Intercomparison of different Agrochemicals (Herbicides) and manual methods of weed control on weed population and weed control efficiency in wheat (*Triticum aestivum* L.)crop in Himachal Pradesh district Mandi

ABSTRACT

Aims: A research study entitled Intercomparison of different Agrochemicals (Herbicides) and manual methods of weed control on weed population and weed control efficiency in wheat crop (*Triticum aestivum* L.)in Himachal Pradesh district Mandi.

Study design: The experiment was designed using a Randomized Block design method.

Place and duration of study: Department of agronomy, School of Agriculture, Abhilashi university, Chail Chowk, Mandi, (H.P.) during the *Rabi* season of 2022-23.

Methodology: The field trail was conducted with eight treatments and replicated thrice. The investigation included eight different weed control techniques *i.e*. T_1-weedy check, T_2 - weed free, T_3 - hand weeding at 30 DAS, T_4 - 2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS,T_5-Pendimethalin @ 1.5 kg a.i. ha^{-1}(P.E) + Quizalofop-ethyl @ 50 gm a.i ha^{-1}(PoE at 25 DAS) +one hand weeding, T_6- 2, 4-D @ 0.5 kg a.i. ha^{-1}, T_7 - 2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS**,** T_8- 2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS.

Results: The investigation found that the most effective ways to control weeds are by keeping the area completely weed free by usingpendimethalin @ 1.5 kg a.i. ha^{-1}(P.E) + Quizalofop-ethyl @ 50 gm a.i ha^{-1}(PoE at 25 DAS) + one Hand weeding(Treatment T_2) was found the most successful in terms of achieving the lowest weed density and highest weed control efficiency. Application of pendimethalin @ 1.5 kg a.i. ha^{-1}(P.E) + Quizalofop-ethyl @ 50 gm a.i ha^{-1}(PoE at 25 DAS) + one hand weedingwas found to be better than using herbicides to reduce weed infestation in wheat crops.

Conclusion: Based on the results, it can be concluded that integrated weed managementpractices weed-free treatment was the most effective option for managing weeds in wheat.

Key words:wheat,*weed population, weed control efficiency and weed control*.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important winter cereal of India. However, at present, this crop has become a staple food crop next to rice and its consumption is gradually increasing because of change in food habit and economic prosperity.Wheat is an important source of carbohydrates, it also contains 12% protein, 60-68% starch, 1.5-2.0% fat, 2.0-2.5% cellulose, 1.8% minerals. The uniqueness of wheat is different to other cereals i.e. wheat contains gluten protein that's enables leavened dough to arise by forming very small gas cells and this property of wheat enables bakers to produce lighted breads. In India the whole meal wheat (atta) is chiefly used for making chapatis, parathas and poories. Wheat is also used in making many kinds of breads, cakes, cookies, pancakes, noodles, piecrust, ice-cream cones, pizza, burger and other baby foods. Wheat sowing time varies from October to December with temperature range of 10 to 32^0 C. In life cycle of wheat all stages of development are sensitive to temperature (Satbhai et al. 2016).

Heavy weed infestation is a major recognized bottleneck in reducing the yield potential of wheat. The weed competition became serious in wheat growing areas with the introduction and large area adoption of high- yielding dwarf varieties areas with the introduction and large area adoption of high yielding dwarf varities in India. Wheat is generally infested with diverse kind of weed flora including broad and narrow leaf weeds. It results in 20-40% average reduction in grain yield (Kumar et al.2010). Many production factors affect yield and productivity of wheat but among them, weeds are considered a serious threat as they compete with crops for growth factors (Najwa et al. 2012), and in absence of an effective control measures, weeds remove a considered quantity of applied nutrients and water which results in higher crop yield loss (Sharma and Singh, 2011). The heavy infestation with complex weed flora in wheat has become a serious threat in increasing the yield and productivity. Thus, a suitable combination of new herbicides like sulfosulfuron, metsulfuron, fenoxaprop, clodinafop, and metribuzin, reported to be very effective against associated weed species in wheat crop (Verma et al. 2015), is required for effective broad-spectrum control of weeds (Pal et al. 2016) as continuously rely on single herbicide to a longer period not only results herbicidal resistant but also creates weed shifts. In addition to herbicide combinations, cultural practices, being economical and ecofriendly (Sharma and Singh, 2011), also play a significant role in weed suppression particularly during the initial stages or crop establishment. Again, weeds have a habit to shift with the alteration in tillage, agronomic management, and cropping system although there are other factors that govern the alterations in the weed flora. Although being a serious problem in crop field, this problem always remains under-estimated although they cause higher reduction in economic yield of crops than other pests and diseases. The critical period of crop weed competition is 11- 21 days after crop emerged (Galon et al. 2019) and reduction of grain yield in late sown wheat was reported up to 34.3% due to mixed weed flora (Meena et al. 2017).

Integrated weed management (IWM) involves deployment of different methods of weed prevention and control in right proportion and at appropriate time against the target weeds (Gupta et al. 2008**)**. Popular of the research in India on integrated weed management was herbicide-based. However, majority of the farmers have not been benefitted by herbicides in India. Herbicides must be made economically and ecologically affordable to farmers by creatively integrating with other components of integrated weed management. Usage of some herbicides has led to development of resistant weeds and has worsened weed problems. For example, in rice-wheat cropping system of Punjab and Haryana, Phalaris minor (Wild oat) has developing resistance against isoproturon.The productivity and quality of wheat depends on the environmental conditions and the agronomic practices especially sowing time and weed management strategies which play a significant role in achieving higher productivity of wheat crop. Yield potential of wheat is not being exploited fully on account of many biotic and abiotic factors. Among various factors, sowing time and weeds infestation are the most important constraints which affect crop productivity. Drastic reduction in yield of wheat has been recorded with the delay of sowing beyond optimum time. It has been estimated that timely sowing of wheat is of utmost importance for obtaining higher yield and productivity (Mukherjee, 2012).

2 Material and Methods

A research project titled "Intercomparison of different Agrochemicals (Herbicides) and manual methods of weed control on weed population and weed control efficiency in wheat crop (*Triticum aestivum* L.)in Himachal Pradesh district Mandi" was conducted during the *Rabi* season of 2022-23 at the Research farm of School of Agriculture, Abhilashi University Mandi (H.P.) India. The experimental farm is located at 30□32’N latitude and 74□53’E longitude, with an elevation of 1391m above mean sea level. The soil has a slightly acidic reaction with apH of 5.64, an electrical conductivity of 0.33 and organic carbon of 0.33. The available nitrogen (251.51) and available phosphorus (18.25) was low, while available and potassium (208.02) are medium. The net plot size was 3.0 × 1.5m and the gross plot size was 4.0m × 2.5 m. The observation was recorded at 30, 60, 90 DAS and at harvest on growth studies,yield attributes and yield studies.IncludingPlant height (cm), Number of tillers (m^{-2})andDry matter accumulation (gm^{-2}), No. of effective tillers (m^{-2}), Length of spike (cm), No. of grains $spike^{-1}$ and Test weight,Grain yield, Straw yield (q ha^{-1}), Biological yield (q ha^{-1}) and Harvest Index.Thewheat cultivar variety PBW-343 was sown manually in rows with a spacing of 20cm and a seed rate of 100 kg ha^{-1}. The experimental design was a randomized block design (RBD) with eight treatments and three replications. The treatments, viz.,T_1-weedy check, T_2 - weed free, T_3 - hand weeding at 30 DAS, T_4 - 2, @ 4-D 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS,T_5-Pendimethalin @ 1.5 kg a.i. ha^{-1}(P.E) + Quizalofop-ethyl @ 50 gm a.i ha^{-1}(PoE at 25 DAS) + one hand weeding, T_6- 2, 4-D @ 0.5 kg a.i. ha^{-1}, T_7 - 2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DASandT_8- 2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS.Pendimethalin, Sulfosulfuron, Quizalofob-ethyl 2,4-D were applied according to their respective treatments. No weed management was performed in the T_1 treatment (weedy check).

3. Result and discussion

3.1Growth studies

3.1.1Plant height (cm)

Wheat plant height measurements at 30, 60, 90, and at harvest are shown in Table1 and are depicted in fig.1. The findings showed that, with the exception of 30 DAS, weed management techniques had a substantial impact on plant height at all phases of crop growth. Treatment T_2 (weed free) produced significantly higher plants (65.87, 95.57, and 103.80 cm) at 60, 90 DAS and at harvest, which was comparable to treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1} plus two hand weeding at 30 and 45 DAS). In the meantime, treatment T_1 (weedy check) had the lowest plant height measured throughout the entire growth stage (20.14, 39.74, 60.78, and 74.21 cm). The reason for the reduction in plant height in weedy check is that excessive weed growth completely outcompetes crop plants, perhaps resulting in crop development that is not as fast as it could be, which in turn limits vertical crop growth. Treatments for weed management raised plant height and improved crop growth factors' availability. Meena and Singh (2011), Jat et al. (2009), and Pandey and Kumar (2005)all reported similar findings.

Table 1 Effect integrated weed management practices on plant height (cm) of wheat crop

Sr. no.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
T_1	Weedy check	20.14	39.74	60.78	74.21
T_2	Weed free	25.19	65.87	95.57	103.80
T_3	Hand weeding at 30 DAS	22.41	53.55	80.29	92.29
T_4	2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS	22.10	48.97	78.74	88.23
T_5	Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + quizalofop-ethyl 50 gm a.i ha^{-1} (PoE at 25 DAS) + one hand weeding	23.67	58.78	85.21	97.54
T_6	2, 4-D @ 0.5 kg a.i. ha^{-1}	21.83	45.59	76.89	83.81
T_7	2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS	22.92	55.35	82.40	93.72

T_8	2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS	24.97	63.73	90.25	101.78
SEm±		1.03	1.48	2.82	1.52
CD (P= 0.05)		NS	4.54	8.65	4.65

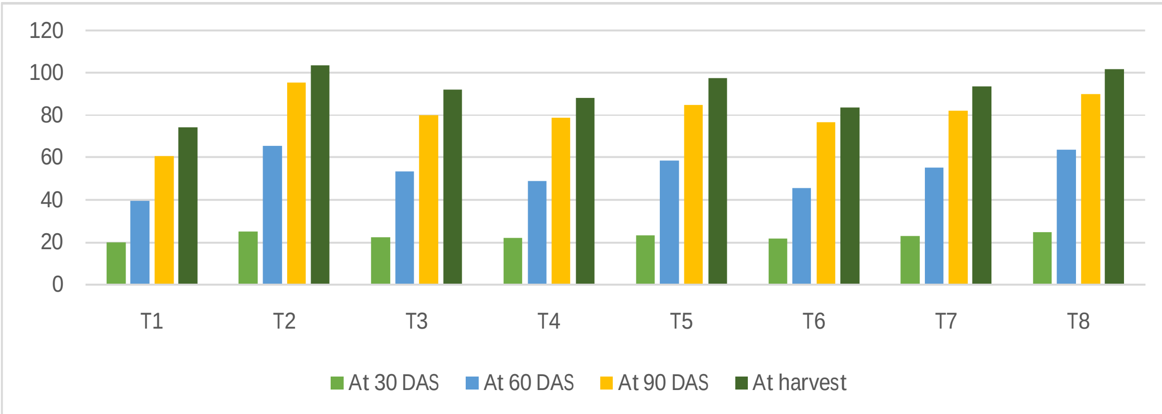

Fig- 1Effect integrated weed management practices on plant height (cm) of wheat crop

3.1.2 Number of tillers (m^{-2})

The number of wheat tillers that were counted at 30, 60, 90 DAS, and at harvest are shown in Table-2 and fig-2. The findings showed that, with the exception of 30 DAS, weed control techniques have a significant impact on the quantity of tillers at all crop growth stages. At 60, 90 DAS and at harvest stage, treatment T_2 (weed free) had the highest number of tillers (371.20, 400.19, and 380.17 m-^{2}) compared to treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1}) (365.10, 390.33 and 375.19 m^{-2}). Under treatment T_1 (weedy check), the fewest tillers (186.15, 210.29, and 195.20 m^{-2}) were noted during the study.T_5 Pendimethalin 1.5 kg a.i. ha^{-1}(P.E) + Quizalofop-ethyl 50 gm a.i ha-^{1}(PoE at 25 DAS) + one hand weeding, T_7 (2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS), and T_3 (Hand weeding at 30 DAS) were the herbicidal treatments with the highest number of tillers. The greatest number of tillers m^{-2} may have been attained as a result of improved nutrient availability and decreased crop weed competition. Additionally documented by Bibi et al. (2008) andPisal et al. (2013).

Sr. no.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
T_1	Weedy check	50.21	186.15	210.29	195.20
T_2	Weed free	60.27	371.20	400.19	380.17
T_3	Hand weeding at 30 DAS	55.25	347.17	368.26	355.13
T_4	2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS	54.18	325.20	351.33	335.25
T_5	Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + quizalofop-ethyl 50 gm a.i ha^{-1} (PoE at 25 DAS) + one hand weeding	57.32	355.38	382.48	364.15

T_6	2, 4-D @ 0.5 kg a.i. ha^{-1}	52.30	315.23	333.67	325.16
T_7	2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS	58.14	347.24	374.25	356.12
T_8	2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS	60.15	365.10	390.33	375.19
SEm±		4.83	2.25	4.07	4.07
CD (P= 0.05)		NS	NS	12.46	14.40

Table. -2 Effect of integrated weed management practices on number of tillers (m^{-2}) of wheat crop

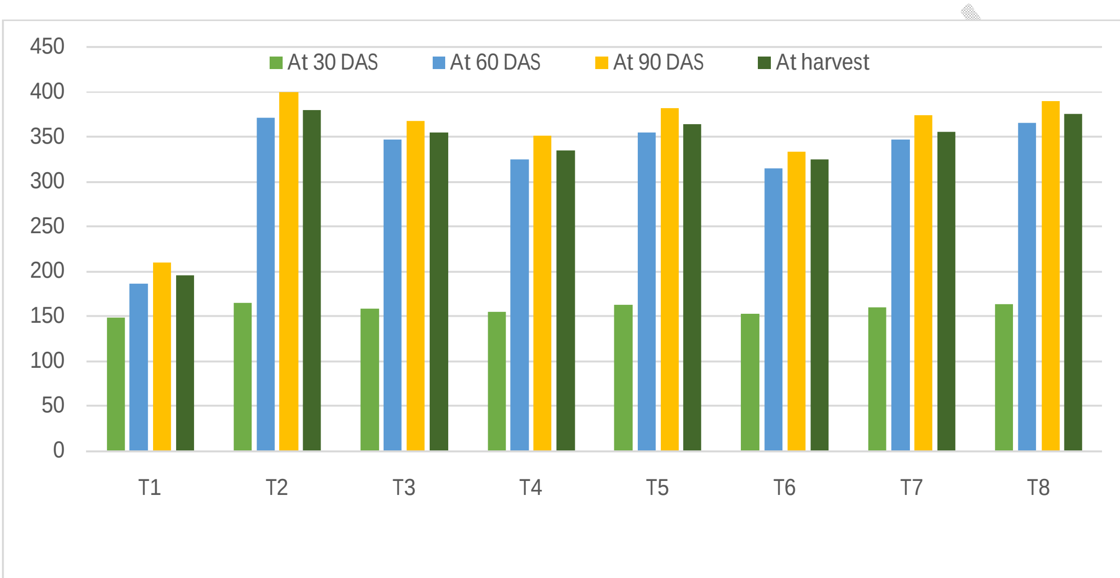

Fig.-2 Effect of integrated weed management practices on number of tillers (m^{-2}) of wheat crop

3.1.3 Dry matter accumulation (gm^{-2})

Wheat dry matter accumulation was measured at 30, 60, 90, and at harvest. The results are shown in Table-3 and Fig-3. The data showed that weed management techniques significantly affect dry matter accumulation at all crop growth stages, with the exception of 30 DAS.Treatment T_2 (weed free) showed increased dry matter accumulation at 60 and 90 DAS, comparable to treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1} + hand weeding at 30 and 45 DAS) over other treatments. Under treatment T_1, the lowest dry matter accumulation was observed (weedy check).This may be explained by plants growing in less weedy environments producing more food materials. Paswan and Kumar (2012) have also reported increase in dry matter production with herbicides as compare to weedy check. Also reported by Pandey and Dwivedi (2007).

Table. -3 Effect of integrated weed management practices on dry matter accumulation (gm^{-2}) of wheat crop

Sr. no.	Treatments	30DAS	60DAS	90DAS	At harvest
T_1	Weedy check	57.81	345.37	551.87	785.76
T_2	Weed free	64.78	501.73	745.03	1008.87

T_3	Hand weeding at 30 DAS	60.83	401.81	618.64	901.38
T_4	2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS	59.15	389.78	594.28	871.53
T_5	Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + quizalofop-ethyl 50 gm a.i ha^{-1} (PoE at 25 DAS) + one hand weeding	62.81	456.77	685.20	951.07
T_6	2, 4-D @ 0.5 kg a.i. ha^{-1}	58.73	368.80	579.43	837.74
T_7	2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS	61.11	421.86	641.32	925.81
T_8	2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS	63.92	482.45	721.23	985.12
SEm±		1.57	6.70	8.08	13.26
CD (P= 0.05)		NS	20.52	24.75	40.63

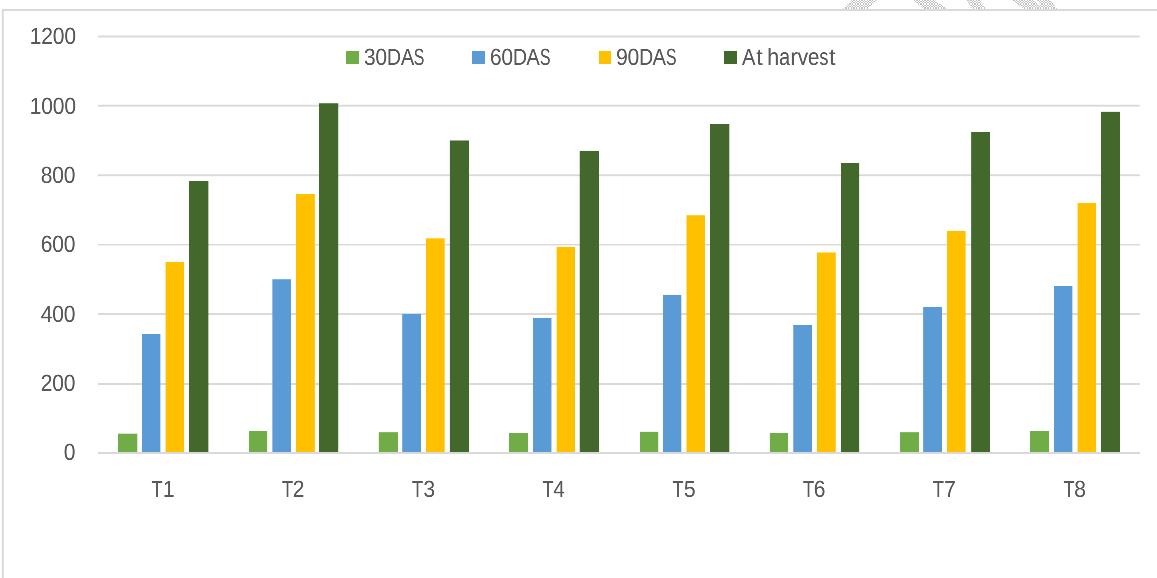

Fig. -3 Effect of integrated weed management practices on dry matter accumulation (gm^{-2}) of wheat crop

3.2 Yield attributes

The yield parameters, which include the number of effective tillers, spike length, grain per spike, and test weight, have been recorded and are displayed in Table 4 and Fig. 4.

3.2.1No. of effective tillers (m^{-2}),Length of spike (cm) and No. of grains $spike^{-1}$

The number of effective tillers (m^{-2}), length of the spike and number of grain $spike^{-1}$was shown to be considerably impacted by the weed management approaches. The treatment T_2 (weed free) yielded the greatest number of effective tillers,have maximum spike length (12.7 cm) and highest no of grain per spike which was on par with T_8 (2, 4-D 0.5 kg a.i. ha^{-1} + two manual weeding at 30 and 45 DAS), while T_1 (weedy check) produced the fewest effective tillers, minimum spike length and lesser grain per spike.The treatment T_5 (pendimethalin @ 1.5 kg a.i. ha-1 (P.E) + quizalofop-ethyl 50 gm a.i $ha-^{1}$ (PoE at 25 DAS) + one hand weeding) produced the longest spike length among the integrated weed control methods, which was followed by T_7 (2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS) and T_3 (Hand weeding at 30 DAS).

3.2.2 Test weight

The weed management techniques had no discernible impact on test weight. The treatment weed free yields the maximum test weight of 42.20, whereas the weedy check yields the minimum. The outcome of a plant's vegetative and reproductive development is its yield qualities.

With weed control techniques over weed check, all the yield parameters, such as effective tillers m^{-2} and grain $spike^{-1}$, rose dramatically. This could be because there were more nutrients, moisture, spaces, and lights available, which led to the plants' improved growth and development. Similar results are also illustrated by Singh (2011).In Junagadh, Gujarat, Pisal and Sagarka (2013) found that pre-emergence treatment with pendimethalin (0.9 kg ha^{-1}) resulted in a significantly higher number of effective tillers, spikelets per spike, and grain weight per plant when weed free conditions were observed compared to weedy check conditions.According to Meena and Singh (2011), 2, 4-D.Na. Salt @ 625g ha^{-1} was found to be effective on plant height, ear head length, and comparison to a weeded check. as 2, 4-D was applied to wheat, there were 24.5% more productive tillers m-2, 3.4% longer spikes, and 7.2% more full grains/panicle with greater grain (31.4%) and straw (31.4%) yields as compared to the weedy control (Surin et al., 2013). Comparing metribuzin to farmer practice, there was a beneficial impact on plant height, effective tiller m^{-2}, spikelet number ear^{-1}, and ear length (Singh et al., 2010).

Table-4 Effect of integrated weed management practices on yield attributes of wheat crop

Sr. No.	Treatments	No. of effective tillers (m^{-2})	Spike length (cm)	Grains per spike	Test weight (g)
T_1	Weedy check	185.29	7.21	31.28	37.11
T_2	Weed free	378.19	12.72	42.94	41.97
T_3	Hand weeding at 30 DAS	345.26	10.19	34.90	40.92
T_4	2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS	329.33	9.88	33.84	39.64
T_5	Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + quizalofop-ethyl 50 gm a.i ha^{-1} (PoE at 25 DAS) + one hand weeding	358.48	11.02	38.52	41.12
T_6	2, 4-D @ 0.5 kg a.i. ha^{-1}	309.67	9.64	32.90	38.93

T_7	2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS	351.25	10.21	36.31	41.85
T_8	2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS	368.32	12.52	40.97	41.09
SEm±		4.22	0.12	0.83	1.44
CD (P= 0.05)		12.94	0.38	2.55	NS

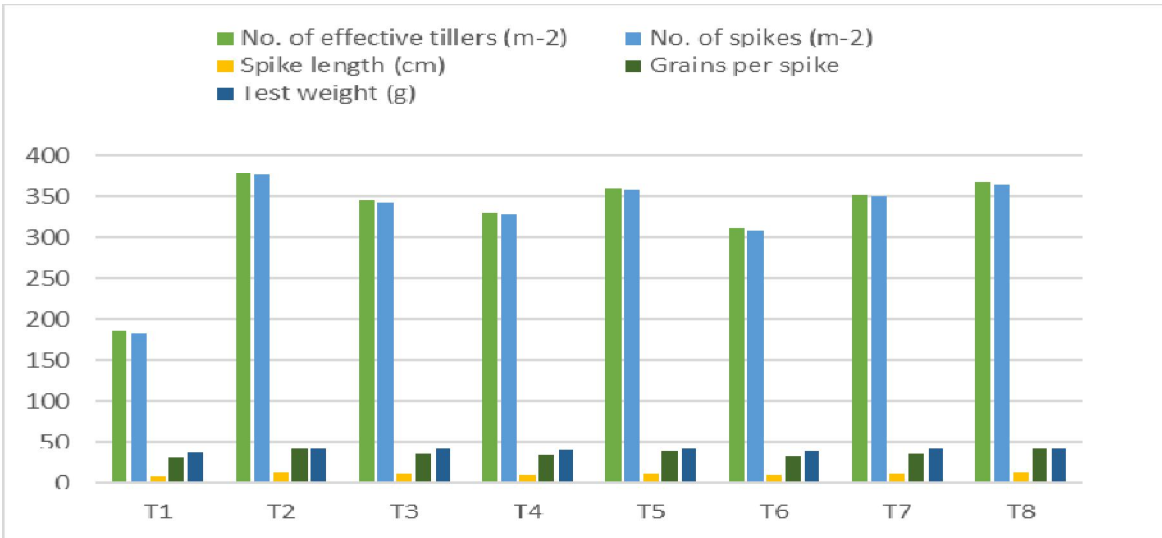

Fig-4 Effect of integrated weed management practices on yield attributes of wheat crop

3.3 Yield studies

The data pertaining to the grain yield, straw yield, biological yield and harvest index were presented in Table-5 and depicted in Fig.5.

3.3.1Grain yield

The findings of the study demonstrated a considerable impact of weed management strategies on the wheat crop's grain production. The maximum grain yield of 45.08 q ha^{-1} was achieved by the weed-free treatment T_2, which was significantly greater than the other treatments and statistically comparable to treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS). The treatment T_1 (weedy check) had the lowest grain (30.49 q ha^{-1}) during the experiment.Because the related weed management tactics decreased weed growth and provided the crop with additional space, nutrients, and canopy interception—all of which boosted food translocation from source to sinkthey also increased grain output. In addition to a single hand weeding 30 days after sowing, the crop treated with post-emergence application of isoproturon + 2,4-D @ at 0.5 kg a.i. ha^{-1} saw a significant increase in grain production as well as a decrease in weed population and dry matter in the wheat crop (Chandra et al. 2018). In contrast to the other treatments, the weed-free environment yielded the highest yield. Malik et al. (2013) and Tomar and Tomar (2014) reported nearly identical findings.

3.3.2Straw yield (q ha^{-1})

In comparison to the weedy control, the data show that the weed control techniques had a substantial impact on the straw yield. During the experiment, treatment T_2 (weed free) produced the highest straw production, which was significantly on par with treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS). Treatment T_1 (weedy check) produced the lowest straw yield. Compared to alternative weed management techniques, these results imply that efficient weed control produced superior growth characteristics and yield attributes, which in turn produced a larger straw yield. Tomar and Tomar (2014) and Malik et al. (2013) have also published findings that are similar.

4.2 Biological yield (q ha^{-1})

The findings demonstrate that biological yield was significantly impacted by weed control techniques. Weed-free plots (T_2) produced the maximum biological output, matching treatment T_8 (2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 & 45 DAS), which was followed by T_5, $T_7$and T_4. However, treatments T_1, T_6, and T_3 had the lowest biological yields that were noted. This could be the result of more growth and development leading to a higher biological yield as a result of treatment enhancement or successful weed control. In comparison to the weedy check plot, which recorded the lowest biomass output, these treatments produced 72.9, 71.7, and 55.4 percent more biomass yield (Mukherjee, 2018). Similar findings were published in 2014 by Tomar and Tomar, Malik et al. (2013), and Mukherjee, D. (2018).

4.2Harvest Index

The outcomes demonstrated that the harvest index was not significantly impacted by the weed management methods. Nevertheless, throughout the experiment, the lowest harvest index (39.88%) was found with treatment T_5, while the maximum (41.29%) was recorded in the weedy check treatment (T_1). T_3, T_6, and T_4 (41.08%, 41.07%, and 40.72%) recorded the greatest harvest index during the experiment, among the other treatments. The inhibition of weed growth, which increased the amount of plant nutrients available for the wheat crop, is probably the cause of this increase in the harvest index.Better grain yield formation resulted from this improved photosynthetic yield use. The best percentage of harvest index was obtained with the sencor @ 250 g ha^{-1} + one interculture (T_7) treatment (Sharda R. and Fayaz A. 2021). Similar outcomes were reported by Riaz et al. (2006), who observed that interculture activities combined with herbicide application at the 2-3 leaf stage of weeds, followed by hand weeding after 50 days of crop seeding, resulted in a higher harvest index (35%).

Table-5 Effect of integrated weed management practices on grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) of wheat crop

Sr. No.	Treatments	Yield (q ha^{-1})			Harvest index (%)
		Grainyield	Straw yield	Biological yield	
T_1	Weedy check	30.49	43.35	73.84	41.29
T_2	Weed free	45.08	67.52	112.60	40.04
T_3	Hand weeding at 30 DAS	40.69	58.36	99.06	41.08
T_4	2, 4-D @ 0.5 kg a.i. ha^{-1} + Sulfosulfuron @ 0.02 kg a.i. ha^{-1} at 30 DAS	41.22	60.02	101.24	40.72
T_5	Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + quizalofop-ethyl 50 gm a.i ha^{-1} (PoE at 25 DAS) + one hand weeding	42.27	63.71	105.98	39.88
T_6	2, 4-D @ 0.5 kg a.i. ha^{-1}	36.18	51.92	88.10	41.07
T_7	2, 4-D @ 0.5 kg a.i. ha^{-1} + one hand weeding at 30 DAS	41.54	61.21	102.75	40.43
T_8	2, 4-D @ 0.5 kg a.i. ha^{-1} + two hand weeding at 30 and 45 DAS	43.65	64.84	108.49	40.23
SEm±		0.90	0.95	1.77	0.31
CD (P= 0.05)		2.77	2.81	5.44	NS

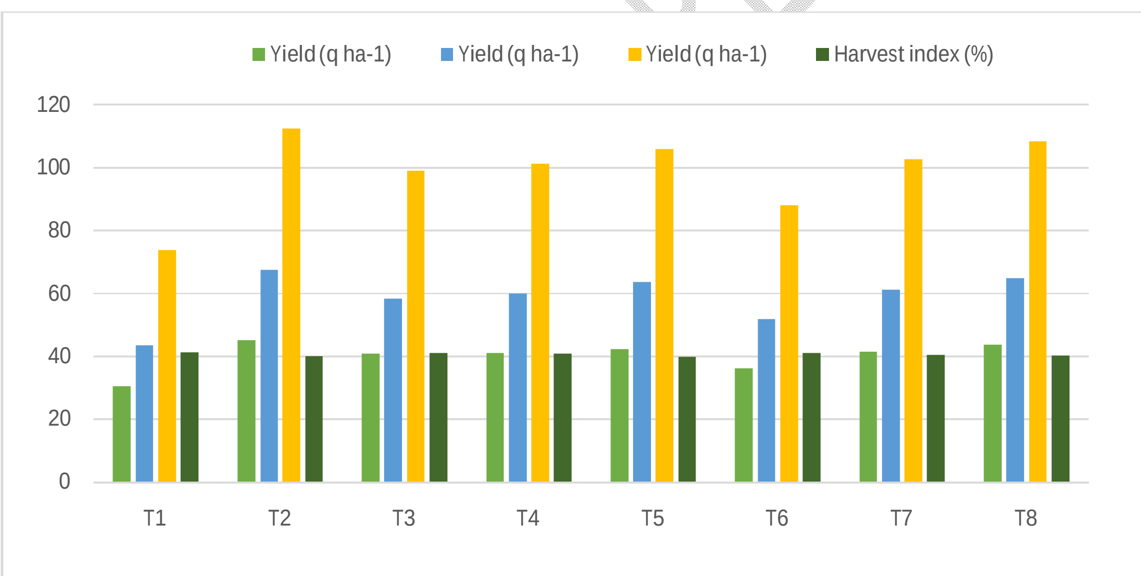

Fig-5 Effect of integrated weed management practices on grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) of wheat crop

4. CONCLUSIONS

On the basis of results, it could be concluded that weed free treatment(Pre-emergence application of pendimethalin +Post emergence application of 2,4 D+ Thrice hand weeding)was the best option which should be adopted for effective weed management in wheat crop. Treatment T_8(2, 4-D @ 0.5kga.i. ha^{-1} + two hand weeding at (25 DAS and 30 DAS and 45 DAS) andT_5(Pendimethalin @ 1.5 kg a.i. ha^{-1} (P.E) + Quizalofob-ethyl @ 50gm a.i. ha^{-1} (PoE at 25 DAS) + one hand weeding) also recommended to the farmer because it is cost effective. The growth parameters *viz*- Plant height (cm), Number of tillers (m^{-2})andDry matter accumulation (gm^{-2}). Yield attributes *viz*- No. of effective tillers (m^{-2}), Length of spike (cm), No. of grains spike^{-1} and yields*viz*- Grain yield, Straw yield (q ha^{-1}), Biological yield (q ha^{-1}) and were found maximum under treatment T_2 Weed free. Whereas,thetest weight, Harvest Index were found non-significant.

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Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Reference

BibiS, Khan BM, Gul Hand KhanNM. 2008.Effect of herbicides and wheat population on control of weeds in wheat. *Pakistan Journal of Weed Science Research* 14 (3&4): 111-119

Chandra S, Kumar S, Acharya S, Kumar P and Tyagi S.2018. Effect of different weed management practices on growth and yield of wheat and associated weeds. *International Journal of Current Microbiology Applied Science* 7, 3859-3865

Galon L, Basso FGM, Chechi L, Pilla TP, Santin CO, Maico Andre Michelon, Bagnara Mam, 2019. Weed interference period and economic threshold level of ryegrass in wheat. Bragantia, *Campinas* 78(3): 409- 422

Gupta HS, Gopinath K, Pandey Ak. 2008. Integrated weed management in wheat (*Triticum aestivum*) *Indian Journal of Weed Science* 25(3): 112-116

Jat RK, Punia SS and Malik RK.2009. Efficacy of herbicide mixtures and sequential applications against different weeds in wheat (*Triticum aestivum* L.). *Indian Journal of Weed Science* 39(1&2): 132–134

Kumar N, Mina Bl, Singh KP, Chandra S, Kumar M And Srivastava AK. 2010. Weed control for yield and profit maximization in wheat (*Triticum aestivum* L.) *in Indian Himalayas. Indian Journal of Agronomy* 55(2): 119–122

MalikRSYadavAandKumarR.2013. Readymixformulationofclodinafoppropargyl + metsulfuron-methyl against complex weed flora in wheat*. Indian Journal ofWeed Science*45(3):179-182

Meena SR, Singh MK. 2011. Weed management in late sowing zero-till wheat (*Triticum aestivum*) with varying seed rate*. Indian Journal of Agronomy* 56(2):127-132

Meena V, Kaushik MK, Meena SK, Bhimwal JP, Chouhan BS. 2017. Influence of pre- and post-emergence herbicide application on weed growth and nutrient removal in wheat (*Triticum aestivum* L.). *Journal of Pharmacognosy and Phytochemistry* 6(6): 2413- 2418

Mukherjee D. 2012. Resource Conservation Through Indigenous Farming System in Hills of West Bengal. *Journal of crop weed* 8: 160-64

Mukherjee D. 2018. Effect of various weed management practices on wheat productivity under new alluvial zone. *Journal of Crop and Weed* 14(2): 188-194

Najwa S, Johani A, Aytah A and Boutraa T. 2012. Allelopathic impact of two weeds, *Chenopodium murale* and *malvaparvi*. *Indian JournalofAgricultureScience* 85(3): 536-340

Pal S, Sharma R, Sharma HB and Singh R. 2016. Influence of different herbicides on weed control, nutrient removal and yield of wheat. *Indian Journal of Agronomy* 61(1): 59–63

Pandey IB and Dwivedi DK. 2007. Effect of planting pattern and weed control methodsand weed growth and performance of wheat (*Triticum aestivum* l.). *Indian Journal of Agronomy* 52(3):235-238

Pandey IB and Kumar K. 2005. Response of wheat (*Triticum aestivum*) to seeding methods and weed management. *Indian Journal of Agronomy* 50 (1): 48-51

Paswan, A.K., Kumar, R., Kumar, P. and Singh, R. K. 2012. Influence of metsulfuronmethyl and carfentrazone-ethyl either alone or in combination on weed flora, crop growth and yield in wheat (*Triticum aestivum* L). *Madras Agriculture journal*99(7/9): 560-562

Pisal RR and Sagarka RK.2013. Integrated weed management in wheat with new molecules (*Triticum aestivum* L). *Indian Journal of Weed Science* 45(1):25-28

Riaz, M, Malik M, Mahmood T and Jamil M.2006. Effect of Various Weed Control Methods on Yield and Yield Components of Wheat Under Different Cropping Patterns*. International Journal of Agriculture and Biology* 8:637-640

Satbhai R, Kale A and Naik R. 2016. Study on effect of high temperature stress in wheat genotypes using sds protein profile. *Journal of Wheat Research* 8(1): 51-58

Sharda R and Fayaz A. 2021. Effect of different weed control treatments on growth and yield of wheat. *International Journal of Botany Studies* 6 (5): 538-542

SharmaSNandSinghRK.2011.ProductivityandEconomicsofWheat(*Triticumaestivum*) as Influenced by Weed Management and Seed Rate. *Progressive Agric*ulture 11(2):242-250.

Singh G, Singh OP, Singh S and Prasad K. 2010. Weed management in late sown wheat (*Triticum aestivum*) low land. *Indian Journal of Agronomy* 55(2):83-88

TomarSK.AndTomarTS.2014.Effectofherbicidesandtheirtankmixmixtureonweed dynamics and yield of zero-tilled wheat (*Triticum aestivum*) under rice – wheatcroppingsystemof eastern UttarPradesh.*IndianJournal of agronomy*59(4):624-628

Verma SK, Singh SB, Prasad SK, Meena RN and Meena RS. 2015. Influence of irrigation regimes and weed management practices on water use and nutrient uptake in wheat. Bangladesh *Journal* of botany 44(3): 437–442.