RESEARCH ARTICLE

EFFECT OF AGRONOMIC WEED MANAGEMENT PRACTICES ON GROWTH, YIELD ATTRIBUTES AND YIELD OF BARLEY (*HORDEUM VULGARE* L.)

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Abstract: A field experiment was carried out during rabi 2021-22 to study the effect of agronomic weed management practices on growth, yield attributes and yield of barley (*Hordeum vulgare* L.).The experiment was laid out in randomized complete block design with eight treatments replicated thrice. The weed control treatments comprised of weedy check, weed free, weed free for 15, 30 and 45 days and weedy up to 15, 30 and 45 days. The highest weed density (66.6 plants/m²) and weed dry weight (63.0 g/m²) were recorded in weedy check whereas, weed free recorded minimum (0.70 plants/m² and 0.70 g/m² respectively). Weedy check treatments recorded higher weed density and weed dry weight however weed free treatments recorded lower weed density and weed dry weight. Weed free for 15, 30 and 45 days and weedy upto 15 days recorded significantly lower weed index however weedy check for 30 and 45 days recorded higher weed index. The highest grain yield (45.3 q/ha) was recorded in weed free which was significantly higher than weedy check, weedy up to 15, 30 and 45 days (32.0 q/ha, 38.0 q/ha, 36.3 q/ha and 34.7 q/ha respectively) but was at par with rest of the treatments. Similar trend was also observed in growth parameters and yield attributes.

Keywords: Barley, Growth parameters, Weed, Yield attributes

INTRODUCTION

Barley (*Hordeum vulgare* L.) is one of the most important cereals of the world. Barley ranks fourth, next to maize, wheat and rice both in acreage and production. It grows well in temperate and sub tropical region of earth. Due to hardy nature, it can withstand adverse agro- climatic conditions like drought, salinity, alkalinity, varied topography like under rainfed and irrigated conditions etc. Barley grows best in well drained, moderately fertile loam or light soil. Barley grain is mostly used as feed for animals, malt, and food for human consumption. Farmers also use barley straw as animal feed in West Asia, North Africa, Ethiopia, Eritrea, Yemen, the Andes region and East Asia. In 2021, the barley production was 147.05 million metric tones. In India, barley was grown on 590 thousand hectares area producing 1720 thousand tones in 2021. In 2019-20, barley was grown in 6.2 thousand hectares in punjab with a production of 23.4 thousand tonnes and average yield of 37.81 quintals per hectare (15.30 quintals per acre).Weed management is essential for better grain yield of barley. Among different factors, efficient weed control is the key factor for successful cultivation of barley. The total annual loss of agricultural produce from various pests in India, weeds roughly account for 37%, insects for 29%, diseases for 22% and other pests for 12% (Yaduraju, 2006). Yield reduction caused by weeds is directly proportional to the number of weeds present in the crop and in certain areas of the province which this can result in losses of 10% (Paynter and Hills 2009). If the weeds are not controlled at the critical stages of crop, they may cause reduction in yield up to 66%. Weeds are the most underestimated crop pests in tropical agriculture and cause maximum loss in the yields of crops than other pests and diseases. Weeds usually pose greater problem in irrigated areas. Under normal conditions, both broadleaf and grassy weeds infest the crop. Weeds compete with crop plants for light, water and nutrients. Weed interference is one of the most important limiting factors which decrease crop yields and consequently global food production. The yield reduction in barley depends upon the type and density of associated weed flora. Among the grass weeds, wild oats can cause yield reduction in irrigated barley from 15-50% and *Chenopodium album*, *Anagallis arvensis* and *Lapidium sativa* and other broadleaf weeds also compete with crop causing reduction up to 25%.

MATERIALS AND METHODS

A field experiment was laid out during *rabi* 2021-22 at the Agriculture Research Farm, RIMT University, Mandi Gobindgarh, Punjab. The experimental site (Mandi Gobindgarh) is situatedin Punjab at 30.6642º N latitude and 76.2914º E longitude at an altitude of 268 meters above mean sea level. The maximum and minimum temperatures show several alternations during different months of the year. The average annual rainfall of Mandi Gobindgarh is 730.2 mm, about three-fourth of which is contributed by the south west monsoon during July to September. The experiment comprised of 8 treatments viz. weedy check, weed free, weed free for 15 days,weed free for 30 days, weed free for 45 days, weedy up to 15 days, weedy up to 30 days, weedy up to 45 days was conducted in randomized complete block design

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replicate thrice. The variety PL-426 was sown with seed rate of 45 kg/ha at a row to row spacing of 22.5 and plot to plot spacing of 15 cm and the plot size was 3.0 m × 1.5 m. Half dose of nitrogen (35 kg N/ha) and full dose of phosphorus (30 kg P2O5/ha) were applied as basal before sowing. Remaining doses of nitrogen (35 kg N/ha) was top dressed after 30 days of sowing. Five plants were selected randomly from each plot for taking observations. Seed, straw and biological yields were converted into quintal/hectares. Weed dry weight was recorded after drying the weed samples at 70±2°C for 48 hr. Weed density and weed dry weight were square root transformed before analysis. However, for better understanding, original values are given in parenthesis. Weed index and weed control efficiency was calculated based on the data recorded at the harvest stage of barley as per the formula as given below:

Weed Index (%) = $\frac{X-Y}{X}$ × 100

Where, X = seed yield from weed free plot.

Y = seed yield from the treated plot for which weed index is to becalculated.

Weed control efficiency = $\frac{A-B}{A}$ × 100

Where, A = weed dry weight in unweeded plot

B = weed dry weight in treated plot

RESULTS AND DISCUSSION

Weed studies at harvest

Barley was heavily infested with grassy, sedges and broad-leaved weeds. The major weed species noticed in crop field were *Rumex dentatus* (Toothed dock), *Cyperus rotundus* (Nut grass), *Phalaris minor* (Little seed canary grass), *Chenopodium album* (Goosefoot), *Melilotus indica (*Senji*), lathyrus aphaca* (Yellow pea), *Polypogon monspelienst*s (Annual beard-grass) and *Fumaria parviflora* (Fine leaf fumitory). Singh and Punia (2007) also reported similar weed species in barley.

The weed density was significantly influenced by different crop weed competition treatments (Table 1). Weedy check treatments recorded higher weed density than weed free treatments. In weed free treatment, the weeds were removed completely during the entire crop growth period. Significantly lowest weed density was observed in weed free (0.70 plants/m²). The highest weed density was recorded in weedy check (66.6 plants/m²) followed by weedy up to 45 days (43.6plants/m²), weedy up to 30 days (40.3 plants/m²), weedy up to 15 days (22.6 plants/m²), weed free for 15 days (36.6 plants/m²), weed free for 30 days (33.0 plants/m²) and weed free for 45 days (30.0 plants/m²). This is because of the heavy weed infestation in weedy check. Increased in duration of crop weed competition increased the weed density. Pala (2020) also reported higher weed density in weedy check treatments and lower weed density in weed free treatments.

The crop-weed competition treatments significantly influenced the weed dry weight (Table 1). Weed dry weight recorded in weedy check treatments are higher than weed free treatments. The weed dry weight in weed free was removed completely during the entire crop growth period. Significantly lowest weed dry weight (0.70 g/m²) was recorded in weed free treatment. Weedy check recorded the highest weed dry weight (63.0 g/m²) followed by weedy up to 45 days (39.0 g/m²), weedy up to 30 days (37.3 g/m²), weed free for 15 days (32.6 g/m²), weed free for 30 days (30.0 g/m²), weed free for 45 days (28.3 g/m²) and weedy up to 15 days (16.3 g/m²). This is because heavy weed infestation in weedy check resulted in higher weed dry weight. Higher weed dry weight in weedy check treatments and lower weed dry weight inweed free treatments were also reported by Naeem *et al.* (2021).

Weed index (WI) is the percent of yield loss caused due to weeds as compared to weedfree. Data on weed index (WI) was computed based on the maximum grain yield recorded. Higher weed index was recorded in weedy check and lower in weed free (Table 1). Weedy check recorded highest WI (29.3%). WI in weed free was recorded 0% and minimum WI wasrecorded in weed free for 45 days (7.5%).

Weed control efficiency (WCE) was compute based on the weed dry weight recorded in unweeded control. WCE was significantly influenced by crop weed competition treatments (Table 1). Among the weed management treatments, weed free throughout recorded 100% WCE. Higher WCE was recorded in weedy up to 15 days (74.1%), weed free up to 45 days (55.0%),weed free up to 30 days (52.3%) and lower WCE were recorded in weed free for 15 days (48.2%), weedy up to 30 days (40.7%) and weedy up to 45 days (38.0%). This is because high weed population leads to lower WCE and less weed population leads to higher WCE.

Growth parameter

At harvest, barley plant height recorded significantly influenced by agronomic weed management practices. Weed free treatments recorded higher plant height and weedy check treatments recorded lower plant height (Table 2). The highest plant height was observed in weed free (89.0 cm) which was at par with weed free for 30 days (85.0 cm) and weed free for 45 days (86.0 cm) but was significantly higher than the rest of the treatments. The growth of plants was suppressed by weeds resulting in less plant height in weedy check treatments than weed free treatments. Kebede *et al*. (2017) also recorded highest plant height in weed free and lowest plant height in weedy check.

At harvest, agronomic weed management practices significantly influenced the number of tillers per meter row length. Weed free treatments recorded higher number of tillers per meter row length and weedy check treatments recorded lower number of treatment per meter row lenght (Table 2). Highest number of tillersper meter row length was recorded in weed free (76.6) which was at per with weed free for 15 days (65.5), weed free for 30 days (67.0) and weed free for 45 days (68.0) but was significantly higher thanweedy check (48.3), weedy up to 15 days (62.0), weedy up to 30 days (60.3) and weedy up to45 days (58.0). Lowest number of tillers per meter row length was observed in weedy check (48.3). The probable reason for higher number of tillers per meter row length in short competition durations was theless time available for competition of resources between crop and weeds.

Yield attributes

Agronomic weed management practices significantly influenced the spike length of barley (Table 3). Spike length was longer in weed free treatments and shorter in weedy check treatments. Longest spike length was observed in weed free (10.0 cm) which was at par with weed free for 15 days (8.0 cm), weed free for 30 days (8.6 cm) and weed free for 45 days (9.0 cm) but was significantly higher than weedy check (6.7 cm), weedy up to 15 days (7.5 cm), weedy up to 30 days (7.0 cm) and weedy up to 45 days (6.9 cm). Shortest spike length was observed in weedy check (6.7 cm). Heavy weed infestation and heavy competition between crop and weed in weedy check treatments resulted in shorter spike length and vice versa. Singh and Bajpai (1992) reported that longer spike length was observed in weed free treatments and shorter spike length was observed in weedy check treatments

The weed management treatments significantly influenced the number of grains perspike. The results of number of grain per spike as influenced by weed management treatments are presented in (Table 3). Weed free treatments recorded higher number of grain per spike and weedy checktreatments recorded lower seeds number of grains per spike. Highest number of grains per spike was recorded in weed free (65.0) and lowest in weedy check (51.0). Heavy competition between crop and weed in weedy check treatments reduced the number of grains per spike and less competition between crop and weed in weed free treatments increased the number of grain per spike.

The agronomic weed management technique significantly influenced the 1000 grain weight. The data regarding 1000 grains weight is presented in (Table 3). Weed free treatments recorded higher 1000 grain weight (44.0 g) and weedy check treatments recorded lower 1000 grain weight (35.7 g). Among the crop-weed competition treatments, the 1000 grain weight was highest in the weed free (44.0 g) which was at par with weed free for 30 days (42.2 g) and weed free for 45 days (43.0 g) but was significantly higher than the rest of the treatments. Lowest 1000 grain weight was recorded in weedy check (35.7 g).

Agronomic weed management practices significantly influenced the number of effective tillers per meter row length (Table 3). The highest effective tillers per meter row length was observed in weed free (70.0) but was significantly higher than the rest of the treatments. The lowest effective tiller was recorded in weedy check (45.0). Heavy competition between crop and weed in weedy check treatments reducedthe number of effective tillers per meter row length and less competition between crop and weed in weed free treatment increased the number of effective tillers per meter row length. Kumar *et al.* (2019) also reported lowest number of effective tillers in weedy check treatment.

Yield

The grain yield was significantly influenced by the agronomic weed management practices. Higher grain yield was recorded in weed free treatments and lower grain yield was recorded in weedy check treatments (Table 3). The highest grain yield was recorded in weed free (45.3 q/ha) which was at par with weed free for 30 days (41.0 q/ha) and weed free for 45 days (41.9 q/ha) but was significantly higher than weedy check (32.0 q/ha), weed free for 15 days (39.0 q/ha) weedy upto 15 days (38.0 q/ha), weedy up to 30 days (36.3 q/ha) and weedy up to 45 days (34.7 q/ha). Higher seed yield in weed free treatments could be ascribed to better control of weeds which favored higher uptake of nutrients and water resulting optimum growth characters. Further, it might have enhanced photosynthetic activity and assimilates resulting in improvement of yield. These findings were in close conformity with Meena *et al.* (2021).

The agronomic weed management technique significantly affected the straw yield. Higher straw yield was recorded in weed free treatments and lower in weedy check treatments (Table 3). Weed free recorded highest straw yield (60.0 q/ha) which was at par with weed free for 15days (54.0 q/ha), weed free for 30 days (56.0 q/ha) and weed free for 45 days (56.6 q/ha) but was significantly higher than the rest of the treatments viz. weedy check (48.0 q/ha), weedy up to 15 days (53.3 q/ha), weedy up to 30 days (52.0 q/ha) and weedy up to 45 days (50.0 q/ha).The lowest straw yield was recorded in weedy check (48.0 q/ha). Same as in grain yield, higher straw yield in weed free treatments could be ascribed to better control of weeds which favored higher uptake of nutrients and water. Highest straw yield in weed free treatment and lowest straw yield in weedy check treatment were also reported by Girma (2019).

The biological yield was significantly affected by the weed management practices (Table 3). Higher biological yield was recorded in weed free treatments and lower in weedy check treatments. Weed free recorded highest biological yield (105.3 q/ha) which was at par with weed free for 15 days (93.0 q/ha), weed free for 30 days (97.0 q/ha) and weed free for 45days (98.5 q/ha) but was significantly higher than the rest of the treatments viz. weedy check (80.0 q/ha), weedy up to 15 days (91.3 q/ha), weedy up to 30 days (88.3 q/ha) and weedy up to 45 days (84.7 q/ha). The lowest biological yield was recorded in weedy check (80.0 q/ha). Same as in grain yield, higher biological yield in weed free treatments could be ascribed to better control of weeds which favoured higher uptake of nutrients and water.

The agronomic weed management practices failed to influence the harvest index of barley (Table 3). Harvest index is higher in weed free treatments and lower in weedy check treatments. Among the crop weed competition treatments, weed free recorded highest harvest index (43%) followed by weed free for 45 days (42.5 %), weed free for 30 days (42.2 %), weed free for 15 days (41.9 %), weedy up to 15 days (41.6 %), weedy up to 30 days (41.1 %), weedyup to 45 days (40.9 %) and weedy check (40.0 %). Weedy check recorded lowest harvest index (40.0 %). Increased in harvest index might be due to the increased number of grain yield and straw yield.

Table 1. Effect of crop weed competition on weed parameters.
Data were subjected to square root (√x + 0.5) transformation and the figures in parentheses aretheoriginal values.

Treatments	**Weed density(plants/m²)**	**Weed dry weight (g/m²)**	**Weed control Efficiency (%)**	**Weed Index (%)**
T_1 weedy check	8.20(66.6)	7.97(63.0)	0	29.3
T_2 weed free	0.70(0.0)	0.70(0.0)	100	--
T_3 weed free up to 15 days	6.10(36.6)	5.76(32.6)	48.2	13.9
T_4 weed free up to 30 days	5.79(33.0)	5.52(30.0)	52.3	9.4
T_5 weed free up to 45 days	5.53(30.0)	5.36(28.3)	55.0	7.5
T_6 weedy up to 15 days	4.81(22.6)	4.09(16.3)	74.1	16.1
T_7 weedy up to 30 days	6.39(40.3)	6.15(37.3)	40.7	19.8
T_8 weedy up to 45 days	6.64(43.6)	6.28(39.0)	38.0	23.3
C.D at 5%	**3.38**	**4.07**	**--**	**--**

Table 2. Effect of agronomic weed management practices on growth parameters of barley.

Treatments	**Plant height (cm)**	**Number of tillers per meter row length**
	At harvest	**At harvest**
T_1 weedy check	77.9	48.3
T_2 weed free	89.0	76.6
T_3 weed free up to 15 days	84.0	65.3
T_4 weed free up to 30 days	85.0	67
T_5 weed free up to 45 days	86.0	68
T_6 weedy up to 15 days	82.0	62
T_7 weedy up to 30 days	80.0	60.3
T_8 weedy up to 45 days	79.0	58
C.D at 5%	**6.72**	**6.69**

Table 3. Effect of agronomic weed management practices on yield attributes and yield of barley.

Treatments	**Effective tillers per meter row length**	**Spike length (cm)**	**No. of grains per spike**	**1000 grain weight (g)**	**Grain yield (q/ha)**	**Straw yield (q/ha)**	**Biological yield (q/ha)**	**Harvest Index (%)**
T_1 weedy check	45.0	6.7	51.0	35.7	32.0	48.0	80.0	40

T_2 weed free	70.0	10.0	65.0	44.0	45.3	60.0	105.3	43.0
T_3 weed free up to 15 days	61.0	8.0	60.0	41.0	39.0	54.0	93.0	41.9
T_4 weed free up to 30 days	62.0	8.6	61.5	42.2	41.0	56.0	97.0	42.2
T_5 weed free up to 45 days	60.6	9.0	63.0	43.0	41.9	56.6	98.5	42.5
T_6 weedy up to 15 days	58.0	7.5	59.0	40.5	38.0	53.3	91.3	41.6
T_7 weedy up to 30 days	55.6	7.0	57.5	39.6	36.3	52	88.3	41.1
T_8 weedy up to 45 days	53.0	6.9	55.5	38.3	34.7	50.0	84.7	40.9
C.D at 5%	**8.51**	**1.37**	**6.35**	**4.81**	**5.38**	**6.59**	**8.715**	**NS**

CONCLUSION

It may be concluded that higher grain yield of barley crop can be obtained by removing weeds at proper time and in right manner. Weeds affect the crop more when the crop were young. Among various treatments, weed free for 45 days recorded higher yield. Therefore, in order to get higher yield, barley crop must keep weed free during the period of up to 45 days after sowing.

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