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Effect of Nitrogen Management Practices on the Productivity of Late Sown Wheat (*Triticum aestivum* L.) Varieties

Shiv Vendra Singh[1], Avanish Kumar Singh[2]*, Nikhil Raghuvanshi[1] and R.A. Singh[1]

[1]Department of Agronomy, Narendra Dev University of Agriculture and Technology, Faizabad (U.P), India
[2]ICAR-Agricultural Technology Application Research Institute, Kanpur (U.P), India
*Corresponding author

ABSTRACT

A field experiment was carried out at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during Rabi season of 2014-15 to study the response of late sown wheat varieties to different nitrogen management practices. Twenty treatment consisted of five doses of nitrogen (90 kg N ha^{-1}, 120 kg N ha^{-1}, 90 kg N ha^{-1} + 25% N through FYM, 120 kg N ha^{-1} + 25% N through FYM, 150 kg N ha^{-1}) and four varieties of wheat (HD-2643, HUW-234, PBW-373 and HD-2285).The experiment was conducted in Randomized Block Design (R.B.D.) factorial with three replications on silt loam having low organic carbon (0.38%), nitrogen (204 kg ha^{-1}), medium in phosphorus (15.35 kg ha^{-1}) and potassium (267 kg ha^{-1}). The growth characters like plant height, dry matter accumulation, number of tillers, leaf area index were significantly higher under 150 kg N ha^{-1} being at par with120 kg N ha^{-1} + 25% N through FYM over rest of the levels and among the varieties PBW- 373 was at par with HD-2285 while significantly superior over HP-2643 and HUW-234. The yield components like number of ears per meter row length, ear length (cm), number of grain ear^{-1}, grain weight ear^{-1} (g) grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and nitrogen uptake at harvest (kg ha^{-1}) were maximum under 150 kg N ha^{-1} which was at par with 120 kg N ha^{-1} + 25% N through FYM and among the varieties PBW-373 being at par with HD-2285 with respect to the yield components while grain yield (kg ha^{-1}) and straw yield (kg ha^{-1}) was maximum under PBW-373 followed by HD-2285. Harvest index and 1000-grain weight (g) were not influenced significantly due to nitrogen management practices and varieties. Thus it may be concluded that nitrogen management practice of 150 kg N ha^{-1} proved as the most suitable practice for exploitation of the yield potential of late sown wheat. Among the varieties PBW-373 and HD-2285 were found most suitable for cultivation under late sown condition for achieving higher yield and economics.

Keywords

Wheat, *Triticum aestivum* L. Wheat varieties, Nitrogen Management Practices.

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Introduction

Wheat (*Triticum aestivum L.*) is a staple food of the world and falls under Poaceae family. It is primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. It is the single most important cereal crop that has been considered as integral component of the food security system of the several nations. It ranks first in the world among the cereals both in respect of area (225.43 mha) and production (696.94 mt.). In India, total area under wheat is 29.90 mha with the production and productivity of 93.90 mt and 3140 kg ha^{-1}, respectively (Anonymous, 2013).

Major wheat producing countries in the world are China, India, USA, France, Russia, Canada, Australia, Pakistan, Turkey, UK, Argentina, Iran and Italy. These countries contribute about 74.82% of the total world wheat production. As far as India is concerned, about 90% of the total wheat production is contributed by northern states. Among them, Uttar Pradesh ranks first with respect to area (9.734 mha) and production (30.30 mt) but the productivity is much lower (3113 kg ha^{-1}) than Punjab (5097 kg ha^{-1}) and Haryana (5182 kg ha^{-1}) (Anonymous, 2013).

The demand of wheat by 2020 has been projected to be between 105 to 109 mt in the country. Most of the increase in production will have to manage from integrated use of resources, as the land area under wheat is not expected to expand further. The productivity of wheat in eastern U.P. is very low (2500 kg ha^{-1}), might be due to adoption of cereal-cereal (Rice-Wheat) cropping system, late sowing, poor weed management and imbalance fertilization, etc.

The late transplanting of rice or use of long duration varieties of rice in low land delays the sowing of wheat from mid November to December. The preceding crops such as sugarcane, potato, toria etc. and other factors forced to sow the wheat as late as in the month of December and January. Due to delay sowing wheat yield is declined drastically. Low temperature, poor mineral accumulation, less translocation of photosynthates from source to sink, hot desiccating wind during milking stage forced premature drying, unsuitable location specific varieties, imbalanced nutrient management are responsible for low yield under late sown wheat. Different varieties under late sown condition respond variably to various nitrogen management practices.

Balanced fertilizer through organic and inorganic sources improves the soil health as well as boosts the productivity of wheat. Organic matter is the substrate for a large number of soil living beneficial organisms which are essential to keep the plant healthy. All India Co-ordinate Research Project on microbial development reported that organic manure can be enriched by *Aspergillus awamori*. Application of 5 tonnes of same enriched compost under rice – wheat sequence gave adequate phosphate, comparable to the application of 40 kg Missouri rock phosphate. Enriched FYM improves the nutrient availability and increases wheat yield. Organic matter in soil increases the water holding capacity, cation exchange capacity as well as improves the soil structure for better performance of microorganisms. The soil which enriched in organic matter has been found to respond better to the application of nitrogenous fertilizers (Subbiah and Bajaj, 1968). About 40% of cattle dung is available for manuring, rest being wasted or used as fuel (Whyte, 1957). Thus, a good amount of organic waste is lost which is an important input for agricultural production. In the event of widespread energy crisis and deterioration of soil fertility due to intensive agriculture and imbalance use of fertilizers, it is highly desirable for making massive efforts to adopt organic matter recycling as a source of bio-energy and to supplement the demand gap of N,P,K as well as to enrich the soil in respect to micronutrients.

Thus, the combination of FYM with inorganic fertilizers may be highly effective for increasing the yield under late sown wheat as well as better quality of produce in addition to sustaining biological health and maintaining balanced C: N ratio of the soil. The information on nutrient management under late sown wheat is very meager and fragmentary. Keeping these facts in view, the present investigation entitled "Effect of nitrogen management practices on the productivity of late sown wheat (*Triticum aestivum* L.) varieties" was under taken at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during *Rabi* season of 2014-2015 to achieve the following objectives;

- To find out the suitable nitrogen management practice for late sown wheat,

- To assess the performance of wheat varieties under various nitrogen levels.

Materials and Methods

The field experiment was conducted at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj) Faizabad (U.P.), during *Rabi* season of 2014-15. The experimental site falls under sub-tropical zone in Indo-gangatic plains and lies between 26^0.47 North latitude, 82^0.12 East longitudes, at an attitude of about 113.0 meter from mean sea level. The soil of experimental field was low in available nitrogen (204.00 kg/ha) and organic carbon (0.34%), medium in available phosphorus (15.35 kg/ha) and high in potassium (267.00 kg/ha). The reaction of the soil was slightly alkaline. The total rainfall during course of experimentation was 124.0 mm. During the crop season, the lowest temperature (5.9^0C) was recorded in the month of December to January and the maximum (36.8^0C) in the month of April. The highest mean relative humidity (86.6%) was recorded in the month of January. The experiment was laid out in randomized block design with four varieties (HD-2639, HUW-234, PBW-373 and HD-2285) and five nitrogen management practices (90 kg N ha^{-1}, 120 kg N ha^{-1}, 90 kg N ha^{-1} + 25% N through FYM, 120 kg N ha^{-1} + 25% N through FYM, 150 kg N ha^{-1}) with three replication. There were twenty treatment combinations comprised of 4 varieties and 5 nitrogen management practices. The sowing was done on 15 December 2014 with the seed rate of 125 kg ha^{-1} and spacing between rows was 20 cm apart. The nitrogen as per treatment through FYM was applied 15 days before sowing, while rest of the nitrogen was applied through Urea and DAP (18% N and 46 % P_2O_5). Half of the Urea was applied as basal (at time of sowing) and remaining half dose of nitrogen was applied at 30 days after sowing through the Urea. However, 60 kg P_2O_5 ha^{-1} through DAP and 40 kg K_2O ha^{-1} through muriate of potash was applied at the time of sowing as a basal dose. Five irrigations were given, coinciding with the critical stage of the plant growth, beside pre-sowing irrigation by Tube-well. In order to check the weeds growth one manual weeding was done at 35 days after sowing. The crop was harvested at proper stage of maturity as determined by visual observations on 25 April 2015.

Half meter length on either end of each plot and 2 border rows from each side (border rows) were first removed from the field to avoid error. The crop in net plot was harvested for calculation of yield data. Produce was tied in bundles and weighted for biomass yield. Threshing of produce of each net plot was done by using pull man's thresher. Five plants selected randomly were tagged from the net plot area of each treatment for recording various biometric observations and the data collected were analyzed statistically following the procedure described by Gomez and Gomez (1984).

Results and Discussion

Growth characters

Plant height (cm)

Plant height increased progressively at the successive stages of crop growth as influenced by various varieties and nitrogen management practices. Data pertaining to plant height is summarized in table 1. In general, plant height increased successfully at 30, 60 and 90 DAS. There after the rate of increase in plant height was nominal at harvest stage of the crop. Maximum plant height was recorded with variety PBW-373, which was at par with HD-2285 and significantly superior over HD-2643 and HUW-234 varieties. Same trend as 60DAS was found at 90 days after sowing and at harvest stage. Regarding nitrogen management practices, plant height as increased significantly with increasing levels of nitrogen from 90 kg N ha^{-1} to 150 kg N ha^{-1}. Application of 150 kg N ha^{-1} was found at par with 120 kg N ha^{-1} + 25% N through FYM and 120 kg N ha^{-1} and it was found significantly superior with respect to the plant height over rest of the nitrogen management practices at 30 days after sowing. Same trend was found at 60 and 90 DAS whereas at harvest stage, it was at par only 120 kg N ha^{-1} + 25% N through FYM and significantly superior over all other nitrogen management practices. Variation in plant height among varieties might also be probably due to their genetic characters. Similar finding in respect to varieties were reported by Brijkishor (1998). The significant increase in plant height was recorded in present investigation, which was mainly due to more availability of nitrogen (Table 1). Higher nitrogen level resulted higher nitrogen uptake, which ultimately results into increased protein synthesis, cell division and cell enlargement which express morphologically an increase in height of plant. Similar findings were reported by Mankotia *et al.,* (2007).

Number of tillers m^{-1} row length

The number of tillers m^{-1} row length increased progressively at the successive stages of crop growth as influenced by various varieties and nitrogen management practices. Data pertaining to number of tillers m^{-1} have been summarized in table 2. In general, number of tiller increased progressively up to 90 DAS stage. There after the rate of increase in number of tillers decreased at harvest stage of the crop. Maximum number of tillers was found at 90 days after sowing and thereafter, decreased till the maturity. The higher number of tillers m^{-1} row length were recorded with variety PBW-373, which was at par with variety HD-2285 and significantly superior over all other varieties. Same trend was found at 60, 90 DAS and at harvest stage. Number of tillers was significantly affected by various nitrogen management practices at all the stages of crop growth. Regarding nitrogen management practices, number of tillers increased significantly with increasing levels of nitrogen. Application of 150 kg N ha^{-1} was found at par with 120 kg N ha^{-1} + 25% N through FYM and 120 kg N ha^{-1} and significantly superior over rest of the nitrogen levels at 30 DAS, while at 60, 90 DAS and harvest stage it was only at par with 120 kg N ha^{-1} + 25% N through FYM and significantly superior over all other nitrogen management practices. Variation in number of tillers might be due to their own genetic characteristics. Similar finding in respect to varieties were reported by Behra (1994) and Singh (1998). The number of tillers per meter row length at 30, 60, 90 days after sowing and at harvest stage and effective tillers were influenced significantly by nitrogen management practices (Table 2). The significant increase in number of tillers per meter row length was recorded only upto 150 kg N. Similar results were reported by Gontia and Joshi (2000), Avijit *et al.*, (2003) and Ram and M.I.R. (2006).

Dry matter accumulation (g m^{-1} row length)

Dry matter accumulation was affected considerably due to various varieties and nitrogen management practices. Data pertaining to number of tillers have been summarized in table 3. The table revealed that dry matter accumulation was significantly influenced by various varieties and nitrogen management practices. In general, the dry matter accumulation increased with advancement in crop growth stages. A perusal of data in table revealed that maximum dry matter accumulation was recorded with variety PBW-373 which was at par with HD-2285 and significantly superior to rest of the varieties at 30, 60, 90 DAS and at harvest stage. Regarding nitrogen management practices, dry matter accumulation was influenced significantly. Maximum dry matter accumulation was recorded with the application of 150 kg N ha^{-1} which was found at par with 120 kg N ha^{-1} + 25% N through FYM and significantly superior over all other nitrogen levels at all stages of crop growth.

Significant dry matter accumulation by plants was because of more number of tillers per meter row length. Healthy shoots due to higher nutrients absorption capacity, more number of ear bearing tillers due to less mortality resulted higher dry matter production. Minimum dry matter accumulation (167.01 g m^{-1} row length) recorded with variety HUW-234 at harvest stage. However, which reflected due to less number of ears bearing tillers m^{-1} row length resulted less dry matter production. Similar findings were reported by Singh (1998). The Dry matter accumulation influenced significantly due to different nitrogen management practices at all the stages (Table 3). Significant dry matter accumulation recorded upto150 kg N. This might be attributed due to more synthesis of food material in plants. Similar findings were reported by Singh (1991).

Yield contributing characters

The data pertaining to yield attributing characters *viz*., number of ear m^{-1} row length, ear length, number of grains ear^{-1}, grain weight ear^{-1} and 1000-grain weight have been presented in table 4.

Number of ear m^{-1} row length

The data presented in table 4 revealed that number of ear per meter row length was significantly influenced by varieties and nitrogen management practices. Maximum numbers of spikes per meter row length were recorded in variety PBW-373 which found was at par with HD-2285 and significantly superior over all other varieties. Regarding nitrogen management practices, application of 150 kg N ha^{-1} produced maximum number of ear per meter row length which was at par with 120 kg N ha^{-1} + 25% N through FYM and significantly superior over all other of nitrogen management practices.

Length of ear (cm)

The length of ear influenced significantly by varieties and nitrogen management practices. The maximum length of ear was recorded with variety PBW-373, which was at par with variety HD-2285 and significantly superior over rest of the varieties. As regards nitrogen management practices, maximum ear length was recorded with 150 kg N ha^{-1} which was at par with 120 kg N ha^{-1} + 25% N through FYM. However, it was significantly superior over rest of the nitrogen management practices.

Number of grains ear^{-1}

The number of grains ear^{-1} influenced significantly by varieties and nitrogen management practices. The maximum number of grains ear^{-1} was found with variety PBW-373, which was at par with variety HD-2285 and significantly superior over all other varieties. Application of 150 kg N ha^{-1} produced significantly higher number of grains ear^{-1} which was at par with 120 kg N ha^{-1} + 25% N through FYM and significantly superior over other nitrogen management practices.

Grain weight ear^{-1}

Grain weight ear^{-1} influenced significantly by varieties and nitrogen management practices. The maximum grain weight ear^{-1} was found with variety PBW-373, which was at par with variety HD-2285 and significantly superior over all other varieties. Application of 150 kg N ha^{-1} produced significantly higher grain weight ear^{-1} which was at par with 120 kg N ha^{-1} + 25% N through FYM and significantly superior over all other nitrogen management practices.

1000-grain weight (g)

Data pertaining to 1000-grain weight have been presented in table 4. The data revealed that the 1000-grain weight (g) was not influenced significantly by varieties as well as nitrogen management practices. Different cultivars tested during experimentation could not reach to the level of significance in increasing the test weight. However, the higher value of test weight (39.28) was obtained with the PBW373. However, the higher test weight of 40.10 g was recorded with the application of 150 kg N ha^{-1}.

Yield was the resultant of co-ordination of yield attributes. Vigorously growing plants are able to absorb larger quantity of mineral nutrients through well developed root system. The variety PBW-373 gave higher number of ears m^{-1} row length, grain ear^{-1}, length of ear and 1000 grain weight than other varieties (Table 4). It might be due to the genetic character of the variety like more reproductive tillers producing capacity, more ear length etc. Minimum yield contributing characters were credited recorded to HUW-234. It was due to less reproductive tillers, less ear length as well as less number of grain ear^{-1}. Similar findings were reported by Singh and Singh (1989), Singh and Singh (1991), Brijkishor (1998) and Liaquat *et al.,* (2003). The yield contributing characters viz. number of effective tillers, ear length, number of grains ear^{-1}, grain weight ear^{-1}, test weight (1000-grain weight) increased with increase in nitrogen levels. The significant increase of these characters obtained only upto 150 kg N (Table 4). This might be due to enhanced tillering, photosynthetic area and increased sink size in presence of adequate nitrogen. Similar research findings were reported by Kumpawat and Rathore (2003), Singh (2002) and Parihar (2004).

Yield

Grain yield (q ha^{-1})

The data pertaining to grain yield were recorded and presented in table 5. The data revealed that the grain yield influenced significantly by varieties as well as nitrogen management practices. Among the varieties, maximum grain yield was recorded with variety PBW-373, which was significantly superior over all other varieties. Increased in grain yield was recorded upto the application of 150 kg N ha^{-1} but it was not increasing significantly.

Application of 150 kg N ha^{-1} recorded higher grain yield which was at par with120 kg N ha^{-1} + 25% N through FYM and 120 kg N ha^{-1} and significantly superior over all other nitrogen management practices. The grain yield significantly increased only up to 150 kg N ha^{-1} (Table 5). This might be due to more ear length, number of grains ear^{-1}, grain weight ear^{-1} and 1000 grain weight. Similar findings were reported by Singh *et al.,* (2003).

Table.1 Effect of different treatments on plant height at various growth stages of the wheat crop

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
(A) Varieties				
HD-2643	19.28	55.18	76.14	77.40
HUW-234	18.84	53.48	73.81	75.05
PBW-373	20.37	59.12	81.59	82.97
HD-2285	19.91	57.42	79.26	80.58
SEm±	0.34	1.10	1.50	1.37
CD (P=0.05)	0.98	3.14	4.79	3.93
(B) Nitrogen management practices				
90 kg N ha^{-1}	18.52	52.36	72.26	73.49
120 kg N ha^{-1}	19.75	56.86	78.47	79.76
90 kg N ha^{-1} + 25% N through FYM	18.98	54.05	74.58	75.83
120 kg N ha^{-1} + 25% N through FYM	20.06	57.99	80.03	81.37
150 kg N ha^{-1}	20.68	60.24	83.15	85.55
SEm±	0.38	1.23	1.67	1.53
CD (P=0.05)	1.10	3.51	4.79	4.39

Table.2 Effect of different treatments on number of tillers at various growth stages of the wheat crop

Treatments	Number of tillers m^{-1} row length			
	30 DAS	60 DAS	90 DAS	At harvest
(A) Varieties				
HD-2643	58.91	87.22	95.25	94.09
HUW-234	57.10	84.54	92.34	91.20
PBW-373	63.09	93.45	102.11	100.81
HD-2285	61.30	90.78	99.14	97.90
SEm±	1.20	1.60	1.82	1.67
CD (P=0.05)	3.42	4.59	5.22	4.79
(B) Nitrogen management practices				
90 kg N ha^{-1}	55.89	82.77	90.33	89.27
120 kg N ha^{-1}	60.70	89.87	98.17	96.96
90 kg N ha^{-1} + 25% N through FYM	57.72	85.45	93.32	92.17
120 kg N ha^{-1} + 25% N through FYM	61.89	91.67	100.11	98.87
150 kg N ha^{-1}	63.29	95.23	104.01	102.73
SEm±	1.34	1.79	2.04	1.87
CD (P=0.05)	3.83	5.13	5.83	5.35

Table.3 Effect of different treatments on dry matter accumulation at various growth stages of the wheat crop

Treatments	Dry matter accumulation (g m^{-1} row length)			
	30 DAS	60 DAS	90 DAS	At harvest
(A) Varieties				
HD-2643	14.02	108.29	172.28	211.22
HUW-234	13.59	104.96	167.01	204.64
PBW-373	15.02	116.04	184.61	226.30
HD-2285	14.58	112.71	179.31	219.83
SEm±	0.21	2.06	3.12	3.69
CD (P=0.05)	0.61	5.90	8.95	10.57
(B) Nitrogen management practices				
90 kg N ha^{-1}	13.29	102.75	163.49	200.42
120 kg N ha^{-1}	14.42	111.61	177.57	217.65
90 kg N ha^{-1} + 25% N through FYM	13.73	106.08	168.74	206.88
120 kg N ha^{-1} + 25% N through FYM	14.74	113.83	181.08	221.97
150 kg N ha^{-1}	15.32	118.24	188.12	230.58
SEm±	0.24	2.30	3.49	4.13
CD (P=0.05)	0.68	6.60	10.00	11.82

Table.4 Effect of different treatments on yield contributing characters of wheat crop

Treatments	Number of ears m^{-1} row length	Ear length (cm)	Number of grains ear^{-1}	Grain weight ear^{-1} (g)	Test weight (1000-grain weight)
(A) Varieties					
HD-2643	63.92	9.02	37.72	1.48	39.12
HUW-234	61.93	8.73	36.59	1.44	39.17
PBW-373	68.45	9.67	40.42	1.59	39.28
HD-2285	66.49	9.38	39.27	1.54	39.23
SEm±	0.87	0.12	0.59	0.02	0.70
CD (P=0.05)	2.48	0.34	1.68	0.06	NS
(B) Nitrogen management practices					
90 kg N ha^{-1}	60.64	8.54	35.83	1.35	38.53
120 kg N ha^{-1}	65.84	9.29	38.87	1.54	39.68
90 kg N ha^{-1} + 25% N through FYM	62.58	8.83	36.94	1.41	38.61
120 kg N ha^{-1} + 25% N through FYM	67.16	9.48	39.66	1.59	40.05
150 kg N ha^{-1}	69.78	9.86	41.21	1.66	40.10
SEm±	0.97	0.13	0.66	0.02	0.78
CD (P=0.05)	2.78	0.38	1.88	0.07	NS

Table.5 Effect of different treatments on grain yield, straw yield and harvest index of the wheat crop

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
(A) Varieties			
HD-2643	38.60	50.71	43.21
HUW-234	33.70	45.06	42.76
PBW-373	45.80	62.38	42.32
HD-2285	39.70	54.99	41.90
SEm±	0.80	0.91	0.50
CD (P=0.05)	2.28	2.61	NS
(B) Nitrogen management practices			
90 kg N ha^{-1}	35.51	49.23	41.91
120 kg N ha^{-1}	40.24	54.26	42.62
90 kg N ha^{-1} + 25% N through FYM	38.66	52.97	42.21
120 kg N ha^{-1} + 25% N through FYM	41.03	54.69	42.89
150 kg N ha^{-1}	41.82	55.27	43.09
SEm±	0.89	1.02	0.55
CD (P=0.05)	2.55	2.67	NS

Straw yield (q ha^{-1})

The data presented in table 5 quite reveal that the straw yield was affected significantly due to varieties and nitrogen management practices. Among the varieties, maximum straw yield was recorded with variety PBW-373, which significantly higher over all other varieties. Straw yield increased significantly with increasing levels of nitrogen upto 150 kg N ha^{-1}. Further increase in nitrogen levels up to did not bring significant increase in straw yield. Application of 150 kg N ha^{-1} recorded maximum straw yield which was at par with 120 kg N ha^{-1} + 25% N through FYM and 120 kg N ha^{-1} and significantly superior over rest of the nitrogen management practices. Straw yield influenced significantly up to 150 kg N ha^{-1} (Table 5). This may be probably due to higher shoots and increased rate of dry matter accumulation. Similar results were given by Singh (2002).

Harvest index (%)

Harvest index as influenced by various varieties and nitrogen management practices (Table 5). Harvest index indicate the relationship between economical yield and biological yield. The data reveals that varieties and nitrogen management practices not influenced significantly. The maximum harvest index (5) was recorded with varieties HD 2643 and it was recorded minimum (41.90) with variety HD 2285 during experimentation. Regarding nitrogen management practices it was highest (43.09) with 150 kg N ha^{-1} and minimum (41.90) with 90 kg N ha^{-1}. Harvest index of wheat was not affected significantly due to nitrogen management practices (Table 5). Similar results were given by Singh (1998). The highest grain and straw yield was recorded with variety PBW-373 followed by variety HD-2285 (Table 5). The reason behind this may be because of good plant stand, more number of ear bearing tillers, long ear head and more number of grains ear^{-1} with more test weight. Minimum grain yield recorded with variety HUW-234, might be due to less number of ear bearing tillers, small ear head and less number of grains ear^{-1} and poor grain development. Similar findings were obtained by Singh (1998) and Sardana *et al.*, (1999). The varieties did not differ significantly in harvest index.

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