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Boosting Peach Production in Rainfed Areas of Punjab Through Mulching Techniques

Muhammad Yunas[1*], Majid Rahim[1], Riffat Bibi[1], Azhar Mahmood Aulakh[1], Waqas Naseem[1], Safia Naureen Malik[1], Sultan Ahmad Rizvi[1] and Obaid-ur-Rehman[1]

[1]Soil and Water Conservation Research Institute, Chakwal, Pakistan
Corresponding author's email: soilscientist2002@gmail.com

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Abstract

Mulching is an approach to cover soil around plants with materials like polyethylene sheets, organic matter or crop residues, gaining wide recognition for its capability to enhance soil moisture retention, regulate soil temperature and suppress weed growth. The experiment was conducted at Soil and Water Conservation Research Institute, Chakwal aimed at investigating the potential of mulching techniques to enhance peach production in rainfed areas of Punjab. The treatments were laid out in Randomized Complete Block Design (RCBD), selecting two years old peach plants. The mulch treatments were polypropylene sheet, black plastic polyethene sheet, grass, gypsum amendment, and control (without any mulch). The results indicated a substantial improvement in mean soil moisture content, with the maximum enhancement observed in the treatment utilizing black sheet mulch (10.8% and 11.2%) followed closely by polypropylene sheet mulch (10% and 10.1%) in 1st and 2nd year respectively. Fruit yield, a critical parameter for assessing orchard productivity, exhibited the highest values in treatment unit comprising black sheet mulch, recording an impressive 27.2 kg plant^{-1}. Conversely, the control showed the lowest fruit yield as 18.5 kg plant^{-1}. These findings emphasize the significant potential of mulching techniques in optimizing soil moisture levels and augmenting peach fruit yield in rainfed areas. The study contributes into sustainable agricultural practices, illustrating the practical benefits of mulching strategies to improve water retention and overall orchard productivity in rain fed areas. This study will be helpful for policymakers, farmers, and researchers for adopting this technique in peach cultivation in rainfed areas of Punjab.

Keywords: Mulching Peach Production; Punjab; Rainfed.

Introduction

Peach (*Prunus persica* L.) holds significant importance as a deciduous stone fruit crop in Pakistan, boosting an annual production of 134.58 thousand tons from an area of 15.4 (000 hac) among which 0.25 (000 hac) area is under Punjab (Agri. Statistics of Pakistan, 2022). It emerges as a vital fruit crop in the Pothwar region, offering lucrative market prices due to its early fruiting. Despite the advantages of early fruiting, the Pothwar region encounters yield constraints due to new ecological adaptations (Sikhandakasmita, *et al*., 2022). The peach growing season aligns with the rainy period in Pothwar, typically spanning from July to October, coinciding with over 80% of the annual precipitation. However, irregular rainfall trend may cause to incur drought spell during the crucial blooming period in early April. Water stress poses detrimental effect on crop growth and yield attributes (Yaghi *et al*., 2013). Optimal soil moisture content during pivotal growth stages amplifies metabolic processes in plant cells and enhances nutrient absorption. Excessive water can lead to flower dropping and disease susceptibility, while insufficient soil moisture can cause flower drying and poor fertilization, resulting in reduced fruit production. (sangakkara *et al*., 2000).

As global agriculture increasingly relies on irrigated lands, efficient water use becomes imperative to sustain crop production amidst escalating challenges. Introducing advanced irrigation methods and enhancing water management practices are prudent measures to expand irrigated areas using available water resources (Zaman *et al*., 2001). Mulching stands out as a water management practice to enhance water use efficiency. The technique revolves around covering bare soil with chopped wheat straw, rice straw, plastic film, or/and grass to mitigate solar radiation and evaporation, thus moderating soil heat and improving water infiltration rate amid heavy rain spells (Gajri *et al*., 1994; Khurshid *et al*., 2006). Mulching proved highly effective in conserving moisture, incrementing organic matter, improving structure and nutrient status of soil (Downer, 2009). Black polythene mulching approach performed best in preventing evaporation losses among inorganic mulches (Sharma *et al*., 2022).

Effective soil moisture management during fruit development is achievable through cultural practices. Developing strategies for sustainable moisture retention and conservation in peach orchards is crucial to provide consistent moisture levels with adequate aeration and to mitigate drought risks (Kumawat *et al*.,

2020). Evaluating mulching techniques presents a promising approach to address these challenges. Different mulches are being used as Polypropylene sheet, Black plastic polythene sheet, Gypsum in basin area and Dry Grass 6 inches layer.

Materials and Methods

A field trial was conducted for two crop years during 2020-21 to 2021-22 on peach cultivar (Early grand) and experiment was performed on farm of Soil and Water Conservation Research Institute, Chakwal. The mulching was done at the time of experiment initiation. Treatments for this study were T_1(Polypropylene sheet), T_2 (Black plastic polythene sheet), T_3 (Gypsum in basin area @ 01ton acre^{-1}), T_4 (Dry Grass 6 inches' layer), T_5 (Control with No mulch).

Parameters to be Recorded

Soil Moisture (%): Soil moisture was measured using digital soil moisture meter (Cambell HS-2 hydro sense ii).

Plant Growth (cm): Under plant growth the stem circumference and canopy area were recorded by measuring tape.

Fruit Yield (g): The fruits were counted and weighed per tree using electrical weighing balance.

No. of Weeds per basin: Different weeds infestation was recorded in the basin of counted fruity tree.

Durability of Material used: The mulch materials were examined visually as well as practically by folding the sheets and the sheets after folding remained in actual shape were used again in continuity.

Statistical Analysis: The experiment was laid out in RCBD replicating thrice. The data was statistically analyzed complying analysis of variance (ANOVA) and comparison of treatments by using LSD at 5% level of significance in the Statistix 8.1 software.

Results and Discussion

Soil Moisture: First year soil moisture data (Table 1) revealed that maximum soil moisture was observed by using black polythene sheet i.e. 10.3 % at one-foot depth and 10.8 % at two-foot depth which was followed by 9.9 % at one-foot depth and 10 % at two-foot depth with poly propylene sheet. These treatments conserve more moisture than control i.e. 7.9 % at one-foot depth and 8.6 % at two-foot depth. Increase in soil moisture percentage against control at one-foot depth was recorded maximum i.e. 29 while at two-foot depth was 26 with black polythene she*et al*so. It showed more absorption of moisture contents in soil rather than evaporation. The findings were in accordance with Li., *et al*. (2016) and with Shirgure, 2012 who observed better moisture retention with black polythene mulch in an experiment on lime fruit. Ampofo 2018; Kumar *et al*., 2015 accounted that mulching significantly affected soil organic matter inducing improvement in physio-chemical and biological characteristics of soil upon decomposition

Table 1. Soil moisture data at one and two-feet depth in 2021

Treatments	Soil moisture percentage(1´depth)	Soil moisture percentage(2´depth)	Increase in moisture percentage against control (1´depth)	Increase in moisture percentage against control (2´depth)
Polypropylene sheet	9.9 AB	10.0 B	24	16
Black polythene sheet	10.3 A	10.8 A	29	25.8
Gypsum	9.5 BC	8.8 CD	19	12.5
Dry grass	9.2 C	9.0 C	15.9	9.1
Control	7.9 D	8.6 D	-	-

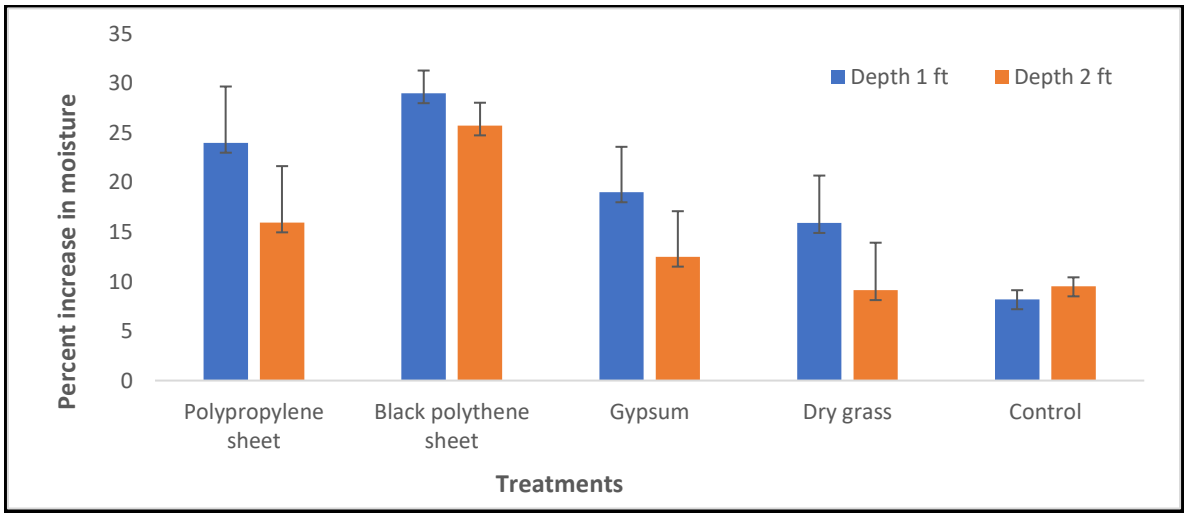

Figure. 1. Increment in moisture % over control in 2021

Second year soil moisture data (Table 2) depicted that maximum soil moisture was observed by using black polythene sheet i.e. 11.3 % at one-foot depth and 11.2 % at two-foot depth which was followed by 9.9 % at one-foot depth and 10 % at two-foot depth with poly propylene sheet. Hence increase in moisture percentage against control was maximum 31 % at one-foot depth and 26.4 % at two-foot depth with black polythene sheet. It conserved more moisture contents in soil which may be justified as Verma *et al*., 2017 concluded that Polyethylene based materials reduces the evapotranspiration losses. The results of the present study were in accordance with Kumar *et al*., 2014 who ascertained that mulching with black polythene sheet caused maximum moisture retention in comparison to other treatments in an experimental study on citrus orchard. Kaur & Bons, 2017 observed that mulching significantly conserved in-situ soil moisture resulting in incremented water use efficiency (WUE). According to the findings of Suo *et al*, 2019, the film mulching improved soil moisture contents, fruit production and WUE. Plastic film mulching (PFM) and straw mulching (SM) enhanced soil moisture contents (1.9–2.9 %) thus reducing the mean annual evapotranspiration of 82.5 mm and 49.3 mm through SM and PFM respectively (Wang *et al*, 2015).

Table 2. Soil moisture data at one and two-feet depth in 2022

Treatments	Soil moisture percentage (1´depth)	Soil moisture percentage(2´depth)	Increase in moisture percentage against control (1´depth)	Increase in moisture percentage against control (2´depth)
Polypropylene sheet	9.9 A	10.1A	28	15.1
Black polythene sheet	11.3 B	11.2 B	31	26.4
Gypsum	9.5 C	8.9 B	24	13.4
Dry grass	9.5 C	10.0 C	19.6	9.0
(Control)	8.5 D	8.9 C	-	-

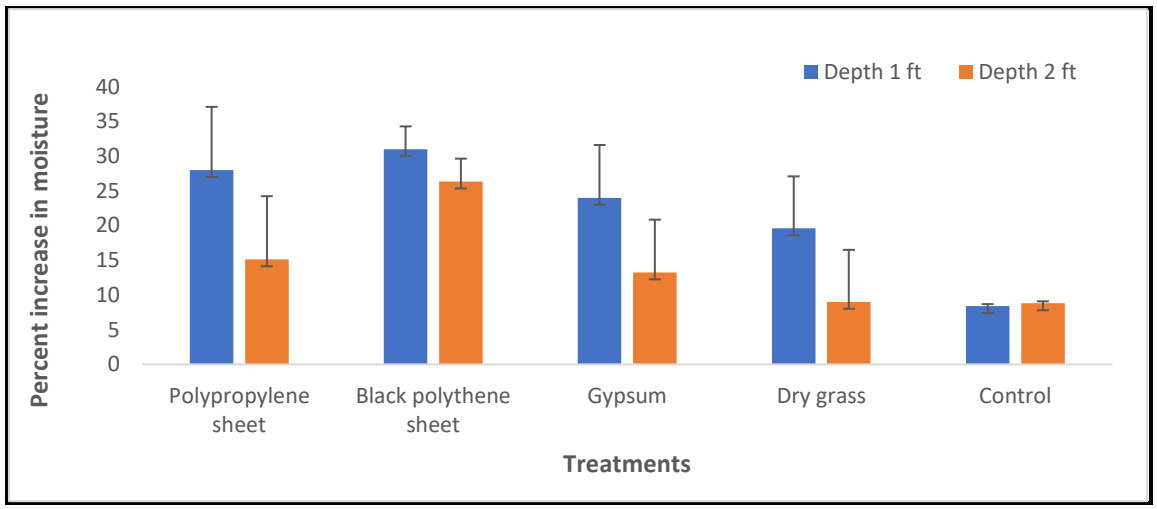

Figure. 2. Increment in moisture percentage over control in 2022

Growth and yield attributes of peach in 2021: In the first year of study, growth of stem circumference (Table 3) was recorded i.e. 12.6 cm and growth of canopy area is 9.9 m^2 with black polythene mulch which is significantly highest than all other treatments as well as control having 9.0 cm and 5.0 m^2 respectively. This indicated the utilization of conserved moisture showed positive effect on the growth of plant as compared control (no mulch). The findings of present study are in line with Gupta *et al*, 2022 stating that in a strawberry experiment mulching approach provided conducive environment for improving its the growth and yield attributes. Mulching of bare soil around plants resulted in extended and vigorous plant growth due to enhanced competitive ability (Pramanik *et al*., 2015; Das *et al*., 2018). It was narrated by Gupta *et al*, 2022 that maximum annual extension in shoot growth (45.20 cm) was with black polythene mulching sheet while minimum was observed in control treatment (35.10 cm). Maximum number of fruits per tree i.e. 128 and fruit yield 27.20 kg was recorded where black polythene mulch was applied followed by 121 fruits per tree and 25.34 kg fruit yield with polypropylene sheet mulch against control exhibiting lowest number of fruits per plant i.e. 94 and 18.50 kg fruit yield. It might be due to enhanced soil moisture retention, buffering of soil temperature and suppression of weed infestation that collectively had an impact on fruit yield and quality. Mehmood *et al*., 2015 described a potential benefit of mulching in enhancing nutrient use efficiency as mulching might be acted as a barrier on soil, restricting leaching of nutrients. Tapiwa, 2019 explained that optimum availability of nutrients and soil moisture due to mulching in a sustained

manner provided conducive environment for better growth and yield of crops.

Table 3. Growth attributes and yield of peach in 2021

Treatments	**Stem circumference** (cm)	**Canopy area (**m2)	**Fruit yield** (Kg)	**No of fruit/tree**
Polypropylene sheet	12.0 b	7.5 c	25.34 b	121 ab
Black polythene sheet	12.6 a	9.9 a	27.20 a	128 a
Gypsum	11.3 c	7.0 c	24.55 b	116 b
Dry grass	11.9 b	8.3 b	24.97 b	117 b
(Control)	9.0 d	5.0 d	18.50 c	94 c

Growth and yield attributes of peach in 2022: In the second year, stem circumference 18.4 cm was recorded (table 4) with black polythene sheet which was non significantly higher than 18.3 cm stem circumference with polypropylene sheet while control showed significantly low stem circumference i.e. 15.1 cm. Hence canopy area recorded was same with polythene and polypropylene mulch i.e. 11.9 m^2 which is significantly higher than canopy area recoded with control i.e. 9.6 m^2. The findings were in line with Gupta *et al*., 2022 narrating that the peach plants mulched with black polythene sheet exhibited maximum shoot extension growth thus inducing enhanced number of leaves bearing nodes. Hence, higher leaf: fruit ratio in plants with black polythene mulching approach might be due to elevated number of leaves per unit shoot length. Raza *et al*., 2019 reported that balanced soil temperature is pivotal for plant growth development mainly due to soil temperature modification and evaporation control. Hence, maximum number of fruits per tree were 148 and fruit yield was 29.56 kg with polythene black sheet and in the control treatment the minimum number of fruits per tree were 126 and fruit yield was 22.52 kg, exhibiting a gap between treatment and control. This might be due to increased soil moisture and nutrient availability which in turn induced better soil micro-climate (Gupta *et al*, 2022). Plastic film mulching and straw mulching could be taken into account as models for better peach production in semiarid rainfed areas due to its efficacy in improving soil moisture contents during bloom and fruit expansion stages (Wang *et al*, 2015).

Table 4. Growth and yield attributes of peach in 2022

Treatments	**Stem circumference** (cm)	**Canopy area** (m2)	**Fruit yield** (Kg)	**No of fruit/tree**
Polypropylene sheet	18.3 a	11.9 a	28.45 a	142 ab
Black polythene sheet	18.4 a	11.9 a	29.56 a	148 a
Gypsum	16.5 a	11.1 b	28.65 a	144 ab
Dry grass	17.9 a	11.5 ab	28.54 a	135 bc
(Control)	15.1 b	9.6 c	22.52 b	126 c

Suppression of Weeds: The data regarding weed infestation represented (table 5) that minimum weeds per plant were recorded with black polythene sheet i.e. 4 and 5 in first and second year respectively. While maximum weeds per plant were recorded with control i.e. 48 and 57 in first and second year respectively. This indicated the unfavorable environmental condition for growth of weeds due to high temperature, check in light etc. Gupta *et al*., 2022 also reported the suppression of weed growth by using black polythene mulch. Impact of mulching in reducing weed establishment plays vital role in provision of growth conducive and less competitive environment to the crops (Matkovic *et al*., 2015). The mulch acts as a barrier and prevents light conductance (red light), inactivating phytochrome system of weed seeds causing its poor germination and reduce emergence of weed seedlings (Altland *et al*., 2016). The present study findings are in line with Vetter *et al*., 2017 who described that black plastic sheet mulching was more effective in controlling weeds because of halting light entrance into the soil. As a matter of fact, black colored polythene enhances soil temperature while white one reflects the radiation thereby lowering the soil temperature (Laulina and Hasan 2018) and similarly use of a single intact piece of poly sheet is considered to be more effective and efficient than pieces of it (Anzalone *et al*., 2014). Mulching materials such as saw dust performed more effectively in soil moisture conservation (Kumar and Dey 2011; Ewere *et al*., 2017) while black polythene sheet mulching effectively controlled weed infestation than other mulching techniques. Conclusively, it can be ascertained that plastic and straw mulching approaches can be used as an effective and efficient chemical-free way to control weeds in peach orchards (Thaukar *et al*, 2012).

As concerned for durability of material (Table 5), the black polythene sheet was used once in two-year experiment while other mulches replaced, so this indicate that polythene sheet is economical and easy to manage than other treatments. Mulching was found as a low-priced and viable alternative amongst the various resource conserving technologies (Hussain *et al*., 2015). However, due to un decomposable nature of plastic

mulch, it may have some environmental concerns. In present study, performance of the polypropylene sheet is also better than other treatments. As it is biodegradable so it can be preferred for future study.

The findings of this study were in accordance with Sagar *et al*., 2020 stating that durability of plastic mulches was priceless and effective in enhancing peach productivity through soil moisture conservation. Besides, the enhanced moisture availability also tends to help in aggravating quality of the produce from the same orchard (Alex and Thomas 2011).

Table 5. Weed infestation and durability of material

Treatments	**Weed infestation (per plant)**		**Durability of Material**	
Year	2021	2022	2021	2022
Polypropylene sheet	4C	6D	1 Year	replaced
Black polythene sheet	4C	5D	long-term	same
Gypsum	18B	22C	applied	applied
Dry grass	15B	31B	applied	applied
(Control)	48A	57A	No mulch	No mulch

Conclusion

It is concluded that black polythene sheet is effective in conserving soil moisture and enhancing peach fruit yield significantly and should be adopted by the farmers of rainfed areas to conserve soil moisture and consequently improving peach fruit yields. However, keeping in view environmental concerns, due to biodegradable nature of polypropylene sheet is more suitable for the said purpose and it should be focusing in future studies.

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