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Effect of tillage management modules and seed rates on yield and economic of late sown varieties of wheat (*Triticum aestivum* L.) in rice fallow

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Abstract
Field experiment was conducted to study the effect of tillage management modules, seed rate and varieties on wheat with variety NW-1014 and HUW-234, at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Narendra Nagar, Faizabad (U.P.) during *Rabi* season of 2013-14 and 2014-15. The farm is located 42 km away from Faizabad city on Faizabad- Raebareily road at 26.47˚ N latitude and 82.12˚ E longitude and about 113 metres above the mean sea level. The treatment included various tillage management modules, seed rate and varieties viz. M_1: (Conventional tillage), M_2= reduced tillage and M_3= zero tillage main plot, b. Seed rate kg ha^{-1} (sub-plot) *viz.*S_1= 100 kg ha^{-1}, S_2=125, S_3=150 and c. Wheat varieties (sub-plot) V_1=NW-1014 and V_2 =HUW-234.The treatment were replicated thrice in Split Plot Design. The experimental soil was silty loam in texture having P^H 8.14, OC% 0.32, EC 0.30 dSm^1, available N:160.40,P: 12.68, K: 218.40 kg $ha^{1.}$The crop was sown om 30th December and 6th January and harvested on 3rd and 8th May of 2013-14 and 2014-15.HUW-234 wheat cultivar recorded significantly higher yield over NW-1014, Conventional tillage has been found most suitable for wheat production. The optimum dose of seed rate has been found as 150 kg ha^1 for wheat production. Wheat cultivar HUW-234 accrued the maximum net return with B:C ratio of 1.40 and 1.44 under conventional tillage with 150 Kg ha1 seed ha1 during the year 2013-14 and 2014-15 respectively.

Keywords: Wheat, tillage management modules, seed rates, yield and economics

Introduction
Wheat (*Triticum aestivum* L.) is a crop of Poaceae family and one of the most leading cereals of many countries of the world including India. Wheat is cultivated world-wide over an area of about 222.16 million hectare with an annual production of about 752 million metric tonnes (Anonymous 2016-17). In India during 2016 total food grains production was 205.43 mt, out of which, wheat production was 93.50 mt, in 30.93 m ha area with a productivity of 3.09 tones per ha (Anonymous, 2015-16) [2]. India is the second largest wheat producing country in the world, contributing about 34 percent of total food grain production. About 91% of the total wheat production is contributed by northern states. Among them Uttar Pradesh ranks first with respect to area (9.65 m ha) and production of (26.87 mt) but the productivity (2786 kg ha^{-1}) is much lower as compared to Punjab (4596 kg ha^{-1}) and Haryana 4407 kg ha^{-1} (Anonymous, 2016) [3]. The major wheat producing countries are china, India, USA, France, Russia, Canada, Australia, Pakistan, Turkey, UK, Argentina, Iran and Italy. These countries contribute about 78.82% of the total wheat production. As far as India is concerned, about 90% of the total wheat production is contributed by northern states.

The late transplanting of rice or use of long duration varieties 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 leads to low production & productivity. Low temperature, poor mineral accumulation, less translocation of photosynthesis from source to sink, hot desiccating wind during milking stage forced premature drying, unsuitable location specific varieties, imbalanced nutrient management are responsible for yield under late sown wheat.

Wheat yield under late sown condition is poor due to the less exploitation of the potentialities of the crop and available resources. Reduction in yield is mainly caused by delayed emergence of seedlings and curtailing the growth and development period of the crop. Delayed emergence of crop followed by high temperature and hot desiccating winds during grain filling stage results forced maturity of late sown wheat because of dehydration which ultimately result in heavy reduction in the whole biomass and yield.

The HUW -234 variety was developed by BHU, Varanasi in 1986 with the parents HUW 12/SPRW. The variety was released by CVRC. This variety is suitable for late sown and irrigated conditions. NW 1014 is a wheat variety was release in 1998 by CVRC. The variety was developed by NDKVV, Faizabad. The variety is widely adopted in the area NEPZ. Zero tillage farming (also called no-till or direct drilling) is a way of growing crops or pasture from year to year without disturbing the soil through tillage.

Materials and Methods

The experiment was laid out in split-plot design with the treatment was allocated to different plots randomly in all three replications using the random number *viz.*, a.M_1= conventional tillage, M_2= reduced tillage and M_3= zero tillage main plot, b. Seed rate kg ha^{-1} (sub-plot) *viz.*S_1= 100 kg ha^{-1}, S_2=125, S_3=150 and c. Wheat varieties (sub-plot) V_1=nw-1014 and V_2 =huw-234.Certified and pure seeds were tested for germination before sowing. Sowing was done on 30th December 2013 and 06 January 2015 using different seed rate 100,125 and 150 kg ha^{-1}. Sowing was done in rows 20 cm apart using zero tillage, reduced tillage and conventional tillage. Planking was also done in case of reduced tillage and conventional tillage.

On the basis of gross plot an uniform dose of nitrogen @ 60 kg ha^{-1} (half dose) through urea, phosphorus @ 60 kg ha^{-1} through single super phosphate and potassium @ 40 kg ha^{-1} through murate of potash were applied to all treatments as basal dressing. Remaining half dose of nitrogen (60 kg ha^{-1}) through urea was top dressed in two equal doses. Wheat was harvested when the leaves and stems turn yellow and become finally dry. Two rows of border from both the side of the plot and 0.5m length of both sides were harvested first and removed from the field and after that net plots were harvested separately.

The grains were obtained after thershing of the net plot area and the grain was weighted and expressed as gain yield kg plot^{-1} and finally converted into q ha^{-1}.The straw yield for each net plot was obtained by subtracting the grain yield from total biological yield and ultimately converted in to q ha^{-1}**.** All the above ground biomass of experimental crop of each plot was harvested, sun dried and weighed in kg plot^{-1} to represent the biological yield and finally converted in to qha^{-1}.The recovery of grain from biological yield (dry matter) was considered as harvest index which expressed in percentage and calculated with the help of following formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \text{ x } 100$$

Cost of cultivation for different treatments were worked out by considering all the expenses incurred in the cultivation of experimental crop and added with variable cost due to treatments. Gross return was worked out by multiplying grain and straw yield separately under various treatments to their existing market price. The money value of both grain and straw yield was added together in order to achieve gross return Rs.ha-1. Net return was calculated by deducting the cost of cultivation from the gross return of the individual treatment. Benefit cost ratio was calculated by dividing net return by cost of cultivation.

$$\text{B: C} = \frac{\text{Net return (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

Results

Grain yield (q ha^{-1})

The data pertaining to grain yield was recorded and presented in Table no-1 and depicted in. The data revealed that the grain yield of wheat was significantly influenced by the different tillage management module, seed rate and varieties. The grain yield of wheat was also significantly affected by tillage management modules. The highest grain yield was recorded with conventional tillage (27.58 and 29.70 q ha^{-1}) which was significantly higher over reduced tillage and zero tillage. The grain yield increased by 11.61% and 12.75% in conventional tillage as compare to zero tillage during the year 2013-14 and 2014-15, respectively. The variation in wheat grain yield was observed significant due to seed rate. Grain yield of wheat 27.03 and 27.18 q ha^{-1} was observed under 150 kg ha^{-1} which was significantly higher over 100 and 125 kg ha^{-1}. Among the varieties, maximum grain yield was recorded with variety HUW-234 (27.08 and 27.38 q ha^{-1}) as compared to NW-1014 (23.84 and 24.48 q ha^{-1}) variety during the year 2013-14 and 2014-15, respectively.

Straw yield (q ha^{-1})

Data pertaining to straw yield indicated that the tillage management module had significant effect on the straw yield of wheat (Table no-1). Significantly higher straw yield (33.96 and 34.54 q ha^{-1}) was recorded with conventional tillage than zero tillage and reduced tillage. The effect of seed rate in respect of straw yield of wheat was observed significant during both the years. The significantly higher straw yield was observed with 150 kg seed rate (33.46 and 33.78 q ha^{-1}) over the treatment 100 kg ha^{-1} and 125 kg ha^{-1} seed rate. Among the varieties, maximum straw yield was recorded with HUW-234 variety (31.06 and 33.01 q ha^{-1}) which was significantly superior over NW-1014 (30.00 and 31.12 q ha^{-1}) variety, respectively during both the year of investigation.

Biological yield (q ha^{-1})

Data pertaining to biological yield per hectare as influenced by different tillage management module, seed rate and varieties shown in Table no-1 revealed that the tillage management module had significant effect and highest biological yield was recorded as 61.55 and 64.24 q ha^{-1} which was significantly higher over rest of the tillage management module during both the years. The effect of seed rate in respect of biological yield of wheat was observed significant in the both years. The seed rate 150 kg ha^{-1} recorded significantly higher biological yield as compared to the treatment where seed rate was @ 100 and 125 kg ha^{-1} during both the years. Among the varieties, maximum biological yield was recorded with HUW-234 (58.14 and 60.39 q ha^{-1}) which was significantly higher over NW-1014 variety (53.84 and 55.60 q ha^{-1}) in respective years.

Harvest index (%)

The data on harvest index as influenced by tillage management module, seed rate and varieties are presented in Table no-1. Data indicated that tillage management modules did not significantly affect the harvest index. Highest harvest index (44.80 and 46.23%) was recorded under conventional tillage and lowest harvest index was observed in zero tillage (43.65 and 43.80%) during both the years, respectively. The effect of seed rate in respect of harvest index was also observed non-significant. The treatment having 100 kg ha^{-1} seed rate application, recorded the highest harvest index (44.39 and 45.02%) but lowest harvest index (43.59 and

44.51%) was observed with 150 kg ha^{-1} seed rate during the both years. Among the varieties, higher harvest index was recorded with HUW-234 in comparison to NW-1014 in both of the years but the varietal effect was non-significant on the harvest index during both the years.

Cost of cultivation

The data presented in table no-2. Obviously revealed that the cost of cultivation with tillage management module and seed rate. The highest cost of cultivation (Rs.27184 and Rs.27334) was recorded with the treatment combination $V_2M_3S_3$ (zero tillage with 150 seed rate under HUW 234 variety) and lowest cost of cultivation (Rs.23734 and Rs.23834) was noted with treatment combination $V_1M_2S_1$ (reduced tillage with 100 kg seed rate under NW-1014 variety) during 2013-14 and 2014-15, respectively.

Gross income

The data on gross income calculated under various tillage management and seed rate presented in table no-2 show that maximum gross income (Rs.63557 and Rs.65107) was recorded with the treatment combination $V_2M_1S_3$ (conventional tillage with 150 seed rate under HUW 234 variety) and lowest gross income (Rs.44558 and Rs.44026) was noted with treatment combination $V_2M_2S_1$ (reduced tillage with 100 seed rate under HUW 234 variety) during 2013-14 and 2014-15, respectively.

Net income

The maximum net income Rs 37123 and 38373 was calculated (Table no-2) under the treatment $V_2M_1S_3$ (conventional tillage with 150 seed rate under HUW 234 variety) and minimum net income Rs 20624 and 19892 was recorded with the treatment combination $V_2M_2S_1$ (reduced tillage with 100 seed rate under HUW 234 variety) in both the seasons 2013-14 and 2014-15, respectively

Benefit cost ratio

The data further revealed that highest benefit cost ratio (1.40 and 1.44) was obtained (Table no-2) with the treatment combination $V_2M_1S_3$ (conventional tillage with 150 seed rate under HUW 234 variety) while lowest benefit cost ratio (0.86 and 0.82) was noted with the treatment combination $V_2M_2S_1$ (reduced tillage with 100 seed rate under HUW 234 variety) during both the year.

Table 1: Effect of different treatments on yields and harvest index (%) of wheat under late sown conditions

Treatment	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Biological yield (q ha^{-1})		Harvest index (%)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Main plot (tillage management module)								
Conventional	27.58	29.70	33.96	34.54	61.55	64.24	44.80	46.23
Reduced	20.37	21.83	25.85	27.73	46.22	49.56	44.12	44.07
Zero	24.71	26.34	31.79	33.75	56.58	60.09	43.65	43.80
SEm±	0.08	0.09	0.06	0.16	0.11	0.18	0.08	0.12
CD at 5%	0.32	0.34	0.25	0.64	0.42	0.69	0.32	0.38
Sub plot (seed rate kg ha^{-1})								
100	24.65	24.95	27.55	30.46	51.81	55.11	44.39	45.02
125	25.90	26.05	30.59	31.77	54.64	57.82	43.67	44.94
150	27.03	27.18	33.46	33.78	56.91	60.95	43.59	44.51
SEm±	0.14	0.20	0.09	0.21	0.15	0.34	0.17	0.12
CD at 5%	0.40	0.58	0.26	0.61	0.44	0.97	0.48	0.38
Sub plot (Variety)								
NW-1014	23.84	24.48	30.00	31.12	53.84	55.60	44.27	44.02
HUW-234	27.08	27.38	31.06	33.01	58.14	60.39	46.57	45.33
SEm±	0.11	0.17	0.07	0.17	0.12	0.27	0.14	0.18
CD at 5%	0.33	0.48	0.21	0.50	0.36	0.79	0.40	0.51

Table 2: Effect of different treatments on Cost of cultivation, Gross income, Net return ₹ ha $^{-1}$, B:C ratio of wheat under late sown conditions

Treatments	Cost of cultivation (Rs. ha^{-1})		Gross income (Rs. ha^{-1})		Net income (Rs. ha^{-1})		B:C ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
V1M1S1	25234	25334	58297.33	59648.67	33063.33	34214.67	1.31	1.35
V1M1S2	25684	25809	59706.33	61682.67	34022.33	35748.67	1.32	1.38
V1M1S3	26134	26284	61226.00	63384.00	35092.00	36950.00	1.34	1.40
V1M2S1	23734	23834	46652.00	46896.33	22918.00	22962.33	0.97	0.96
V1M2S2	24184	24309	48715.00	48967.50	24531.00	24533.50	1.01	1.00
V1M2S3	24634	24784	49915.33	51733.67	25281.33	26799.67	1.03	1.07
V1M3S1	25984	26084	51434.33	55783.83	25450.33	29599.83	0.98	1.13
V1M3S2	26434	26559	53536.00	57905.50	27102.00	31221.50	1.03	1.17
V1M3S3	26884	27034	55312.33	60226.83	28428.33	33042.83	1.06	1.22
V2M1S1	25434	25534	60118.67	61432.50	34684.67	35798.50	1.36	1.40
V2M1S2	25934	26059	61784.33	63272.00	35850.33	37088.00	1.38	1.42
V2M1S3	26434	26584	63557.00	65107.50	37123.00	38373.50	1.40	1.44
V2M2S1	23934	24034	44558.67	44026.33	20624.67	19892.33	0.86	0.82
V2M2S2	24434	24559	49202.67	48917.50	24768.67	24233.50	1.01	0.98
V2M2S3	24934	25084	52781.67	54192.50	27847.67	28958.50	1.12	1.15
V2M3S1	26184	26284	60016.33	60132.67	33832.33	33748.67	1.29	1.28
V2M3S2	26684	26809	61480.33	62465.00	34796.33	35531.00	1.30	1.32
V2M3S3	27184	27334	63163.00	64629.50	35979.00	37145.50	1.32	1.35

Discussion and conclusion

The tillage practices affected the grain yield. The higher Grain yield was recorded with conventional tillage followed by zero tillage. This might be due to surface pulverization of soil comparatively for longer period with conventional tillage, which recorded higher yield attributes resulting in maximum grain yield. Similar research findings were also reported by Khan ali *et al.* (2012) [4], Kadian *et al.* (2005) [5], and Panday *et al.* (2001) [6]. The tillage practices affected the straw yield. The higher straw yield was recorded with conventional tillage followed by zero tillage and reduced tillage. This might be due to surface pulverization of soil comparatively as discussed in case of grain yield under conventional tillage, which recorded higher yield attributes resulting in maximum straw yield. Similar research findings were also reported by Roy *et al.* (1993) [10] and Tripathi and Chauhan (2001) [7]. Tillage practices affected the biological yield. The higher biological yield was recorded with conventional tillage followed by zero tillage and reduced tillage. This might be due to surface pulverization of soil comparatively for longer period which recorded better yield attributes. Sen *et al*. (2003) [11] also reported similar findings. Grain and straw yield significantly influenced by different tillage practices. Higher grain yield was recorded under conventional tillage. The tillage practices altered the grain yield. The maximum value of harvest index in conventional tillage and minimum in zero tillage. Similar result had also been reported by Singh *et al*. (2002) [12].

Maximum cost of cultivation was recorded with the treatment conventional tillage + 150 kg Seed ha^{-1} + variety HUW-234. While minimum under treatment combination of reduced tillage + 100 kg seed ha^{-1} + HUW-234 during both the year of study. Maximum gross return was recorded under the treatment combination of conventional tillage + 150 kg Seed ha^{-1} + variety HUW-234 application. The cost of cultivation was maximum due to tillage management practices such as conventional tillage is more expensive other than zero and reduced tillage, higher dose of seed rate and difference in cost of variety. Gross return was more due to higher production of grain and straw yield (Roy and Pardhan, 1994). Similar finding in respect to varieties were also reported by Ram *et al.* (2013) [8], Ali *et al.* (2013) and Uzun *et al.* (2012) [15].

Highest net return and Benefit-Cost ratio were obtained under treatment combination $M_1S_1V_1$ (conventional tillage +150 kg seed ha^{-1} +HUW-234) during both the year of study. This was due to application of high seed rate resulting that higher yield of conventional tillage as compare to reduce and zero tillage. Similar finding also reported by (Verma and Srivastava, 1989) [14].

On the basis of results, it may be recommended treatment for farmer $M_1S_3V_2$ (conventional tillage, 150 kg seed rate ha^{-1} and HUW-234 for growing of late sown wheat in eastern part of Uttar Pradesh.

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