https://doi.org/10.33472/AFJBS.6.6.2024.8605-8619

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Effect of Tillage, Crop Residue and Weed Management Practices on Yield Attributes and Yield of Timely Sown Wheat (*Triticum Aestivum* L.) in Sub-Tropical India

Ankur Tripathi[1], Anil Kumar Singh[2*], Sanjeev Singh[3], Shweta Gupta[4], Shivam Kaushik[5], Satya Prakash Gupta[6], Manoj Kumar Tripathi[7], Vinay Kumar Singh[8]

[1,5,6]Research Scholar, Department of Agronomy, Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya, India.
[2]Professor and Head, Department of Agronomy, Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya, India.
[3]Assistant Professor (Agronomy), Department of Vegetable Science, Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya, India
[4]Teaching Associate, Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, India.
[7,8]Principal Scientist, ICAR-IISR, Lucknow, India.

Corresponding Email: [2*]anilkumarsinghmausam@nduat.org

Article Info

Volume 6, Issue 6, August 2024

Received: 10 June 2024

Accepted: 12 July 2024

Published: 27 August 2024

doi: 10.33472/AFJBS.6.6.2024.8605-8619

ABSTRACT:

The field experiment was conducted during two successive *Rabi* (winter) seasons of 2021-22 and 2022-23 at the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.). Twenty treatment combinations comprised of 4 crop residue management, viz. conventional tillage without residue, conventional tillage with residue (3.0 tones ha^{-1} rice residue), zero tillage without residue, zero tillage with residue (3.0 tones ha^{-1} rice residue) and 5 weed management practices, viz. Triallate 50% EC PE @ 1250 gm a.i. ha^{-1}, Triallate 50% EC PE @ 2500 gm a.i. ha^{-1}, Clodinafop propargyl 15% + Metsulfuron methyl 1% WP PoE(60 gm + 4 gm a.i. ha^{-1}), hand weeding at 20 and 40 DAS and weedy check in wheat were tested in split-plot design with 3 replications, keeping crop residue management in main plots and weed management practices in subplots. Among the different crop residue management, zero tillage with residue was found most effective in maximizing yield attributes and yield of timely sown wheat followed by conventional tillage with residue. Conventional tillage without residue showed lowest values of yield attributes and yield of wheat crop. While in case of different weed management practices hand weeding at 20 and 40 DAS had a significant impact in maximizing yield attributes and yield closely followed by post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% WP PoE(60 gm + 4 gm a.i. ha^{-1}).

Keywords: Tillage, Crop residue, Weed management, Wheat

1. INTRODUCTION

Wheat (*Triticum aestivum* L.), being a major cereal crop, accounts for 26 per cent of world cereal production (Rahman *et al.*, 2021) and plays an important role in nutritional and food security. It is most extensively grown cereal in the world from temperate dry to irrigated and high rainfall area and from dry cold to warm humid environment. Wheat is the second largest cereal crop in India after rice. It accounts for 33.84 % of India's food grain basket. It covers an area of 30.47 million hectares and has a production of 106.84 million tonnes. The top three wheat producing states in India are Uttar Pradesh, Madhya Pradesh and Punjab, with productions of 33.95 million tons, 22.42 million tons and 14.82 million tons respectively, MA&FW (2022).Wheat crop contributes significantly to the nation's food security as it provides more than half of the calories for the people who depend on it the most. The dominant cropping system in the north-western Indo-Gangetic Plains (IGP) of India is the rice-wheat cropping system, widely covering in Punjab, Haryana, Uttarakhand and western Uttar Pradesh, yielding 34 million tonnes of rice crop residue (Korav *et al*., 2024).Continuous adoption of rice -wheat system has created several soil and environmental related problems due to burning of straw and depletion of ground water table, increase in soil salinity and ultimately yield plateauing etc. The conventional intensive tillage practices results in reduction of soil organic carbon and increased runoff thus reducing soil moisture. Several improved management practices under conservation agriculture has been reported such as zero or minimum tillage in wheat and residue management that improved resource use efficiency and crop productivity (Timalsina *et al*., 2021).Conservation tillage along with residue retention is recognized as cost effective method to enhance soil moisture conservation and maintain productivity of crops (Mukherjee, 2015).

Enhancing soil organic carbon stabilization can be achieved through conservation tillage and residue management, as highlighted by Choudhary *et al.* (2014). Ghimire *et al.* (2008) also found that soil organic carbon sequestration was increased with minimum tillage and surface application of crop residue. It is important to note that repeated tillage can lead to a reduction in soil organic matter and soil organic carbon, as indicated by Baker *et al.* (2007), which in turn can contribute to soil erosion. Soil disruption typically exerts the most significant influence on biological characteristics, affecting both independent and symbiotic fungal communities. Various research works have shown that the excessive tillage associated with conventional farming practices results in heightened soil bulk density, diminished porosity and aggregation, decreased water and nutrient accessibility, as well as unstable and diminishing crop yields. (Fabrizzi *et al*., 2005; Chen *et al*., 2007; He *et al*., 2009; Chan and Heenan, 2005).

The presence of crop residue in the soil has been shown to have a significant impact on the emergence of weeds, as highlighted by Verma *et al.* (2016). Not only does residue retention affect weed emergence, but it also plays a role in the growth and population of weeds. Moreover, the management of crop residue and tillage practices can also influence the effectiveness of soil-applied pre-emergence herbicides. This is because the presence of pre-emergence herbicides and ash content from residue burning can potentially impact the activity of these herbicides. Although several interacting factors may determine the extent of this influence including residue nature, height, type and quantity, prevailing weed flora, soil type and weather conditions (Khankhane *et al*., 2009). Weeds are a significant threat to the productivity of wheat among various production factors. They compete with crops for essential resources such as water, nutrients, and other growth factors, as highlighted by Khokhar and Nepalia (2010) and Najwa *et al.* (2012). In the absence of effective control measures, weeds can deplete a considerable amount of applied nutrients and water, leading to higher yield losses. This becomes even more severe when there is a scarcity of these resources, as mentioned by Singh *et al.* (2009) and Sharma and Singh (2011). Depending on the density and type of weed flora present, uncontrolled weeds throughout the crop period can result in a reduction of more than 50% in grain yield, as stated by Azad (2003). Several studies have demonstrated the effectiveness of various new herbicide molecules in controlling weeds. For instance, Baghestani *et al.* (2008) and Barros *et al.* (2009) found that herbicides such as clodinafop propargyl, fenoxaprop-p-ethyl, iodosulfuron-methyl-sodium, and mesosulfuron-methyl were highly effective in weed control. Additionally, Kumar *et al.* (2011), Singh *et al.* (2012), Malik *et al.* (2013), and Chitband *et al.* (2013) reported that tank mixtures containing clodinafop + metsulfuron, mesosulfuron-methyl + iodosulfuron-methyl-sodium, with or without surfactant provided excellent control of various weed species, including *Phalaris minor, Avena fatua,* *Chenopodium album, Melilotus spp., Medicago denticulata, Vicia sativa, Rumex spp., Anagallis arvensis, Coronopus didymus, Lathyrus aphaca, Polygonum plebejum*, sedges, and many others. Moreover, the use of these herbicides resulted in higher grain yield of wheat. Keeping above facts in view the investigation was carried out to study the effect of tillage, crop residue and weed management practices on yield attributes and yield of timely sown wheat (*Triticum aestivum* L.) under sub-tropical conditions of India.

2. MATERIALS AND METHODS

The present investigation was carried out at the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, India during two successive *Rabi* (winter) seasons of 2021-22 and 2022-23. Geographically, the experimental site is located at about 26°47' N latitude and 82°12’ E longitudes with an altitude of 113 meters above the Mean Sea Level. The soil of the experimental field had silty loam texture, was moderate alkaline in reaction (pH) 8.26 and 8.21, low in organic carbon (0.34% and 0.34%), low in available nitrogen (205.45 kg ha^{-1} and 206.32 kg ha^{-1}), medium in available phosphorus (12.24 kg ha^{-1} and 12.23 kg ha^{-1}) and medium in available potassium (232.65 kg ha^{-1} and 233.37 kg ha^{-1}) during 2021-22 and 2022-23, respectively. The treatment combinations of 4 crop residue management, viz. conventional tillage without residue, conventional tillage with residue (3.0 tones ha^{-1} rice residue), zero tillage without residue, zero tillage with residue (3.0 tones ha^{-1} rice residue) and 5 weed management practices, viz. Triallate 50% EC PE@ 1250 gm a.i. ha^{-1}, Triallate 50% EC PE@ 2500 gm a.i. ha^{-1}, Clodinafop propargyl 15% + Metsulfuron methyl 1% WP PoE(60 gm + 4 gm a.i. ha^{-1}), hand weeding at 20 and 40 DAS and weedy check were tested with 3 replications in split-plot design, keeping crop residue management in main plots and weed management practices in subplots on a fixed site. Treatment combinations were assigned to experimental units randomly employing Fisher and Yates random table method (Panse and Sukhatme, 1985). Since the experiment was carried out under different tillage, no preparatory tillage was carried out for zero-tillage with and without residue retained treatment, zero till-cum-ferti-seed drill was used for sowing of seeds. Whereas, in case of conventional tillage with and without residue treatment, preparation of land was done by tractor driven rotavator. Seed-cum-fertilizer drill was used for sowing of seeds. In conventional tillage with residue, the loose rice residues were spread over between the rows in the field after 10 days of sowing. The wheat crop (variety- HD-2967) was sown at the seed rate of 100 kg ha^{-1} on 21/11/2021 and 22/11/2022 respectively. Before sowing, wheat seed was treated with Thiram @ 2.5 g kg^{-1} to control fungal diseases. The row to row spacing was maintained at 20 cm. An uniform dose of nitrogen, phosphorus and potash at the rate of 120 kg, 60 kg and 40 kg ha^{-1} was applied through urea (46% N), diammonium phosphate (18 % N and 46% P_2O_5) and muriate of potash (60% K_2O), respectively. Half amount of nitrogen and full dose of phosphorus and potash were applied as basal at the time of sowing and remaining amount of nitrogen was top dressed after first irrigation. Pre-emergence application of herbicide Triallate 50% EC was done as per treatment just after sowing whereas Clodinafop propargyl 15% + Metsulfuron methyl 1% WP was sprayed 30 days after sowing. The crop was irrigated at crown root initiation (C.R.I.) stage (21 DAS), booting stage (70 DAS), flowering stage (90 DAS) and dough stage (110 DAS). The crop was harvested on 10.04.2022 and 11.04.2023 respectively during two years of investigation. Number of effective tillers were counted before harvesting from marked area of one square meter quadrate at three places and average value was taken. Ten representative spikes were harvested from marked rows. The spike length (cm) was measured from the base of the peduncle (lower spikelet) to tip excluding awns of spikelet. The average was worked out to get the length of spike in cm.Ten randomly selected spikes for measuring spike length was used for counting spikelets. Average number of spikelets was computed to get number of spikelets spike-^{1}.The total number of grains from ten spikes of each plot were counted and averaged to get the number of grains spike-^{1}. After threshing and winnowing, random samples of grains were drawn from the produce of each net plot and 1000 grains were counted and weighed in gram with the help of electronic balance.The crop from each net plot was harvested and sun dried thoroughly for 3 days in the field. After weighing the total biomass of each net plot, the produce was threshed separately and cleaned grains were air dried to maintain 12 per cent moisture. The weight of grains, harvested from net plot area, was recorded and finally converted into t ha^{-1}. The data recorded during the course of investigation were subjected to statistical analysis using analysis of variance (ANOVA) technique for SPD as prescribed by (Gomez and Gomez, 1984). Standard error of mean in each case was calculated at 5% levels of probability.

3. RESULTS AND DISCUSSION

Yield Attributing Characters

The data pertaining to yield attributes *viz.*, effective tillers m^{-2}, spike length (cm), spikelets spike^{-1}, grains spike^{-1} and 1000 grain weight (g) as influenced by crop residue management and weed management practices are presented in Table 1 and depicted in Fig. 1.1.

Effective Tillers M^{-2}

A perusal of data summarized in table revealed that various crop residue management caused significant variation in the number of effective tillers (m^{-2}) in both the years of investigation. Amongst different crop residue management, significantly maximum number of effective tillers (m^{-2}) were recorded under zero tillage with residue being on par with conventional tillage with residue as compared to zero tillage without residue and conventional tillage without residue at all the stages during both the years. Higher effective tillers under the influence of zero tillage with residue might be discussed in light of the fact that this treatment providing better growing environment to crop ensuring less crop-weed competition resulting into more availability of moisture and nutrients. The results are in close proximity to those of Mitra *et al.* (2014), Kumar *et al.* (2018) and Singh *et al.* (2021).

Amongst weed management practices, maximum number of effective tillers (m^{-2}) was recorded under hand weeding at 20 and 40 DAS being on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly superior over pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} during both years. All the weed management practices were significantly superior to weedy check which had the lowest number of effective tillers (m^{-2}) during both the years. These results are in close conformity with the findings of Shyam *et al.* (2014), Tomar *et al.* (2017) and Yadav *et al.* (2019) who also reported higher effective tiller in wheat under the influence of two hand weeding followed by post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) and lowest in weedy check.

Spike length (cm)

It is obvious from the data that crop residue management and weed management practices caused significant variation in the spike length during both the years of study. Amongst various crop residue management, zero tillage with residue recorded significantly maximum spike length and remained statistically at par with conventional tillage with residue during 2022-23, but significantly superior to zero tillage without residue and conventional tillage without residue during both the years. The similar findings were reported by Singh *et al.* (2021).

In case of weed management practices, maximum spike length was noted under hand weeding at 20 and 40 DAS being on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. $ha^{-1)}$ but significantly superior over pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} during both years. All the weed management practices were significantly superior to weedy check which had the minimum spike length during the course of study. The maximum spike length in wheat with two hand weeding closely followed by post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) compared to other weed management practices under study were also reported by Para *et al.* (2022) and Kumar *et al*. (2023).

Spikelets Spike^{-1}

Zero tillage with residue being at par with conventional tillage with residue recorded significantly highest spikelets spike^{-1} over zero tillage without residue and conventional tillage without residue during both the years of investigation. In weed management practices, maximum spikelets spike^{-1} was noted under hand weeding at 20 and 40 DAS being on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. $ha^{-1)}$ but significantly superior over pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1}) whereas, lowest values were observed in weedy check. All the weed management practices were significantly superior to weedy check which had the minimum spikelets spike^{-1} during the both year of study. The similar findings were reported by Chandra *et al.* (2018) and Kumar *et al.* (2023).

Number of grains spike^{-1}

Significant variations in number of grains spike^{-1} was recorded due to crop residue management and weed management practices during both the years of investigation. Zero tillage with residue recorded significantly maximum number of grains spike^{-1} which remained statistically at par with conventional tillage with residue during both the years. It is also clear from the data that conventional tillage without residue recorded minimum number of grains spike^{-1} during the course of study. This might be due to the fact that plant height, LAI and dry matter accumulation was higher under zero tillage with residue which contributed positively towards formation and development of more grains per spike in this treatment. These results are in close conformity to those reported by Mitra *et al.* (2014) and Singh *et al.* (2021).

All the weed management practices recorded significantly higher number of grains spike^{-1} over weedy check. Highest grains spike^{-1} was observed in hand weeding at 20 and 40 DAS remaining on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly higher over pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} during both years. These results corroborate the findings of Stanzen *et al.* (2016), Tomar *et al.* (2017) and Kumar *et al*. (2023).

Test weight (g)

The 1000-grain weight (g) was influenced significantly due to various crop residue management and weed management practices during both the years. Zero tillage with residue recorded highest test weight and remained statistically at par with conventional tillage with residue, but significantly superior to conventional tillage without residue as well as with zero tillage without residue during both the years. This might be due to the less crop weed competition during the growth period in presence of residue resulting into sufficient supply of photosynthates to individual grains in this treatment. The results are in agreement with the findings of Mitra *et al*. (2014), Kumar *et al.* (2018) and Singh *et al.* (2021).

The perusal of data clearly indicated significant variation in test weight due to different weed management practices during both the years. It is also clear from the data that all the weed management practices proved significantly superior to weedy check in respect of test weight. Maximum test weight was noted under hand weeding at 20 and 40 DAS being on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly better than pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} during both years. These findings are in accordance with that reported by Shyam *et al.* (2014), Tomar *et al.* (2017) and Chandra *et al.* (2018) who also observed highest test weight of wheat grain in two hand weeding compared to other chemical herbicides tested.

Yield

The data pertaining to yield *viz.*, grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) as influenced by crop residue management and weed management practices are presented in Table 2 and depicted in Fig. 2.1.

Grain yield (t ha^{-1})

It is evident from the data that grain yield of wheat was significantly influenced by different crop residue management and weed management practices during both the years of investigation. The highest grain yield was obtained under the influence of zero tillage with residue (4.55 and 4.79 t ha^{-1}) which remained statistically at par with conventional tillage with residue (4.47 and 4.70 t ha^{-1}), but was found significantly higher to rest crop residue management treatments during both the years. The difference in grain yield of conventional tillage without residue and conventional tillage with residue was also significant. Similarly the significant variation in grain yield of zero tillage and zero tillage with residue was also observed during both years of study. The higher yield in zero tillage with residue might be due to proper seed placement at the right depth in narrow slit made by zero till-cum-ferti - seed drill as well as emergence of wheat seedlings under favorable moisture content, which responded in term of good crop yield (Gupta *et al*., 2011). This might also be due to the better growth and yield attributes under this treatment which resulted into higher yield. The result is in close conformity with that of Yadav *et al.* (2005), Mitra *et al*. (2014) and Kumar *et al.* (2016). The wheat yield enhanced by 9.8–11.3% under zero tillage wheat with happy seeder with full residue load over residue burning and residue removal plots (Korav *et al.*, 2024). The results in this study indicated that a zero tillage system can be as equally effective as a conventional tillage system for wheat production in rice-wheat rotation. Similarly, the results showed positive impacts of rice residue retention on wheat grain yield (Pandey and Kandel, 2019).

Hand weeding at 20 and 40 DAS recorded maximum grain yield being on par with the grain yield obtained under the effect of post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly higher than rest of the weed management practices adopted. Grain yield realized under the effect of pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} was also significantly higher than weedy check during both the years of investigation. Only numerical difference was observed in the grain yield of wheat in between pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1}. The weedy check recorded the lowest grain yield because of the largest nutrient and moisture removal by weeds and intense crop weed competition, which led to poor source and sink development, poor yield components and thus low yield. Among the weed management practices, two hand weeding exhibited the highest yield attributes and yield, these higher yield attributes and yields of wheat was owing to effective control of weeds and higher growth and development of wheat in less weedy situation under this treatment. This might be probably due to the creation of modified micro-climate due to mechanical manipulation of soil and lower crop weed competition which had led to better yield components and thus resulted in higher yields. The yield obtained under the effect of post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) was on par with two hand weeding because of better weed control in this treatment. These findings are in close agreement with those of Tomar *et al.* (2017), Singh *et al.* (2019), Kundu *et al.* (2020), Yadav *et al.* (2022) and Para *et al.* (2022).

Straw yield (t ha^{-1})

Data indicated significant variation in straw yield due to different crop residue management and weed management practices during both the years. The highest straw yield was recorded under the influence of zero tillage with residue remaining statistically at par with conventional tillage with residue, but significantly higher to rest crop residue management treatments during both the years. The difference in straw yield of conventional tillage without residue and conventional tillage with residue was also found to be significant. Similarly the significant variation in straw yield of zero tillage and zero tillage with residue was also observed.

Weed management through hand weeding at 20 and 40 DAS recorded highest straw yield being on par with the straw yield obtained under the influence of post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly higher than remaining weed management practices under study. Straw yield realized under the effect of pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} was significantly superior over weedy check during both the years of investigation. Only nominal difference was obtained in the straw yield of wheat in between pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1}.

Biological yield (t ha^{-1})

It is clear from the data that crop residue management and weed management practices caused significant variation in biological yield of wheat during both the years of investigation. The highest biological yield was obtained under the influence of zero tillage with residue remaining statistically at par with conventional tillage with residue, but significantly higher to rest crop residue management treatments. The difference in biological yield of conventional tillage without residue and conventional tillage with residue was also significant. Similarly the significant variation in biological yield of zero tillage and zero tillage with residue was also noticed. The higher biological yield under zero tillage with residue might be due to enhanced plant height, number of tillers m^{-2}, leaf area index indicating higher chlorophilic area improving photosynthetic efficiency of crop. The results corroborate the findings of Kumar *et al.* (2016), Kumar *et al.* (2018), Pandey and Kandel (2019), Singh *et al.* (2021) and Sudarshan *et al.* (2022) who also reported higher yield in zero tillage with residue.

Hand weeding at 20 and 40 DAS recorded maximum biological yield being on par with the biological yield obtained under the effect of post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm + 4 gm a.i. ha^{-1}) but significantly higher than rest of the weed management practices adopted. Biological yield realized under the effect of pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1} was significantly higher than weedy check during both the years of investigation. Only numerical difference was observed in the biological yield of wheat in between pre emergence application of Triallate 50% EC @ 2500 gm a.i. ha^{-1} and Triallate 50% EC @ 1250 gm a.i. ha^{-1}. These results are in close proximity to those of Kumar *et al.* (2018), Chandra *et al.* (2018), Singh *et al.* (2019) and Para *et al.* (2022).

Harvest index (%)

The effect of various crop residue management and weed management practices on harvest index of wheat was found non-significant except during 2021-22 where only crop residue management have shown significant harvest index. Though the effect of different crop residue management on harvest index of wheat was recorded non-significant still treatments containing residue showed better harvest index compared to treatments having no residue. Sudarshan *et al.* (2022) also reported that harvest index of wheat was not affected by different crop establishment methods. Similarly in case of weed management practices numerical increment in harvest index was noticed under the effect of hand weeding at 20 and 40 DAS though statistically it was found non-significant during both the years. Yadav *et al.* (2019) and Para *et al.* (2022) also reported that weed management practices could not influence the harvest index of wheat up to the level of significance.

Table 1: Yield attributes as influenced by weed management practices under varying crop residue management of timely sown wheat (*Triticum aestivum* L.).

Treatment		**Effective tillers (m^{-2})**		**Spike length (cm)**		**No. of spikelets/spike**		**No. of grains/ spike**		**Test weight (g)**	
		2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
A. Crop Residue Management											
Conventional tillage without residue	C_1	295.26	299.94	8.29	8.43	14.37	14.67	34.49	35.20	38.35	39.13
Conventional tillage with residue (3.0 t ha^{-1} rice residue)	C_2	310.45	315.00	9.14	9.36	15.05	15.35	36.11	36.85	40.72	41.56
Zero tillage without residue	C_3	299.85	305.25	8.95	9.11	14.92	15.22	35.80	36.53	39.28	40.08
Zero tillage with residue (3.0 t ha^{-1} rice residue)	C_4	318.15	323.00	9.99	10.18	15.68	16.00	37.64	38.40	40.89	41.72
SEm±		*3.82*	*4.21*	*0.22*	*0.25*	*0.18*	*0.19*	*0.44*	*0.45*	*0.34*	*0.36*
C.D.(P=0.05)		*13.48*	*14.86*	*0.78*	*0.89*	*0.65*	*0.67*	*1.56*	*1.60*	*1.19*	*1.22*
B. Weed Management Practices											
Triallate 50 % EC PE (1250	W_1	296.62	301.49	8.74	8.90	14.78	15.08	35.48	36.20	39.24	40.04

gm a.i. ha^{-1})											
Triallate 50 % EC PE (2500 gm a.i. ha^{-1})	W_2	301.77	306.64	8.89	9.05	14.86	15.16	35.65	36.38	39.43	40.23
Clodinafop Propargyl 15% + Metsulfuron Methyl 1% WP PoE (60 gm + 4 gm a.i. ha^{-1})	W_3	326.47	331.35	9.85	10.02	15.42	15.74	37.01	37.77	41.02	41.86
Hand weeding at 20 and 40 days after sowing	W_4	330.22	335.09	9.99	10.17	15.51	15.82	37.22	37.98	41.27	42.10
Weedy Check	W_5	274.53	279.41	8.07	8.22	14.46	14.75	34.70	35.40	38.10	38.87
SEm±		*5.16*	*5.17*	*0.28*	*0.31*	*0.18*	*0.18*	*0.43*	*0.44*	*0.29*	*0.30*
C.D.(P=0.05)		*14.93*	*14.96*	*0.81*	*0.91*	*0.51*	*0.53*	*1.24*	*1.26*	*0.85*	*0.87*

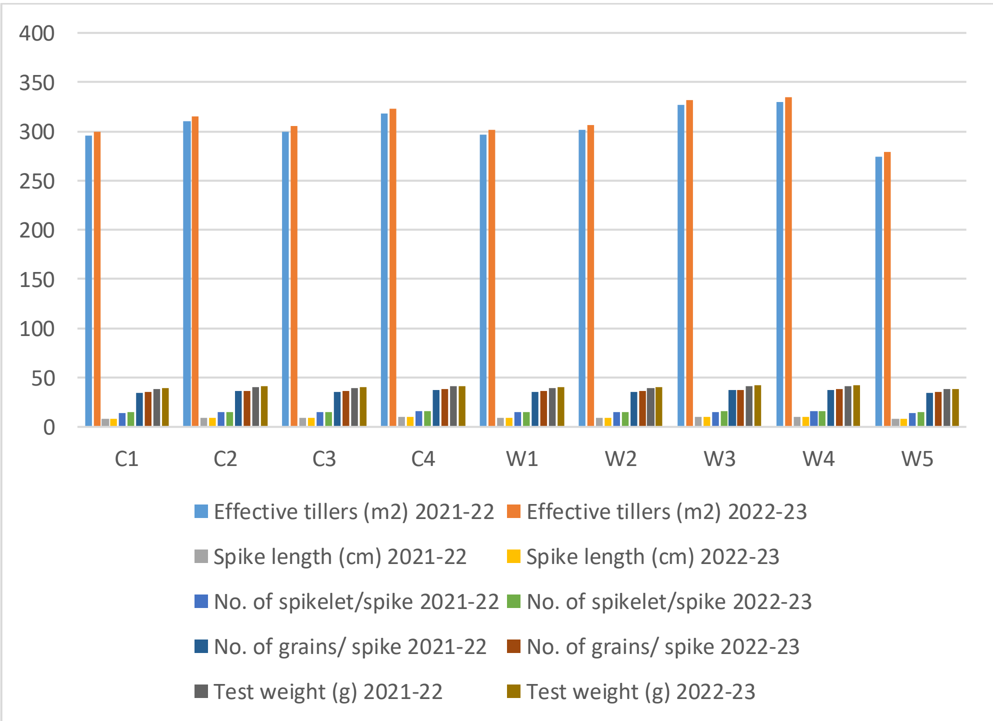

Fig. 1.1: Yield attributes as influenced by weed management practices under varying crop residue management of timely sown wheat (*Triticum aestivum* L.)

Table 2: Grain yield, straw yield, biological yield and harvest index as influenced by weed

Treatments		**Yield (t ha^{-1})**						**Harvest index (%)**	
		Grain		**Straw**		**Biological**			
		2021-22	**2022-23**	**2021-22**	**2022-23**	**2021-22**	**2022-23**	**2021-22**	**2022-23**
A. Crop Residue Management									
Conventional tillage without residue	**C_1**	3.91	4.08	5.45	5.50	9.37	9.59	41.83	42.63
Conventional tillage with residue (3.0 t ha^{-1} rice residue)	**C_2**	4.47	4.70	5.94	6.18	10.42	10.87	42.98	43.36
Zero tillage without residue	**C_3**	4.05	4.22	5.51	5.79	9.55	10.01	42.23	42.12
Zero tillage with residue (3.0 t ha^{-1} rice residue)	**C_4**	4.55	4.79	5.98	6.33	10.53	11.12	43.29	43.27
SEm ±		*0.07*	*0.04*	*0.10*	*0.13*	*0.17*	*0.15*	*0.12*	*0.46*
CD (P= 0.05)		*0.25*	*0.15*	*0.36*	*0.45*	*0.60*	*0.52*	*0.43*	*NS*
B. Weed Management Practices									
Triallate 50 % EC PE (1250 gm a.i. ha^{-1})	**W_1**	4.08	4.25	5.50	5.76	9.57	10.01	42.52	42.42
Triallate 50 % EC PE (2500 gm a.i. ha^{-1})	**W_2**	4.15	4.42	5.68	5.88	9.83	10.30	42.27	42.97
Clodinafop Propargyl 15% + Metsulfuron Methyl 1% WP PoE (60 gm + 4 gm a.i. ha^{-1})	**W_3**	4.64	4.85	6.29	6.57	10.93	11.41	42.44	42.69
Hand weeding at 20 and 40 days after sowing	**W_4**	4.71	4.93	6.31	6.61	11.02	11.53	42.76	42.70
Weedy Check	**W_5**	3.65	3.80	4.83	4.93	8.48	8.73	42.93	43.45
SEm ±		*0.14*	*0.14*	*0.20*	*0.23*	*0.33*	*0.33*	*0.41*	*0.81*
CD (P= 0.05)		*0.41*	*0.40*	*0.57*	*0.67*	*0.96*	*0.94*	*NS*	*NS*

Management practices under varying crop residue management of timely sown wheat (*Triticum aestivum* L.).

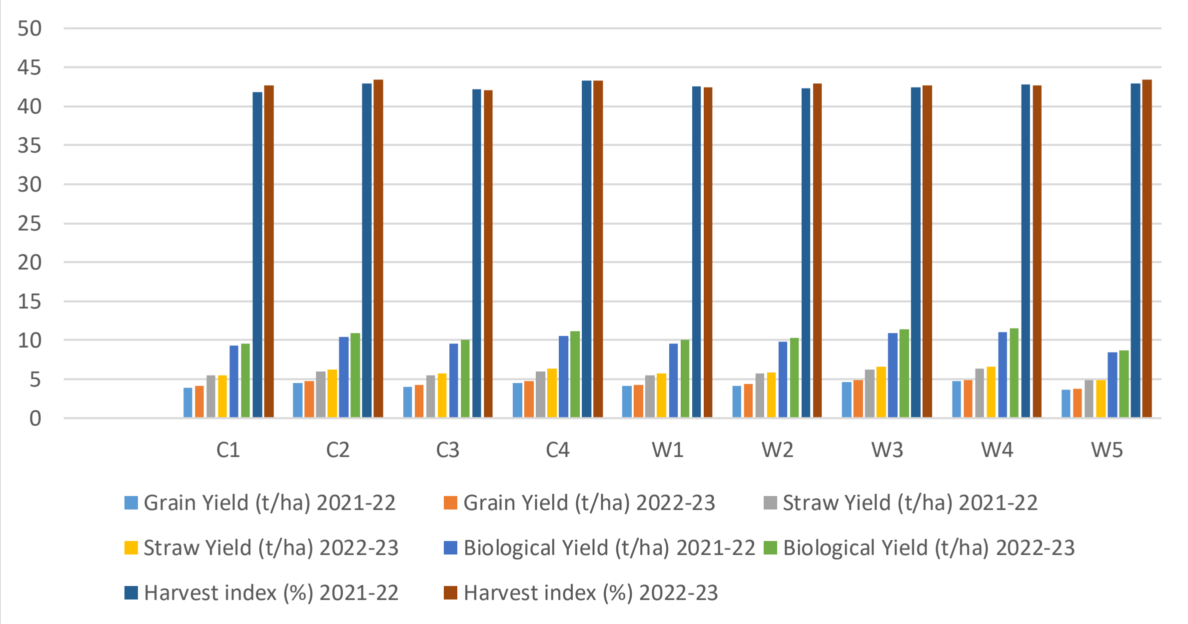

Fig. 2.1: Grain yield, straw yield, biological yield and harvest index as influenced by weed management practices under varying crop residue management of timely sown wheat (Triticum aestivum L.).

4. CONCLUSIONS

Zero tillage with residue (3.0 tones ha^{-1}) proved to be more effective in controlling weeds than conventional tillage with residue, zero tillage without residue and conventional without residue. Zero tillage with residue (3.0 tones ha^{-1}) recorded better yield attributes and highest yield of timely sown wheat crop. Hand weeding at 20 and 40 DAS recorded maximum improvement in yield attributes and yield of timely sown wheat crop being on par with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm+ 4 gm a.i. ha^{-1}) at 30 DAS. Considering the labour scarcity, it might be concluded that zero tillage with residue (3.0 tones ha^{-1}) coupled with post emergence application of Clodinafop propargyl 15% + Metsulfuron methyl 1% (60 gm+ 4 gm a.i. ha^{-1}) at 30 DAS could be recommended to the farmers for effective weed management, better yield and higher profit in timely sown wheat crop under subtropical Indian conditions.

Acknowledgements
The authors thank the Vice Chancellor, Acharya Narendra Dev University of Agriculture and Technology and The Head Division of Crop Production for encouragement and facilities.

5. REFERENCES

1. Azad, B.S. (2003). Efficiency of herbicides for controlling weeds in wheat with special reference to Phalaris minor. Annals of Plant Protection Sciences, 11(1), 119-122.
2. Baghestani, M.A., Zand, E., Soufizadeh, S., Beheshtian, M., Haghighi, A., Barjasteh, A. Birgani, D. G. and Deihimfard, R. (2008). Study on the efficacy of weed control in wheat (Triticum aestivum L.) with tank mixtures of grass herbicides with broadleaved herbicides. Crop Protection, 27(1), 104-111.
3. Baker, J.M., Ochsner, T.E., Venterea, R.T. and Griffis, T.J. (2007). Tillage and soil carbon sequestration-what do we really know. Agric. Ecosyst. Env. 118, 1-5.
4. Barros, J.F.C., Basch, G., Freixial, R. and Carvalho, M.D. (2009). Effect of reduced doses

of mesosulfuron + iodosulfuron to control weeds in no-till wheat under Mediterranean conditions. Spanish J. Agric. Res. **7** (4), 905-912.

5. Chan, K.Y. and Heenan, D.P. (2005). The effects of stubble burning and tillage on soil carbon sequestration and crop productivity in south eastern Australia. Soil Use Manage, 21, 427-443.
6. 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 and Applied Sciences, **7**, 3859-3865.
7. Chen, H.Q., Billen, N., Stahr, K. and Kuzyakov, Y. (2007). Effects of nitrogen and intensive mixing on decomposition of 14 C-labelled maize residue in soils of different land use types. Soil Tillage Res. 96, 114-123.
8. Chitband, A. A., Ghorbani, R., Mohassel, M.H.R., Fizabadi, A.Z. and Abbaspoor, M. (2013). Jointed effects of mesosulfuron-methyl+ iodosulfuron-methyl-sodium and clodinafop-propargyl mixed with adjutants on wild oat. Int. J. Agron. and Pt. Production, 4(9), 2166-2173.
9. Choudhury, S.G., Srivastava, S., Singh, R., Chaudhari, S.K., Sharma, D. K., Singh, S.K and Sarkar D. (2014). Tillage and residue management effects on soil aggregation, organic carbon dynamics and yield attribute in rice–wheat cropping system under reclaimed sodic soil. Soil and Tillage Research, 136, 76-83.
10. Fabrizzi, K.P., Garcia, F.O., Costa, J.L. and Picone, L.I. (2005). Soil water dynamics, physical properties and corn and wheat responses to minimum and no tillage systems in the southern Pampas of Argentina. Soil and Till. Res. 81, 57-69.
11. Ghimire, R., Shah, S.C., Dahal, K.R., Duxbury, J.M. and Lauren, J.P. (2008). Soil organic carbon sequestration by tillage and crop residue management in rice-wheat cropping system of Nepal. J. Inst. Agric. Anim. Sci. 29, 21-26.
12. Gomez KA, Gomez AA. (1984) Statistical procedures for agricultural research. John Wiley & sons.
13. Gupta, M., Bali, A.S., Kour, S., Bharat, R. and Bazaya, B.R. (2011). Effect of tillage and nutrient management on resource conservation and productivity of wheat (Triticum aestivum). Indian Journal of Agronomy, 56(2), 116–120.
14. He, J., Kuhn, N.J., Zhang, X.M., Zhang, X.R. and Li, H.W. (2009). Effects of 10 years of conservation tillage on soil properties and productivity in the farming-pastoral ecotone of inner Mongolia, China. Soil Use Manage, 25, 201-209.
15. Khankhane, P.J., Barman, K.K., and Varshney, J.G. (2009). Effect of rice residue management practices on weed density, wheat productivity and soil fertility in a swell-shrink soil. Ind. J. Weed Sci. 41, 41-45.
16. Khokhar, A.K. and Nepalia, V. (2010). Effect of herbicides and nutrient management on weed flora, nutrient uptake and yield of wheat under irrigated condition. Ind. J. Weed Sci. 42, 14-18.
17. Korav, S., Yadav, D.B., Yadav, A., Rajanna, G.G., Prasad, J., Tallapragada, S., Elansary, H.O. and Mahmoud, E. A. (2024). Rice residue management alternatives in rice-wheat cropping system: impact on wheat productivity, soil organic carbon, water and microbial dynamics. Scientific Reports, 14, Article number, 1822.
18. Kumar, A., Jat, M.L., Kumar, A., Tomar, J., Kumar, S. and Kushwaha, S.R. (2016). Rice residue management in wheat under different tillage practices and nitrogen doses. Annals of Agricultural Research, 37(1), 49–55.
19. Kumar, M., Ghosh, D. and Singh, R. (2018). Effect of crop establishment and weed management practices on growth and yield of wheat. Indian Journal of Weed Science, 50, 129-132.
20. Kumar, M., Kumar, R., Patel, V.K, Suryabhan and Prajapati, A.K. (2023). The effect of

weed management practices on the growth, yields and productivity of wheat. International Journal of Plant and soil Science, 35(19), 644-652.

21. Kumar, S., Angiras, N. N. and Rana, S.S. (2011). Bio-efficacy of clodinafop-propargyl +metsulfuron methyl against complex weed flora in wheat. Ind. J. Weed Sci. 43, 195-198.
22. Kundu, C.K., Goswami, S., Mondal, R. and Kundu. A. (2020). Effect of 2, 4-D ethyl ester 80% EC on weed and yield of wheat in Gangetic plains of West Bengal. Journal of Crop and Weed, 16 (2), 284-289.
23. MA&FW (2022). Agricultural Statistics at a Glance. Fourth Advance Estimates, Department of Agriculture and Farmer Welfare, Ministry of Agriculture and Farmers Welfare, India.
24. Malik, R.S., Yadav, A. and Kumari, R. (2013). Ready-mix formulation of clodinafop-propargyl + metsulfuron-methyl against complex weed flora in wheat. Ind. J. Weed Sci. 45(3), 179-182.
25. Mitra, B., Mookherjee, S. and Das, S. (2014). Performance of wheat under various tillage and nitrogen management in sub-Himalayan plains of West Bengal. Journal of Wheat research, 6(2), 150-153.
26. Mukherjee, D. (2015). Influence of various tillage option along with nutrient management practices in maize –wheat cropping system under mid hill situation of West Bengal. Annals of Plant Sciences, 4(03), 1008-1015.
27. Najwa, S., Johani, A., Aytah, A. and Boutraa, T. (2012). Allelopathic impact of two weeds, Chenopodium murale and Malva parviflora on growth and photosynthesis of barley. Pakistan Journal of Botany, 44(6), 1865-1872.
28. Pandey, B.P. and Kandel, T. P. (2019). Growth and yield response of wheat to tillage, rice residue and weed management under rice-wheat cropping system. Global Journal of Agricultural and allied Sciences, 1 (1), 43.48.
29. Panse, V.G., and Sukhatme, P.V. (1985). Statistical method for Agricultural Workers, I.C.A.R., New Delhi.
30. Para, P. K., Kushwah, S.S., Sasode, D.S., Joshi, E., Sharma, V.K. and Malgaya, G. (2022). Impact of tillage and chemical weed management practices on wheat yield and nutrient uptake. Biological Forum-An International Journal, 14(1), 1726-1734.
31. Rahman, M. M., Crain, J., Haghighattalab, A., Singh, R. P. and Poland, J. (2021). Improving wheat yield prediction using secondary traits and high density phenotyping under heat-stressed environments. Frontiers in Plant Science, 12, 633651.
32. Sharma, S.N. and Singh, R.K. (2011). Seed rate and weed management on yield and nutrient uptake of wheat (Triticum aestivum L.). Indian Journal of Agricultural Sciences, 81(12), 1174.
33. Shyam, R., Singh, R. and Singh, V.K. (2014). Effect of tillage and weed management practices on weed dynamics, weed seed bank and grain yield of wheat in rice-wheat system. Indian Journal of Weed Science, 46(4), 322–325.
34. Singh, H., Sharma, S.K. and Bhatt, M.A. (2021). Performance of wheat under different tillage methods and potassium levels under irrigated and rain fed conditions of Northern India. Journal of Crop and Weed, 17(1), 99-109.
35. Singh, M., Singh, O. and Singh, R. (2019). Impact of Wheat Establishment Methods and Weed Management Practices on Weed Flora, Yield and Nutrient Uptake of Wheat in Rice-wheat Cropping System. Journal of AgriSearch, 6(2), 73-77.
36. Singh, R., Shyam, R., Singh, V.K., Kumar, J., Yadav, S. and Rathi, S. (2012). Evaluation of bio efficacy of clodinafop-propargyl + metsulfuron-methyl against weeds in wheat. Indian Journal of Weed science, 44, 81-83.
37. Singh, R.K., Verma, S.K., Sharma, R. and Singh, S.B. (2009). Bio-efficacy and

selectivity of sulfosulfuron and metribuzin before and after irrigation in wheat under zero-tillage system. Ind. J. Agri. Sci. 79(9), 735-739.

38. Stanzen, L., Kumar, A., Sharma, B. C., Punia, R. and Sharma, A. (2016). Weed dynamics and productivity under different tillage and weed management practices in maize-wheat cropping sequence. Indian Journal of Agronomy, 61(4), 449-454.
39. Sudarshan, S., Shekhawat, K., Rathore, S.S., Singh, R.K., Das, A. and Nagargade, M. (2022). Annals of Agricultural research, new series, 43 (2), 119-126.
40. Timalsina, H. P., Marahatta, S., Shah, S. K. & Gautum, A. K. (2021). Effect of tillage method, crop residue and nutrient management on growth and yield of wheat in rice-wheat cropping system at Bhairahawa condition. Agronomy Journal of Nepal, 5, 52-62.
41. Tomar, S.S., Kumar, A., Naresh, R.K., Singh, Y.P., Singh, A. and Singh, R. (2017). Effect of fertility levels and herbicides combination on weed dynamics and productivity of wheat. Journal of Pharmacognosy and Phytochemistry, SP 1,474-477.
42. Verma, S.K., Kumar, R., Singh, S.B., Meena, R.S., Prasad, S.K. and Gaurav. (2016). Weed dynamics in green gram as influenced by mulching and weed management practices under eight ear old Custard apple plantation in agri-horticultural system. American Journal of Experimental Agriculture, 11(3), 1-13.
43. Yadav, H.L., Gupta, A.K., Chaudhary, R.R. and Kumawat, S. (2019). To study response of different herbicides and herbicide mixtures on performance of wheat and their residual effect on succeeding crops. International Journal of Chemical Studies, **7**(3), 1410-1413.
44. Yadav, M. P.; Mohd., A. and Kushwaha, S. P. (2005). Effect of integrated nutrient management in rice (Oryza sativa L.) wheat (Triticum aestivum L.) cropping system in Central Plain Zone of Uttar Pradesh. Indian Journal of Agronomy, 50(2), 89-93.
45. Yadav, P., Singh, R.S., Kumar, P., Maurya, N.K. Pal, R.K. and Verma, H. (2022). Effect of weed management practices on weed flora of wheat crop. The Pharma Innovation Journal, 11(4), 320-324.