CAREER POINT INTERNATIONAL JOURNAL OF RESEARCH
Career Point International Journal of Research (CPIJR)
©2022 CPIJR | Volume 1 | Issue 3 | ISSN : 2583-1895
March-2024 | DOI: https://doi.org/10.5281/zenodo.13821608

Effect of different Irrigation Systems and Mulching Strategies on the Growth and Yield of Barley Crop

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Abstract :

Barley (Hordeum vulgare L.) stands as the world's fourth-largest cereal crop, following maize, wheat, and rice, contributing to 7% of global cereal production. Its unique appeal lies in its adaptability to challenging soils and marginal lands, rendering it a practical choice for resource-constrained farmers. In an era where water is an indispensable factor in agriculture, especially in regions plagued by water scarcity, its significance cannot be emphasized enough. The burgeoning demand for water in industrial, household, and other sectors is poised to precipitate a looming water crisis in agriculture. Hence, the conservation of water is paramount, not only to ensure food security but also to safeguard livelihoods, a matter of acute concern given the surging food requirements in India and across the globe. In this context, mulching emerges as a fundamental agricultural practice for safeguarding soil moisture and bolstering the physical state of the land. Mulch serves a multifaceted role - it impedes moisture evaporation, thus enhancing water retention, while also acting as a weed control mechanism. Furthermore, it aids in moderating soil temperatures, diminishing runoff, and promoting efficient water infiltration. It's worth noting that soil evaporation is a linchpin in the overall water equilibrium within agriculture, making mulching an invaluable tool in the quest for sustainable and water-efficient farming practices. By embracing such strategies, agricultural systems can weather the impending water crisis and continue to meet the ever-increasing global food demand while minimizing the impact on water resources.

Key Words: Barley, Irrigation, Mulching, Moisture Conservation, Mulch

I Introduction:

Barley, a vital cereal crop, holds significant importance in global agriculture due to its versatility and nutritional value. The growth and yield of barley are profoundly influenced by various agronomic practices, among which irrigation systems and mulching strategies are paramount. These practices not only affect the crop's productivity but also play a crucial role in sustainable agriculture by optimizing resource use and enhancing environmental resilience.

1.1 Irrigation Systems:

Efficient water management is essential for the successful cultivation of barley, especially in regions with limited water resources. Different irrigation systems, such as surface irrigation, drip irrigation, and sprinkler irrigation, offer varied benefits and challenges. Surface irrigation, being one of the oldest methods, involves the distribution of water over the soil surface by gravity. While it is cost-effective and easy to implement, it often leads to water wastage and uneven distribution. Drip irrigation, on the other hand, delivers water directly to the root zone of the plants through a network of pipes and emitters. This method significantly reduces water wastage and ensures uniform water distribution, thereby enhancing water use efficiency. Sprinkler irrigation, which mimics natural rainfall, distributes water through a system of pipes and sprinklers. It is suitable for various soil types and topographies but may result in higher evaporation losses.

1.2 Mulching Strategies:

Mulching, the practice of covering the soil with organic or inorganic materials, is another critical agronomic practice that impacts barley growth and yield. Organic mulches, such as straw, grass clippings, and compost, decompose over time, adding nutrients to the soil and improving soil structure. They also help in conserving soil moisture, regulating soil temperature, and suppressing weed growth. Inorganic mulches, such as plastic films and gravel, provide similar benefits but do not decompose, making them suitable for long-term use. The choice of mulching material and its application method can significantly influence the microenvironment around the barley plants. For instance, organic mulches can enhance soil microbial activity and nutrient cycling, while inorganic mulches can provide better weed control and moisture conservation. The combined effects of these mulching strategies on barley growth and yield are complex and depend on various factors, including soil type, climate, and crop management practices.

1.3 Combined Effects on Barley Growth and Yield:

This study aims to investigate the combined effects of different irrigation systems and mulching strategies on the growth parameters and yield of barley. By understanding these interactions, farmers can adopt more sustainable and productive practices. For example, the integration of drip irrigation with organic mulching could potentially enhance water use efficiency and soil health, leading to improved crop productivity. Similarly, the use of sprinkler irrigation with inorganic mulching might offer better weed control and moisture conservation in certain environments. The findings of this study will provide valuable insights into the optimal combinations of irrigation and mulching practices for barley cultivation. This knowledge will help farmers make informed decisions, ultimately contributing to food security and agricultural sustainability. By adopting these practices, farmers can achieve higher yields with lower resource inputs, thereby promoting environmental sustainability and economic viability.

II Literature Review:

2.1 Mulching and Irrigation Levels on Crop Growth and Plant Height Mohler et al. (1992) conducted a study on the influence of mulching and irrigation levels on crop growth and plant height. They discovered that plant height exhibited a significant increase with higher mulch levels, with wheat mulch resulting in the maximum plant height (186.88 cm), followed by berseem mulch (171.97 cm), and the minimum observed in the no-mulch treatment (164.63 cm). The study indicated a positive correlation between crop height, mulching practices, and crop density. The enhanced plant growth under mulching treatments was attributed to improved soil moisture retention, as indicated by previous research (Sandhu et al., 1980; Mishra, 1996; Brahma et al., 2006).

Supporting these findings, Rahman et al. (2006) reported the highest plant height (82.58 cm) with water hyacinth mulch, followed by rice straw mulch (73.2 cm) and no mulch (80.0 cm). Khurshid et al. (2006) observed the maximum plant height in maize (217.67 cm) with a mulch rate of 12 Mg ha-1, decreasing to 185.63 cm in the control treatment. Ahmed et al. (2007) noted that wheat plants reached their tallest height with a mulch rate of 4 t ha-1, while the control plots had the shortest plants. Pervaiz et al. (2009) reported that maize achieved its maximum height with a mulch rate of 14 Mg ha-1 (2.53 m), followed by 7 Mg ha-1 (2.45 m), with the minimum height recorded in the no-mulch treatment (2.40 m).

Various tillage methods combined with mulching were also explored. Pervez (2009) and Vetsch and Randall (2002) found that conventional tillage with wheat straw mulch resulted in the maximum plant height. Ahamd et al. (2010) observed that weed-free plots without mulch produced the tallest aerobic rice plants (99.95 cm). Yi et al. (2011) conducted a two-year field experiment, showing significantly higher plant height in maize with supplementary irrigation compared to film mulching and rain-fed control.

Zamir et al. (2012) reported that conventional tillage with wheat straw mulch resulted in the tallest plants (202.89 cm), followed by conventional tillage with sawdust mulch

(203.11 cm). Sarwar et al. (2013) found that wheat achieved the maximum height (105.00 cm) with rice straw mulch, followed closely by wheat straw mulch (103.18 cm), while plots with no mulch had the minimum height (97.58 cm).

Yaseen et al. (2014) investigated the impact of irrigation regimes and mulch on maize plant height. They found that the maximum plant height (229.38 cm) occurred with higher irrigation depth (711.2 mm) and straw mulch at 15 Mg ha-1, while the minimum height (217.90 cm) was in the control (no mulch) treatment. Gao et al. (2013) reported that wheat plant height significantly increased with wheat straw mulch application at a rate of 14750 kg/ha.

Kushwah et al. (2013) concluded that mulching with palas leaves resulted in the maximum wheat plant height (59.12 cm), outperforming other materials. Rajput et al. (2014) recorded the highest maize plant height under guava with paddy mulch at different stages, with paddy mulch and legume mulch performing similarly at 40 DAS. Brahma et al. (2007) observed higher plant height in durum wheat with increased irrigation frequency.

Khonok et al. (2012) studied the effect of irrigation and straw mulch on barley, finding that 3 cm mulch significantly increased plant height (57.7 cm) compared to no mulch, regardless of irrigation treatments.

2.2 Mulching and Irrigation Levels on Number of Tillers

Ahmed et al. (2007) observed a notable increase in the number of tillers in wheat with mulch application compared to the control. Mulch applied at rates of 1, 2, 3, and 4 t ha-1 resulted in statistically similar numbers of tillers per square meter, all differing from the control. Guo et al. (2012) concluded that mulch application significantly raised the number of tillers in wheat compared to weedy plots (the control).

Kushwah et al. (2013) found that the application of palas leaves mulch resulted in the highest significant number of tillers per hill in wheat (6.58), followed by paddy straw, polyethylene, and dry grass. The control treatment recorded the minimum number of tillers per hill (3.48). Sarwar et al. (2013) reported that rice straw mulch at 4 t ha-1 led to significantly more spike-bearing tillers in wheat (385.66) compared to wheat straw mulch at 4 t ha-1 (367.00), with both being higher than the minimum number of spike-bearing tillers (311.66) in the no-mulch treatment.

Brahma et al. (2006) noted that the number of effective tillers per meter row length at harvest was markedly higher (147.33) when a five-irrigation schedule was applied at Crown Root Initiation (CRI) + Tillering + Late Jointing + Flowering + Milk stage, in comparison to other irrigation schedules. However, it was statistically comparable to the four-irrigation schedule at CRI + Tillering + Late Jointing + Milk stage (153.56). The lowest number of effective tillers was observed with a one-irrigation schedule at CRI (99.22) in durum wheat.

2.3 Mulching and Irrigation Levels on Leaf Area Index

Bhallacharya et al. (1996) observed that the use of acacia leaf mulches resulted in the significantly highest mean maximum Leaf Area Index (LAI) value (2.3) in black gram, followed by glyricidia (1.3), chan (1.3), and the no-mulch treatment (1.1). Hassan et al. (2003) noted the highest mean LAI (1.35) in clay soil with mulching compared to the non-mulched treatment (1.12). In the case of potatoes, Kar et al. (2007) found the maximum LAI (6.4) in the mulched plot with four irrigations. The study indicated that the maximum LAI was 21–35% greater in the mulched plots than in the non-mulched plots under different irrigation levels, suggesting that straw mulch had an impact on LAI depending on the irrigation treatments.

Qin et al. (2010) reported significantly higher leaf area with the straw mulch treatment in rice cultivated in non-flooded plots compared to the no-mulch treatment. Gao et al. (2013) discovered that the leaf area of soybeans increased with the quantity of wheat straw mulch. The minimum leaf area (14.86 cm2) was recorded in the control treatment, while the highest (20.20 cm2) was noted in the treatment where wheat straw mulch was applied at the rate of 7500 kg/ha. Ram et al. (2013) reported that LAI in wheat significantly increased with higher irrigation levels, and the highest LAI was recorded in the I5 (five irrigations) treatment. This was 11.3%, 13.4%, and 6.8% higher than the I2 (two irrigations) treatment in three years.

2.4 Mulching and Irrigation Levels on Dry Matter Production

Ramakrishna et al. (2006) found that the overall dry matter production in groundnut was significantly higher in the polythene mulch treatment (6.88 t/ha) compared to straw mulch (6.40 t/ha), chemical mulch (6.14 t/ha), and the lowest dry matter production was observed in the unmulched treatment (5.84 t/ha). For barley, Malecka et al. (2008) determined that the treatment involving an oat+pea mixture resulted in the highest total dry matter (7.64 t ha-1) compared to white mustard (6.93 t ha-1), with the lowest total dry matter (5.96 t ha-1) observed in the no-mulch treatment.

Iqbal et al. (2010) reported the maximum plant dry biomass in maize (27.18 Mg ha-1) when mulch was applied at a rate of 12 Mg ha-1, followed by 27.10 Mg ha-1 with a mulch rate of 4 Mg ha-1, and 26.55 Mg ha-1 with a mulch rate of 8 Mg ha-1. The minimum value, 20.54 Mg ha-1, was observed in the control treatment. This resulted in respective increases of 31.95%, 32.34%, and 29.26% in plant biomass compared to the control. These findings align with those of Bonari et al. (1994).

Rajput et al. (2014) determined that maize cultivated under guava trees with the application of paddy straw mulch at all growth stages showed the highest total dry matter accumulation, whereas the control treatment exhibited the lowest dry matter. At the harvest stage, only legume mulch demonstrated comparable results to paddy straw mulch. These findings align with similar observations made by Mishra (1996) in wheat and Samaila (2011) in tomato crops.

2.5 Mulching and Irrigation Levels on Number of Ear Heads

Janawade et al. (2007) explored the influence of irrigation frequency on the number of effective tillers per meter row length at harvest. They observed that the significantly highest count (147.33) was achieved with five irrigations, aligning with the findings of Rathore and Patil (1991), Pal et al. (1996), Jana et al. (2001), and Saren et al. (2004). Brahma et al. (2007) similarly found that in wheat, the number of effective tillers per meter row length at harvest was significantly higher (147.33) with the irrigation schedule involving five irrigations (I5 = Five irrigations at CRI + Tillering + Late jointing + Flowering + Milk stage) compared to other irrigation schedules. This result also corroborates the findings of Rathore and Patil (1991), Pal et al. (1996), Jana et al. (2001), and Saren et al. (2004).

Malecka et al. (2008) evaluated the impact of mulching on barley performance and reported that the treatment with a mixture of oats and peas resulted in the highest number of ears per square meter (618), followed by white mustard straw (553), while the no-mulch treatment had the minimum number of ears per square meter (504). Khurshid et al. (2009) found that in maize, the maximum mean number of cobs per plant (1.06) was observed in the treatment where mulch was applied at 12 Mg ha-1, followed by 1.05 in the treatment with a mulch rate of 4 Mg ha-1, and 1.02 in the treatment with a mulch rate of 8 Mg ha-1, while the control treatment had the minimum mean value of 1.00. Similar results were reported by Albuquerque et al. (2001). Khurshid et al. (2009) noted the maximum number of cobs per plant in maize with zero tillage and wheat straw mulch (T5), which was statistically comparable to treatments with bar harrow tillage and sawdust mulch (T9) and subsoiler tillage and sawdust mulch (T12) (1.46 each). The minimum number of cobs was observed in the treatment with conventional tillage and wheat straw mulch (T2), followed by conventional tillage (T1) (1.13 each).

Javeed et al. (2012) reported that the significantly highest number of cobs per plant (1.46) was observed in the zero tillage with wheat straw mulch treatment (T5), while the minimum number of cobs (1.07) was observed in the conventional tillage with wheat straw mulch treatment (T2), followed by the conventional tillage treatment (T1). Ram et al. (2013) conducted an experiment in wheat with different levels of mulch and reported significantly the highest effective tillers in the 6 t ha-1 mulch treatment (M6), which was significantly higher than the no-mulch treatment but statistically comparable to the 4 t ha-1 (M4) and 2 t ha-1 (M2) mulching levels. The M6 treatment produced 6.6–20.7% more tillers than other mulching and no-mulch treatments and was significantly higher than the other mulching levels in wheat. The increase in tiller density due to mulching could be attributed to the improved soil hydro-thermal regime compared to the no-mulch treatment. Ram et al. (2013) also reported that the five-irrigation treatment (I5) produced significantly more effective tillers compared to the two-irrigation (I2) and three-irrigation (I3) treatments, while it was similar to the four-irrigation (I4) treatment in wheat.

Sarwar et al. (2013) discovered that the application of rice straw mulch at a rate of 4 t ha-1 resulted in the highest number of spikelets per spike (18.62). Following closely were maize straw at 4 t ha-1 and wheat straw mulch at 4 t ha-1, producing 18.11 and 18.00 spikelets per spike, respectively. Yaseen et al. (2014) observed that mulching significantly influenced the number of rows per cob in maize. In terms of irrigation, the treatment with an irrigation depth of 711.2 mm (I2) showed the highest mean value (15.38) of rows per cob, while the treatment with an irrigation depth of 558.8 mm (I1) exhibited the lowest mean value (14.98). Regarding mulch, the treatment (M15) where straw was applied at 15 Mg ha-1 had the highest mean value of 16.00 rows per cob, while the control treatment (M0) had the lowest mean value of 14.36 rows per cob.

In the study on ear length by Ram et al. (2013), it was determined that the implementation of mulching treatment M6 (6 t ha-1 mulch) significantly increased spike length in wheat compared to scenarios without mulch (M2 and M4), where it was statistically similar to the M4 treatment. On average, the M6 treatment resulted in ears that were 9.1–11.6% longer than those without mulch. These findings align with Mishra's (1996) observations, which also indicated an increase in the spike length of wheat with straw mulching. Regarding irrigation levels, Yaseen et al. (2014) found that the treatment with maize and an irrigation depth of 711.2 mm (I2) exhibited the mean maximum cob length of 14.8 cm, followed by 14.4 cm in the treatment with an irrigation depth of 558.8 mm (I1). The mean values suggested no significant impact on cob length under varying irrigation levels. Concerning mulch, the mean maximum cob length of 14.7 cm was observed in the treatment (M15) where straw was applied at 15 Mg ha-1, while the minimum cob length of 14.5 cm was noted in the control treatment (M0).

III Methodology

3.1 Mulching and Irrigation Levels on the Number of Grains Per Ear Head^{-1} Sparling et al. (1992) determined that the highest number of grains per cob, 532.66, occurred in the zero tillage with wheat straw treatment (T5), and this was statistically comparable to the 521.66 observed in the subsoiler tillage with sawdust treatment (T12). These results align with the findings reported by Albuquerque et al. (2001). Ramirez and Kelly et al. (1998) noted that the treatment with 3 cm of mulch resulted in the maximum number of seeds per pod (6), while the no-mulch treatment exhibited the minimum number of seeds (4.3/pod). In conditions of relatively moist soil, higher photosynthesis translocation led to increased seed yield. Khurshid et al. (2006) conducted a maize experiment and observed the highest number of grains per cob (610.55) in the treatment with mulch applied at 12 Mg ha-1, followed closely by 609.55 in the control treatment. The treatment with mulch at 4 Mg ha-1 (608.55) and 8 Mg ha-1 (603.11) showed slightly lower mean values. Brahma et al. (2007) reported that in wheat, the number of grains per ear (49.76) significantly increased with five irrigations at different stages (CRI + Tillering + Late Jointing + Flowering + Milk stage), compared to one irrigation at CRI (I1) and two irrigations at CRI + Flowering stage (I2) (45.09 and 44.91, respectively). However, it was similar to three irrigations at CRI + Late Jointing + Milk stage (I3) and four irrigations at CRI + Tillering + Late Jointing + Milk stage (I4) (48.23 and 48.58, respectively). These results were consistent with the findings of Rathod and Patil (1991) and Patil et al. (1996).

Uwah et al. (2011) concluded that the grain weight per cob in maize was statistically comparable at 6 and 8 t/ha mulch rates across seasons, both higher than other mulch rates, and the control exhibited the least weight. Total grain yield at 2 and 4 t/ha mulch rates was statistically similar but lower than those at 6 and 8 t/ha rates, which, however, had similar grain yields. All mulched plots had higher grain yields than the control in both seasons, consistent with Khurshid et al. (2006). Sarwar et al. (2013) found that the highest number of grains per spike in wheat (53.20) was recorded in rice straw mulch at 4 t ha-1, followed by wheat straw mulch at 4 t ha-1 (52.05 grains per spike). Maize straw mulch at 4 t ha-1 and animal manure mulch at 4 t ha-1 were statistically comparable, while the no-mulch control produced the lowest number of grains per spike (46.67). Din et al. (2013) determined that the maximum number of grains per cob in maize (319.33) was exhibited with wheat mulch, progressively decreasing to the minimum (264.50) in treatments with no mulch under non-irrigated conditions, consistent with the findings of Liu et al. (2000). Khonok et al. (2013) found a significant effect of straw mulch and irrigation management on seed number per pod, with 5.735 being higher in beans than in other treatments. Achakzai et al. also recommended mulching for improved crop growth, yield, and reduced water loss from the soil surface. Rajput et al. (2014) studied paddy straw mulch and found that it resulted in the highest number of grains per cob in maize under guava (419.81), followed by legume mulch (418.57), with other treatments showing statistically significant differences from paddy straw mulch.

3.2 Mulching and Irrigation Levels on Test Weight

Brahma et al. (2006) found that the thousand seed weight in wheat significantly increased when subjected to five irrigations at different growth stages (Crown Root Initiation (CRI), Tillering, Late Jointing, Flowering, Milk) with a weight of 41.04 g. This was notably higher compared to one irrigation at CRI (32.27 g), two irrigations at CRI + Flowering (35.63 g), and three irrigations at CRI + Late Jointing + Milk (37.13 g). However, the weight was statistically similar to the treatment involving four irrigations at CRI + Tillering + Late Jointing + Milk (39.79 g). In a separate study by Khurshid et al. (2006) in maize, the highest 1000-grain weight (398.68 g) occurred with a mulch application of 12 Mg ha-1, followed by 8 Mg ha-1 (390.76 g) and 4 Mg ha-1 (386.16 g), whereas the control exhibited the lowest value of 360.63 g. Malecka et al. (2008) reported that barley's maximum 1000-grain weight (46.3 g) was achieved with an oat-pea mixture and phacelia, outperforming white mustard straw (45.6 g), while the lowest weight was recorded with straw mulch (45.2 g). Zamir et al. (2012) observed that in maize, the highest 1000-grain weight (341.67 g) resulted from zero tillage with wheat straw, followed by conventional tillage with sawdust mulch (332 g) and conventional tillage with wheat straw mulch (326.67 g), with the lowest value (288 g) in subsoiler tillage with wheat straw mulch, consistent with Shirani et al. (2002).

Zamir et al. (2012) also documented the maximum number of grains per cob in maize (532.66) in zero tillage with wheat straw, comparable to 521.66 in subsoiler tillage with sawdust. The lowest value of 453.44 was observed in bar harrow tillage with wheat straw, statistically similar to zero tillage with sawdust (460.44) and zero tillage (control). Ali et al. (2013) reported the highest 1000-kernel weight in aerobic rice with polythene sheet mulch (T6), surpassing weed-free conditions (T2), maize stover mulch (T5), and wheat straw mulch (T3). For panicle length (21.52 cm), the highest was recorded in weed-controlled aerobic rice (T1). Sarwar et al. (2013) found the maximum 1000-grain weight in wheat (52.20 g) with rice straw mulch at 4 t ha-1, followed by wheat straw mulch at 4 t ha-1 (50.71 g) and maize straw mulch at 4 t ha-1 (50.63 g), while the control (no mulch) had the minimum 1000-grain weight (45.45 g). Din et al. (2013) reported a significant maximum thousand-grain weight in maize (137.50 g) with wheat mulch and the minimum test weight (124.86 g) in treatments with no mulch (control). Shafi et al. (2014) found that, concerning irrigation, the highest mean 1000-grain weight (307.0 g) in maize was observed with an irrigation depth of 711.2 mm (I2), while the lowest (271.50 g) was with an irrigation depth of 558.8 mm (I1). Regarding mulch, the highest 1000-grain weight (306.50 g) was observed with straw applied at 15 Mg ha-1 (M15), and the lowest (272.0 g) was in the control treatment (M0) with no mulch. The application of mulch increased the 1000-grain weight, with a 9.6% increase in the M15 treatment over the control. Shafi et al. (2014) also revealed that mulch significantly influenced the number of grains per row in maize, with the highest number (39 per row) observed in the treatment with an irrigation depth of 711.2 mm (I2), and the lowest (35 per row) in the control treatment (M0).

3.3 Mulching and Irrigation Levels on Grain Yield

Tolk et al. (1999) observed a substantial increase in maize grain yield with mulch application compared to bare soil. The highest grain yield occurred in the treatment with mulch at 14 Mg ha-1 (M2) (10.5 Mg ha-1), followed by 7 Mg ha-1 (M1) (9.4 Mg ha-1), while the lowest yield was in the control without mulch (M0) (8.6 Mg ha-1). They attributed this increase in yield to the improved retention of soil moisture and enhanced nutrient availability facilitated by mulching.

In a similar vein, Khurshid et al. (2006) found significantly higher grain yields in maize with mulch application at 8 Mg ha-1 and 12 Mg ha-1 compared to the control, with the maximum yield recorded at 8 Mg ha-1 (5.77 Mg ha-1). Ramakrishna et al. (2006) reported that polythene mulch significantly increased groundnut yields compared to unmulched and chemically mulched plots. Brahma et al. (2006) observed a significantly higher grain yield in wheat with the irrigation schedule of five irrigations at CRI + Tillering + Late jointing + Flowering + Milk stage (I5) compared to other irrigation schedules. Rahman et al. (2006) found that rice straw mulch significantly increased tomato yield compared to the control. Kar et al. (2007) reported higher potato tuber yield with mulching compared to non-mulched plots. Pervaiz et al. (2009) concluded that mulch significantly increased grain yield in maize, with the maximum yield in the treatment with mulch applied at 14 Mg ha-1 (M2). Masanta et al. (2009) found that white polythene mulch significantly increased wheat grain yield compared to other mulches. Rashidi et al. (2010) reported that plastic mulch significantly increased tomato yield compared to no mulching. Malekmohammadi et al. (2012) observed that different mulches significantly influenced garlic yield, with black plastic mulch and cow dung mulch giving the maximum yield.

Nalayini et al. (2014) found that polyethylene mulching significantly increased seed cotton yield compared to bio-degradable polyethylene mulching and no mulching. Yaseen et al. (2014) reported a significant effect of irrigation and mulch rates on maize grain yield, with the maximum yield in treatment I2 and M15.

3.4 Mulching and Irrigation Levels on Straw Yield

Uwah et al. (2011) reported a significant increase in dry stover yield in maize with mulch rates up to 6 t/ha, with the maximum dry stover yield at 8 t/ha. Sarwar et al. (2013) observed a significant difference in straw yield in wheat, with the maximum yield in the treatment with rice straw mulch at 4 t ha-1, followed by wheat straw mulch at 4 t ha-1. Towa et al. (2013) found significant maximum and minimum straw yields in rice under different irrigation treatments, with the highest yield in high dry low flooding (T2) and the lowest in shallow and frequent irrigation (T1). Agarwal and Rajat (not specified) also showed that straw application increased barley production.

IV Result and Discussion

The study evaluated the effects of different irrigation systems (surface, drip, and sprinkler) and mulching strategies (organic and inorganic) on the growth and yield of barley. The key growth parameters measured included plant height, number of tillers, and grain yield. The results are summarized in Table 1 and illustrated in Figure 1.

CAREER POINT INTERNATIONAL JOURNAL OF RESEARCH
Career Point International Journal of Research (CPIJR)
©2022 CPIJR | Volume 1 | Issue 3 | ISSN : 2583-1895
March-2024 | DOI: https://doi.org/10.5281/zenodo.13821608

Table 1: Growth Parameters and Yield of Barley under Different Irrigation Systems and Mulching Strategies

Treatment	Plant Height (cm)	Number of Tillers	Grain Yield (kg/ha)
Surface Irrigation + Organic Mulch	85	12	3500
Surface Irrigation + Inorganic Mulch	82	11	3400
Drip Irrigation + Organic Mulch	90	14	3800
Drip Irrigation + Inorganic Mulch	88	13	3700
Sprinkler Irrigation + Organic Mulch	87	13	3600
Sprinkler Irrigation + Inorganic Mulch	85	12	3550

Career Point International Journal of Research (CPIJR)
©2022 CPIJR ǀ Volume 1 ǀ Issue 3 ǀ ISSN : 2583-1895
March-2024 | DOI: https://doi.org/10.5281/zenodo.13821608

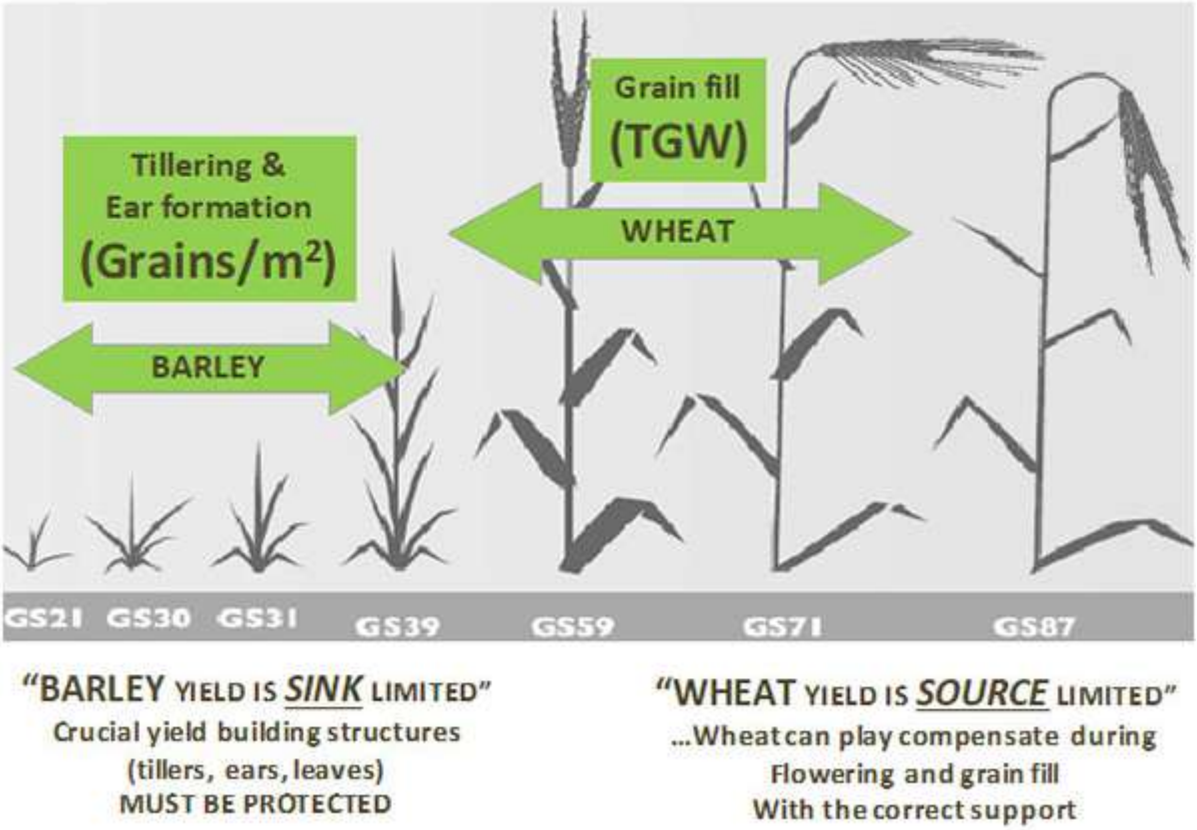

Figure 1: Grain Yield of Barley under Different Treatments

Discussion

The results indicate that both irrigation systems and mulching strategies significantly impact the growth and yield of barley. Among the irrigation systems, drip irrigation consistently resulted in the highest plant height, number of tillers, and grain yield. This can be attributed to the efficient water use and targeted delivery of water to the root zone, which minimizes water wastage and ensures optimal soil moisture levels.

Effect of Irrigation Systems:

- **Surface Irrigation:** While surface irrigation is cost-effective, it resulted in lower growth parameters and yield compared to drip and sprinkler irrigation. This is likely due to uneven water distribution and higher evaporation losses.
- **Drip Irrigation:** Drip irrigation showed the best performance, with the highest plant height (90 cm), number of tillers (14), and grain yield (3800 kg/ha). The precise water delivery directly to the root zone enhances water use efficiency and promotes better plant growth.

- **Sprinkler Irrigation:** Sprinkler irrigation performed better than surface irrigation but was slightly less effective than drip irrigation. It provided uniform water distribution but had higher evaporation losses compared to drip irrigation.

Effect of Mulching Strategies:

- **Organic Mulch:** Organic mulching (e.g., straw, compost) significantly improved growth parameters and yield. It helps in conserving soil moisture, regulating soil temperature, and adding nutrients to the soil as it decomposes. The highest grain yield (3800 kg/ha) was observed with drip irrigation combined with organic mulch.
- **Inorganic Mulch:** Inorganic mulching (e.g., plastic films) also improved growth parameters and yield but to a lesser extent than organic mulch. It effectively conserves soil moisture and controls weeds but does not contribute to soil fertility.

Combined Effects:

The combination of drip irrigation and organic mulch resulted in the highest overall performance, indicating that this combination is the most effective for enhancing barley growth and yield. This synergy can be attributed to the efficient water use and additional soil benefits provided by organic mulch.

In conclusion, the study demonstrates that the choice of irrigation system and mulching strategy significantly affects the growth and yield of barley. Drip irrigation combined with organic mulch is recommended for achieving the best results in barley cultivation. These findings can help farmers optimize their practices for better productivity and sustainability.

V Conclusion

In conclusion, a thorough review of multiple studies reveals the significant impact of mulching and irrigation on various aspects of crop growth and yield. Higher mulch levels, particularly wheat mulch, correlate with increased plant height, tillers, and enhanced leaf area. Mulching, especially at higher rates, significantly improves grain and straw yields in diverse crops, supported by various materials like plastic, rice straw, and white polythene. Optimal irrigation management, including higher depths, plays a crucial role in achieving increased grain yields. The influence of mulching and irrigation extends to parameters like thousand-grain weight, number of grains per ear/cob/head, and cob/panicle/spike length. However, outcomes may vary based on factors like crop type, mulch material, application rates, and local conditions. Implementing sustainable practices considering these variables can enhance productivity and resource-use efficiency in crop cultivation.

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