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Effect of different sowing methods and varieties on growth and yield performance of wheat crop

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ABSTRACT

A field experiment was carried out during 2017-18 at Regional Research Station of Chaudhary Charan Singh Haryana Agricultural University located at Kaul, Haryana, India, to examine the effect of different sowing methods and varieties on performance of wheat. The experiment had four sowing techniques (S_1: Sowing with turbo seeder after retaining all the residue of combine harvested rice, S_2: Sowing with turbo seeder in intact residue after removing the loose straw of combine harvested rice, S_3: Sowing with zero till seed cum fertilizer drill after manual harvested rice, S_4: Sowing under conventional tillage conditions after manual harvested rice), and six varieties (V_1: HD 2967, V_2 : HD 3086, V_3: WH 1105, V_4 : WH 711, V_5 : WH 1124 and V_6 : WH 1142) in sub plots. The study was laid out in strip plot design with three replications. The results revealed that sowing techniques significantly influenced the performance of different varieties. The growth attributes (plant height, dry matter accumulation) and yield (seed, straw and biological yield) were significantly higher in sowing of wheat with turbo seeder after retaining all the residue of combine harvested rice (S_1) as compared to sowing with conventional tillage conditions after manual harvested rice (S_4). Whereas, in the case of varieties, wheat variety WH1142 performed better and registered maximum plant height which was statistically at par with HD 3086. However, highest dry matter accumulation, seed, straw and biological yield were achieved with HD 3086 variety as compared to rest of varieties. In conclusion, sowing techniques had significant effect on growth and yield parameter of wheat. The different varieties also perform differently in term of growth and productivity. So, it may be understood that HD 3086 variety had improved growth resulting in more yield when sown with tubro seeder under full rice residue retention.

Keywords: Wheat varieties, tillage, residue retention, yield, growth characters, zero tillage, turbo seeder.

INTRODUCTION

Wheat (*Triticum aestivum*) is an important staple food crop in the world growing, and grows well in different geographical regions and climatic situations. It secures 2nd position as a source of staple food after rice crop, in India. Nutritionally, wheat has almost 1-1.5% fat, 2-2.5% fibre, 8-15% protein and 62-70% carbohydrates, and provides 73% of calories in human diet. The increase in production of wheat advanced quickly during green revolution through introduction of high yielding varieties along with fertilizer and irrigation facilities. Nonetheless, major apprehension is to upsurge production pace with demand of increasing population. The scope of increasing agricultural land as well as intensification of cropping systems under wheat is very limited.

Therefore, to sustain food and nutritional security of country, enhancing and improving the productivity of wheat is the best strategy. To meet this challenge, agronomical technologies including residue management, choice of best genotype, weed management, timely sowing, and irrigation and fertilizer application are imperative to enhance productivity and assure safe environment.

Rice-wheat cropping system is biggest production system practiced on 13.5 M ha^{-1} in Indo-Gangetic plain of south Asia, of which nearly 10.3 M ha^{-1} is in Indian IGP (Jat *et al.*, 2009). The availability of minimum support price of both crop as well as subsidy on irrigation and fertilizers amenities made it a profitable and dominant cropping system. But, its sustainability is at risk due to declining soil productivity and changing climate scenario. Increasing mechanized farming using combine harvester leave huge quantity of residues after crop harvest. Farmers generally find burning of paddy straw, before sowing of wheat, as an easy and cheap option, but it results in loss of essential nutrients along with adverse impact due to air environment pollution caused by smoke (Thorat *et al.*, 2015). Crop residues are important natural resources and this is crucial to manage rice residue via proper disposal rather than burning (Rafiq *et al.*, 2017). Conventional tillage practices are energy intensive and costly input result in soil compaction, and reduced aggregates stability (Gathala *et al.*, 2011). Moreover, intensive tillage practices also delay the wheat sowing in rice-wheat cropping system. Minimum soil disturbance, residue retention and soil cover are vital components of conservation agriculture. Wheat sown under zero tillage helps in conserving soil, water, and other saves energy, improves soil organic carbon pool, microbial properties, soil aggregates and nutrients (Chaudhary and Sharma, 2019). The retention of crop residues as mulch along with zero till is promising besides increasing carbon sequestration (Singh *et al.*, 2019), and also helps in temperature regulation and moisture conservation in soil. The presence of high quantity of loose straw after combine harvesting of rice chokes the machinery and adversely the normal functioning of zero till seed drill. Therefore, usage of modern technology "Happy Seeder" which chops, carries and deposits the rice straw on soil surface as mulch coupled with sowing of wheat crop has emerged as an important option (Sidhu *et al.*, 2015). The zero tillage wheat with residue as surface mulch, using turbo happy seeder has increased yield of wheat, reduced evaporation loss and also boosted enzyme activities (Khaira *et al.*, 2017). Because of genetic distinction, different varieties vary in their growth, development, yield as well as response to various management practices (Ram *et al.*, 2017). So there is scope for enhancing the yield of wheat with the cultivation of multi-character high yielding varieties. The cultivation of high yielding wheat varieties along with improved package of agronomic techniques may help to enhance wheat productivity. For that reason, the present experiment on effect of residue retention and tillage practices on performance of wheat varieties was performed.

MATERIALS AND METHODS

Site Specifications

The experiment was carried out at the research farm of College of Agriculture at Kaul, CCS Haryana Agricultural University, Hisar, Haryana, India. Village Kaul of district Kaithal is situated at an elevation of 241 m above the mean sea level with coordinates of 29°51′ N latitude and 76°41′ E longitude (Fig. 1). It is about 35 km away from Karnal and 30 km from Kurukshetra. It is located in North Eastern (NE) part of Haryana which is also called "Rice Bowl of Haryana". At the experimental site, sub-tropical with sub-humid climate conditions prevail and is characterized by hot desiccating winds during summer season and moderate to severe cold in winter season.

The mean weekly weather data were collected at meteorological observatory located at Research Farm of Rice Research Station, Kaul (Kaithal) during the crop growing period from Nov. 2017 to April 2018. The perusals of the meteorological data are presented in Fig. 2 revealed that all weather conditions were normal for better growing of wheat crop. The average weekly standard meteorological of maximum and minimum temperatures fluctuated between 17.5°C to 37.6°C and 2.6°C to19.8°C, respectively during 2017-18. The mean weekly relative humidity (RH) in morning and evening ranged from 56 to 100 per cent and 24 to 75 per cent, respectively. The total rainfall during the crop growing period was 29.9 mm. Highest number of average bright sunshine hours (8.3) was recorded during the crop duration in 16th standard meteorological week. The weekly average wind velocity (WV) ranged from 1.2 to 6.1 km/hour. The highest open pan evaporation was recorded 7.7 mm per day 16th standard weeks whereas, evaporation

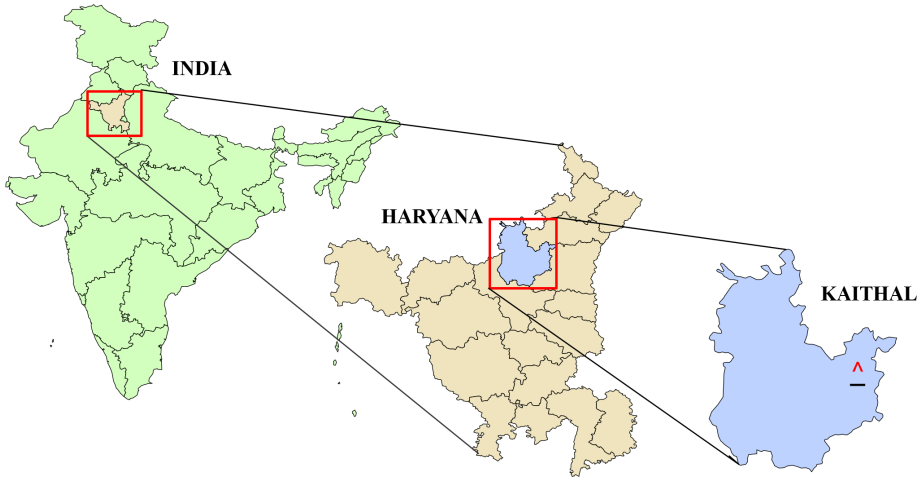

Fig. 1. Location of the experimental area

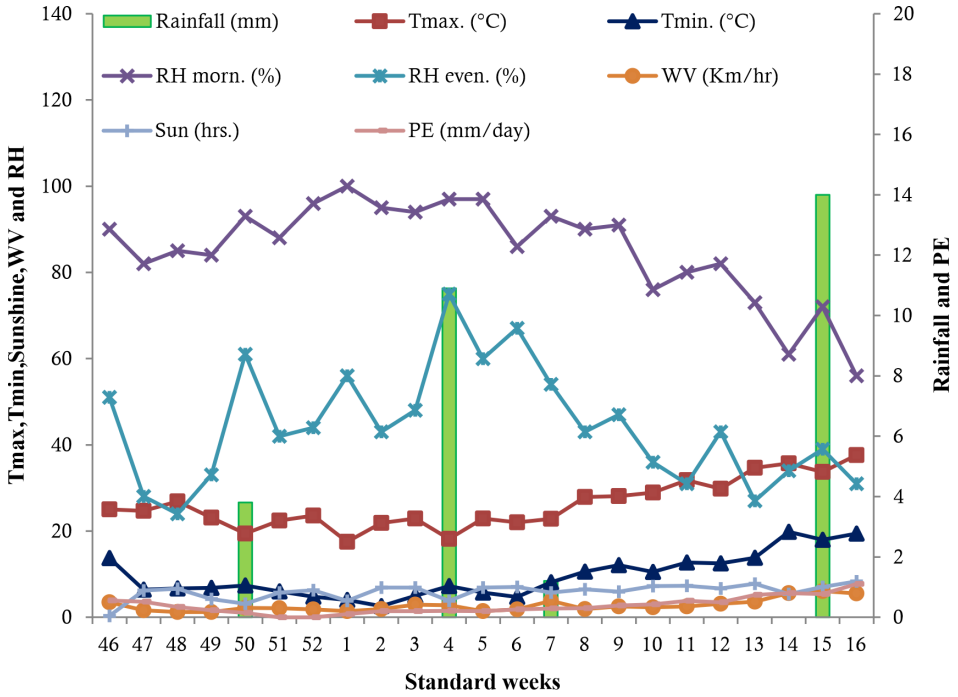

Fig. 2. Mean weekly meteorological data during crop growth period

was lowest during the 51th standard weeks with zero mm per day.

Initial status of the soil at the experiment site

Before sowing of crop, representative soil samples (0-15 cm depth) of experimental field were collected randomly from five places to determine the physico-chemical properties of the soil. Soil was loamy in texture containing 41.3 per cent sand, 32.6 and 326 per cent silt and 26.1 per cent clay. The soil was low in organic carbon (0.42%) and available nitrogen (106.0kg/ha), medium in phosphorus (26.0 kg/ha), high in potassium (312 kg/ha) and alkaline (pH 8.0) in nature.

Treatment Details

Experiment was carried out in strip plot design (SPD) with four sowing methods in main plots and six wheat varieties in sub plots with three replications. The description of treatments is depicted in table 1. Gross experimental plot size was kept to 10.0 × 2.2 m^2.

Table 1. Description of treatments under field experiment

Treatments details
Sowing Methods (S)
S_1 - Sowing with turbo seeder after retaining all the residue of combine harvested rice
S_2 - Sowing with turbo seeder in intact residue after removing the loose straw of combine harvested rice
S_3 - Sowing with zero till seed cum fertilizer drill after manual harvested rice
S_4 - Sowing under conventional tillage conditions after manual harvested rice
Varieties (V)
V_1 - HD 2967
V_2 - HD 3086
V_3 - WH 1105
V_4 - WH 711
V_5 - WH 1124
V_6 - WH 1142

Detail of operations practiced during experimentation

In the experimental field, the previous rice crop was partly harvested with combine harvester, leaving loose straw and standing paddy straw (20-25 cm height) in S_1 treatment while in S_2 treatment, only standing straw was retained after manual removal of loose straw. In S_3 and S_4, rice crop was harvested manually leaving no standing stubble or loose straw in the field. The field was ploughed twice with disc harrow and followed by planking in S_4 treatment whereas such operations were not practice in S_1, S_2 and S_3 and, pre- sowing irrigation was applied to the experimental field.

The different wheat cultivars (HD 2967, HD 3086, WH 1105, WH 711, WH 1124 and WH 1142) were sown with seed drill under S_4 treatment while, in treatment S_3, sowing of wheat was done with zero till seed cum fertilizer drill. Turbo seeder locally known as happy seeder also was used to establish different wheat varieties under S_1, S_2 and S_3 treatments. Turbo seeder can sow wheat seed in the presence of paddy residue/straw and manage the stubbles in the front of sowing tynes. The seed rate of 100 kg ha^{-1} for all wheat varieties was taken with sowing depth of 3-5 cm keeping row spacing of 20 cm. The dose of nitrogen and phosphorus is 150 kg N $ha^{-1}$and 60 kg ha^{-1} P_2O_5. Full dose of phosphorus through DAP fertilizer was applied with wheat seed while, nitrogen was applied through urea fertilizer in two equal splits i.e., half dose of nitrogen applied at the time of sowing and remaining nitrogen dose was applied at 25 DAS, at the time of first irrigation. All other cultural practices were adopted as per the recommendations package of practices issued by CCS Haryana Agricultural University, Hisar for Haryana region.

Observation Recorded

To understand the mechanism of plant growth and development, it is essential to study its behavior and performance under different treatments. Five plants were tagged randomly from each plot for documented plant height (cm) of crop recoded at 30, 60, 90, 120 days after sowing (DAS) and at maturity. The plant height of wheat plant was noted from base (main stem) near ground surface up to tip last leaf (fully open) before ear emergence. After heading stage of crop, height was documented base of plant to tip of ear head. Whereas, dry matter of wheat crop was accessed at through cutting plants from 25 cm row length in each plot from two places in the second row on either side in each plot. Plant samples were first sun dried and then oven dried at 65 ± 5°C till they attain a constant weight. Then dry weight of sample plants was documented and expressed as gram per meter row length. For calculating biological yield, firstly the bundles of wheat crop were sun dried for 3-4 days and then weight plot wise was noted. Afterwards, grains were separated with the help of mini plot thresher from sun dried biological yield obtained from each plot. Straw yield was calculated by deducting the grain yield plot wise from total biological yield. The grain, straw and biological yield obtained from net plot was converted into tonnes/ha.

Statistical analysis

Experimental data were statistically analyzed by using the methods of analysis of variance (ANOVA) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Impact of different sowing methods and varieties on plant height of wheat recorded at different time intervals

The data pertaining to plant height which was recorded periodically at 30, 60, 90, 120 DAS and maturity are depicted in Figure 3. The plant height of wheat increased from 30 DAS till maturity irrespective of the treatments under trail. The result revealed that plant height of wheat crop was not affected significantly by sowing methods at 30 DAS.

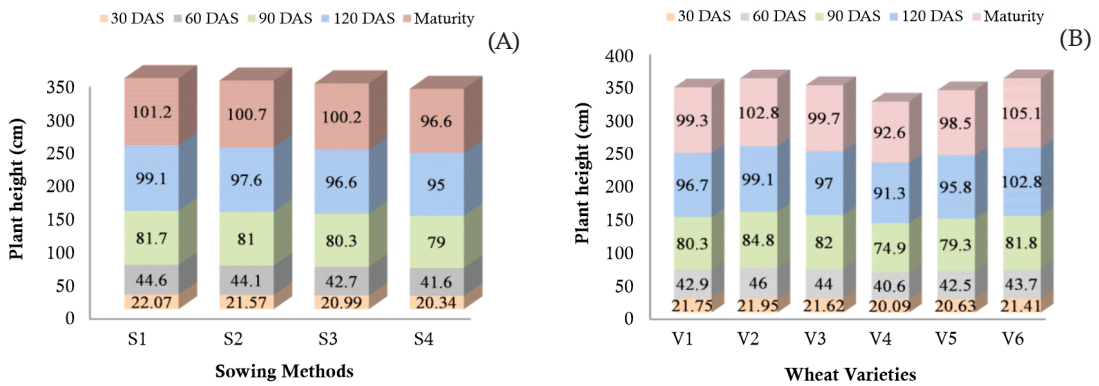

Fig. 3. Plant Height (cm) of wheat crop recorded at different time intervals as influenced by different treatments viz., (A) Sowing Methods such as S_1= Sowing with turbo seeder after retaining all the residue of combine harvested rice, S_2= Sowing with turbo seeder in intact residue after removing the loose straw of combine harvested rice, S_3= Sowing with zero till seed cum fertilizer drill after manual harvested rice, S_4= Sowing under conventional tillage conditions after manual harvested rice (B) Wheat Varieties such as; V_1= HD 2967, V_2 = HD 3086, V_3=WH 1105, V_4 =WH 711, V_5 =WH 1124 and V_6 =WH 1142

The rate of increase in plant height of wheat was maximum during the period (60 to 90 DAS) and after that slowed down. At all the crop stages starting from 30 DAS till harvest, maximum plant height was registered under S_1 treatment which was significantly higher than S_4 but statistically at par with S_2 and S_3 treatment. The differences in plant height among sowing methods might be credited by improved soil micro-environment under residue based conservation practices. These results are in unison with findings of Yadav *et al.* (2005) and Meena (2010).

Whereas, in case of varieties, different wheat varieties also did not influence plant height at 30 days after sowing, however, significant differences were observed at later stages of crop growth. At 60 and 90 days after sowing time intervals, significantly taller plants were recorded with HD 3086 being at par with WH 1105 and WH 1142 but significantly more than HD 2967, WH 1124 and WH 711 wheat varieties. But at 120 DAS and maturity stage, the wheat variety WH1142 performed better and registered maximum plant height which was statistically at par with HD 3086. The lowest plant height was recorded in variety WH 711 at different time intervals. This might be due to their genetic differences among wheat varieties. These results are confirmed by Suleiman *et al.* (2014).

Effect of different sowing methods and varieties on dry matter accumulation of wheat

Dry matter accumulation of crop is regarded as important parameter of crop growth. The dry matter accumulation data recorded at 120 DAS is given in Table 2. The interaction effect of different sowing methods and varieties on dry matter production at 120 DAS was found significant. Among different sowing treatment, the dry matter accumulation of all wheat varieties was maximum in S_1 treatment which was significantly higher than S_4 but at par with S_2 and S_3 treatments. It might be due to soil temperature regulation, better light interception, enhanced moisture of soil and improved soil microbes count. Such findings were also reported by Ram *et al.* (2010).

Treatment details; sowing methods viz., S_1: Sowing with turbo seeder after retaining all the residue of combine harvested rice, S_2: Sowing with turbo seeder in intact residue after removing the loose straw of combine harvested rice, S_3: Sowing with zero till seed cum fertilizer drill after manual harvested rice, S_4: Sowing under conventional tillage conditions after manual harvested rice, Wheat Varieties such as; V_1: HD 2967, V_2 : HD 3086, V_3: WH 1105, V_4 : WH 711, V_5 : WH 1124 and V_6 : WH 1142.

While among wheat variety, HD 3086 had significantly higher dry matter accumulation as compared to HD 3086, WH 1105, WH 711, WH 1124 and WH 1142 at all the sowing method treatments except but in S_4 treatment, in which HD 3086 wheat variety was at par with WH 1105 and HD 2967. The varieties differed in their efficacy to accumulate dry matter during crop cycle due to genetic differences. Similar outcomes were reported by Chhokar *et al.* (2018) and Mondal *et al.* (2015).

Table 2. Interaction effect of sowing techniques and varieties on dry matter accumulation of wheat

Treatments	Sowing methods (S)				
	S_1	S_2	S_3	S_4	Mean
Wheat varieties (V)					
V_1: HD 2967	349.8	348.5	347.5	327.8	343.4
V_2: HD 3086	375.3	375	362.6	335.1	362.0
V_3: WH 1105	359.6	354.8	347.4	328.9	347.7
V_4: WH 711	337.2	333.7	333.6	314.3	329.7
V_5: WH 1124	321.5	315.9	314.2	308.8	315.1
V_6: WH 1142	329.2	328.7	322.5	316	324.1
Mean	345.4	342.8	338	321.8	
			Factor (B) at same level of A		
			SEm (±)		5.5
			CD (0.05)		11.2
			Factor (A) at same level of B		
			SEm (±)		5.8
			CD (0.05)		11.8

Impact of different sowing methods and varieties on seed, straw and biological yield of wheat crop

A perusal of data on grain, straw and biological yield are presented in **Table 4**. Among different sowing methods, S_1 produced maximum grain (5.3 tonnes/ha), straw (6.3tonnes/ha) and biological yield (11.6 tonnes/ha) which was significantly higher than S_4 but there was no marked variation when compared with S_3 and S_4 treatment respectively. The increase in percentage of grain yield was 9.3%, 8.1% and 7.7% in S_1, S_2 and S_3 treatments in comparison to S_4 treatment during study, respectively. The lowest grain yield was registered under S_4 sowing method. The better yield under turbo seeder (TS) with full residue retention was combined effect of taller plants, more dry matter and tillers. The results collaborate with the findings of Brar *et al.* (2010) who reported that the surface retention of rice residue (mulch) during wheat crop in rice-wheat system did not reduce wheat yield when compared with paddy straw burnt plot. Rafiq *et al.* (2017) and Bera *et al.* (2018) reported that higher grain yield in turbo seeded wheat crop.

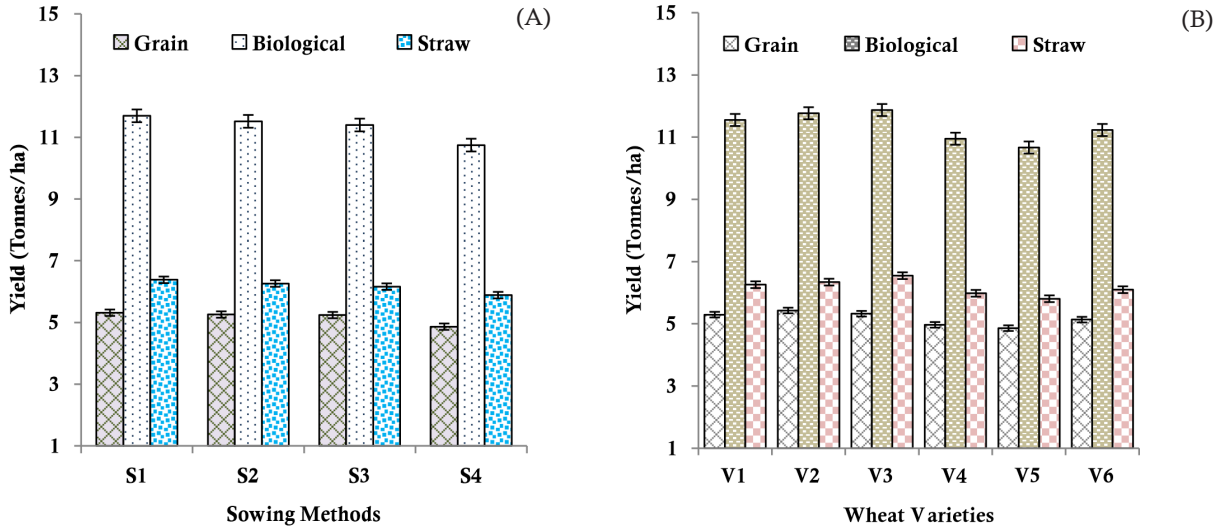

Figure 4. Wheat seed, straw and biological yield influenced by different treatments viz., (A) Sowing Methods such as S_1- Sowing with turbo seeder after retaining all the residue of combine harvested rice, S_2- Sowing with turbo seeder in intact residue after removing the loose straw of combine harvested rice, S_3- Sowing with zero till seed cum fertilizer drill after manual harvested rice, S_4- Sowing under conventional tillage conditions after manual harvested rice (B) Wheat Varieties such as; V_1- HD 2967, V_2- HD 3086, V_3- WH 1105, V_4 - WH 711, V_5 - WH 1124 and V_6 - WH 1142.

Significantly highest grain yield of 5.42 tonnes/ha were recorded by variety HD 3086 during 2017-18 and 2018-19, respectively which was statistically at par with variety WH 1105 (5.32 tonnes/ha) and HD 2967 (5.29 tonnes/ha) but significantly higher than variety WH 1142, WH711 and WH 1124. Lowest grain yield was obtained from variety WH 1124 (4.86 tonnes/ha). Whereas, Variety WH 1105 recorded maximum biological yield was followed by varieties by HD 3086, HD 2967, WH 1142, WH 711 and WH 1124 in descending order. Biological and straw yield of WH 1124 was lowest among rest of varieties. The yield differences in wheat varieties were might be due to higher number of effective tillers grains/spike and test weight. Secondly, it might be of better growth in terms of plant height, dry matter, number of tillers which resulted in more light interception and synthesized more food through photosynthesis and translocation of assimilates from source to sink and attributed to better grain yield. These results are confirmed by Nawaz *et al*. (2017) and Kaur (2017).

CONCLUSION

Among different sowing methods, wheat sown with turbo seeder, with full residue retention, significantly improved growth parameters which resulted in highest grain yield and productivity in comparison to conventional sown wheat with no residue retention. Among varieties, HD 3086 performed better in relation to growth and yield parameters. It may be concluded that wheat varieties HD 3086 sown with tubro seeder under full rice residue retention can register better crop growth resulting in highest productivity.

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