

The effect of mulching on leaf parameters viz., petiole length, leaf length, leaf area, leaf width, leaf perimeter, leaf area index and chlorophyll content observed maximum increase with T_6-12 cm thickness of dry grass. These results may be clarified in the light of improvement of

Table 4. Effect of mulching on leaf area (cm^2) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf area (cm^2)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	7.28	7.34 (0.82)	7.49 (2.88)	7.96 (9.34)	8.31 (14.14)	8.46 (16.20)	8.60 (18.13)
T_1 (2 cm thickness of dry grass)	7.37	7.45 (1.08)	7.63 (3.52)	8.25 (11.94)	8.57 (16.28)	8.79 (19.26)	8.91 (20.89)
T_2 (4 cm thickness of dry grass)	7.95	8.04 (1.13)	8.28 (4.15)	9.05 (13.83)	9.40 (18.23)	9.62 (21.00)	9.75 (22.64)
T_3 (6 cm thickness of dry grass)	9.28	9.39 (1.18)	9.72 (4.74)	10.61 (14.33)	11.04 (18.96)	11.37 (22.52)	11.50 (23.92)
T_4 (8 cm thickness of dry grass)	9.59	9.72 (1.35)	10.12 (5.52)	11.03 (15.01)	11.48 (19.70)	11.92 (24.29)	12.13 (26.48)
T_5 (10 cm thickness of dry grass)	8.66	8.80 (1.61)	9.21 (6.35)	10.09 (16.51)	10.53 (21.59)	10.84 (25.17)	11.21 (29.44)
T_6 (12 cm thickness of dry grass)	7.25	7.39 (1.93)	7.80 (7.58)	8.79 (21.24)	9.21 (27.03)	9.42 (29.93)	9.50 (31.03)
SEm ±	-	0.03	0.06	0.25	0.21	0.30	0.63
CD (5%)	-	0.10	0.18	0.77	0.64	0.92	1.91

physico-chemical properties of soil through comparatively better congenial environment in the root zone (Kumar *et al,* 2008, Singh *et al,* 2004 in plum and Helaly *et al,* 2017 in gooseberry).

The microbial population [(Bacteria 4.35 $\times 10^5$ and Fungi 3.10 $\times 10^3$ ($\times 10^5$ cfu/g soil)] as presented in Table 4.9 was recorded maximum in T_6 (12 cm thickness of dry grass) treatment at the time of final observation during February. It might be due to the decomposition of applied mulch material. Garg *et al* (2007) reported that the average fungal and bacterial counts in the guava orchard soil were highest under banana leaf mulch.

CONCLUSION

Therefore, it can be said that the administration of treatment T6, which involved applying dry grass with a thickness of 12 cm, had a greater impact on the growth and development of *Khirni* plants. The dry grass with a thickness of 12 cm showed superior growth and development efficacy.

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Table 5. Effect of mulching on leaf perimeter (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf perimeter (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	9.47	9.52 (0.52)	9.64 (1.79)	9.95 (5.06)	10.39 (9.71)	10.52 (11.08)	10.70 (12.98)
T_1 (2 cm thickness of dry grass)	9.42	9.48 (0.63)	9.68 (2.76)	10.13 (7.53)	10.48 (11.25)	10.65 (13.05)	10.84 (15.07)
T_2 (4 cm thickness of dry grass)	9.75	9.83 (0.82)	10.05 (3.07)	10.54 (8.10)	10.91 (11.89)	11.06 (13.43)	11.27 (15.58)
T_3 (6 cm thickness of dry grass)	10.88	10.98 (0.91)	11.23 (3.21)	11.81 (8.54)	12.20 (12.13)	12.40 (13.97)	12.64 (16.17)
T_4 (8 cm thickness of dry grass)	10.25	10.35 (0.97)	10.60 (3.41)	11.15 (8.78)	11.51 (12.29)	11.75 (14.63)	11.99 (16.97)
T_5 (10 cm thickness of dry grass)	9.69	9.80 (1.13)	10.04 (3.61)	10.59 (9.28)	10.95 (13.00)	11.19 (15.47)	11.47 (18.36)
T_6 (12 cm thickness of dry grass)	9.46	9.58 (1.26)	9.86 (4.22)	10.40 (9.93)	10.79 (14.05)	11.02 (16.49)	11.25 (18.92)
SEm ±	-	0.02	0.05	0.15	0.16	0.13	0.21
CD (5%)	-	0.06	0.14	0.45	0.49	0.39	0.64

Table 6. Effect of mulching on chlorophyll content (mg/g) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatment	Chlorophyll content (mg/g)	
	Initial value (Ma rch)	Final value (February)
T_0 Control (Without mulch)	0.99	1.19 (20.20)
T_1 (2 cm thickness of dry grass)	1.03	1.25 (21.35)
T_2 (4 cm thickness of dry grass)	1.08	1.33 (23.14)
T_3 (6 cm thickness of dry grass)	1.15	1.43 (24.34)
T_4 (8 cm thickness of dry grass)	1.18	1.49 (26.27)
T_5 (10 cm thickness of dry grass)	1.19	1.52 (27.73)
T_6 (12 cm thickness of dry grass)	1.21	1.57 (29.75)
SEm ±	-	0.32
CD (5%)	-	0.99

Table 7. Effect of mulching on soil microbial population of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during end of experiment (February, 2020).

	Bacteria ($\times 10^5$ cfu/g soil)	Fungi ($\times 10^3$ cfu/g soil)
Initial values	**2.90**	**1.90**
Treatment	**End of experiment (February, 2020)**	
T_0 Control (Without mulch)	2.70	1.80
T_1 (2 cm thickness of dry grass)	2.85	1.93
T_2 (4 cm thickness of dry grass)	3.95	1.97
T_3 (6 cm thickness of dry grass)	3.40	2.20
T_4 (8 cm thickness of dry grass)	3.90	2.55
T_5 (10 cm thickness of dry grass)	4.20	2.90
T_6 (12 cm thickness of dry grass)	4.35	3.10
SEm ±	0.04	0.03
CD (5%)	0.12	0.09

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