Original Research Article

 **“Economic Assessment of Wheat Cultivars under various NPK Concentrations in Zero Tillage and Conventional Tillage Systems”**

**Abstract**

 Wheat is a most consumed staple grain worldwide. In India, it is grown largely in irrigated conditions under rice-wheat cropping system where temporal arrangements of crops are utmost important. The demand for recommended doses of fertilizers also needs to be revisit for harnessing production potential of high yielding varieties. Keeping these facts in mind, a field experiment was conducted in the *rabi* season of 2023–2024 and 2024–2025 at the agriculture research farm of Banda University of Agriculture & Technology in Banda, Uttar Pradesh, India. The experiment was carried out in split-split plot design where zero tillage and conventional tillage were split into two main plots which were further split into three sub plots for accommodating three high yielding wheat cultivars i.e. HD 3226, HD 3249 and DBW 187 along with three levels i.e. 100% NPK, 125% NPK and 150% NPK of recommended doses in sub-sub plots. All 18 treatment combinations were replicated thrice. The results revealed the higher grain yield of 5.06 t/ha in 2023-24 and 4.91t/ha in 2024-25 was recorded in zero tillage while in case of wheat cultivars, significant higher economic yield of 5.13 t/ha in 2023-24 and 4.93 t/ha in 2024-25 was received from DBW 187 over others. Amid nutrient management practices, considerably higher grain yield 5.21 t/ha in 2023-24 and 5.01 t/ha in 2024-25 was recorded from plots supplied 150% recommended doses of NPK over others. During both cropping seasons, the less cost of cultivation (5.24% and 5.13%), higher gross return (₹137127.00/ha and ₹141294.00/ha), higher net return (₹93177.00/ha and ₹96402.00/ha) and higher B:C ratio (2.12 and 2.14) were recorded in zero tillage. Among wheat cultivars, significantly higher gross return (₹139306.00 and ₹142111.00 / ha), higher net return (₹94140.00 and ₹96003.00 /ha) and higher B: C ratios (2.08 and 2.08) were reported with DBW 187 during both years of study. In nutrient management practices, 150% NPK levels attained significantly higher gross return (₹141603.00/ha and ₹144444.00/ha), net return (₹94592.00/ha and ₹96303.00/ha) and B: C ratio (2.02 and 2.01) during both seasons.

***Key words:*** Zero Tillage, conventional tillage, cost of cultivation, gross return, net return and B: C ratio.

**1. Introduction**

 Wheat (*Triticum aestivum* L.) being a important component of rice-wheat cropping system, playing crucial role in global food security by providing food to billions of people and half of the dietary protein and more than half of the calories (**Meena *et al.* 2017a Meena *et al.*2017b**). As wheat accords 20% of the global protein and calorie diet, it is established as an impressive crop fostering hunger and enhancing food security in today's world (**Shiferaw *et al.* 2013**). Over a billion people worldwide eat it in various forms such as bread, pasta, noodles, pastries, and breakfast cereals (**Kumar *et al.* 2017**). For a sizable portion of the livestock in the country, wheat straw is an excellent source of feed. Globally wheat is occupied highest acreage among all crops and is grown in an area about 215.91 million hectares with an annual production of about 791.02 million metric tons with 3.46 tonnes per hectare productivity. Worldwide, India’s ranks second in terms of production (14%) next to China (17%). In India, wheat is occupied around 31.83 million hectares area and produces 113.29 million tonnes with a national average yield of 3559 kg/ha (**Agricultural statistics at a glance 2023-24**). In India, Uttar Pradesh ranks first both in area and production of 9.52 Mha (30.31 %) and 33.61 mt (30.40%), respectively.

 The production and productivity of wheat largely depends upon the better crop management including tillage, use of high yielding varieties and proper nutrition. Among tillage practices, zero tillage, a component of conservation agriculture, plays a vital role in harnessing the production potential of high yielding varieties with sustainable manner. Zero tillage facilitates to sowing wheat in the standing stubbles of previous crop. It deals with the manipulation of soil in narrow strip where seeds are placed. Wheat grown after rice is generally delayed up to 15-20 days and at each day 1% yield penalty have faced by farmers if, sown after 25thNovember (**Hobbs *et al.* 1988**). Zero tillage technology has been evolved to makeup the time loss in pre-sowing irrigation and field preparation as sowing is done at residual moisture in unprepared field directly. It facilitates sowing of wheat on time result in good crop establishment. As a component of conservation agriculture its function is to protect the soil physically from sun, rain and wind and to feed soil biota. The soil micro- organisms and soil fauna take over the tillage function and soil nutrient balancing (**Rathod *et al.* 2021**). It also offers the benefits of retaining surface residues and reduces soil-water losses. With zero-tillage technology, up to 10% production cost is reduced in one hand and comparatively higher yields is received in another hand with improves soil health and fertility (**Ghosh *et al.* 2010**). Level offertility in soil with proper management plays a vital role in the performance of high yielding wheat varieties. These kinds of cultivars have a high nutrient demand, especially primary nutrients i.e. N, P and K. Adequate and balanced supply of nutrients coupled with maximization of yield potential.

 Keeping in consideration of above facts the objective of this study is to economic assessment of wheat production under contrasting tillage systems and nutrient management strategies.

**2. Materials and methods**

 The cost of field preparation, irrigation, fertilizer application, herbicide spraying, weeding, harvesting, threshing, and bagging, as well as the cost of seed, fertilizers, pesticides, labor, fuel and depreciation all were taken into consideration for calculating the cost of crop cultivation. The total revenue generated from the sale of the crop yield, including grain and straw, was considered the gross return. The net return was computed by deducting the total cultivation cost from the gross return. The B:C ratio was computed by dividing the net return by the total cost of cultivation. The data was analyzed on Microsoft excel sheet.

**2.1 Site for the experiment**

An on-farm field study was carried out at the agriculture research farm of Banda University of Agriculture & Technology, Banda, Uttar Pradesh, India during *rabi* season of crop year 2023–2024 and 2024–2025. The farm is located at an altitude of 228.61 meters above mean sea level and lies between 25.53° N latitude and 80.33° E longitude. The climate of this area is hot and semi-arid. Rainfall in this region ranges from 750 to 950 mm per year.The soil of experimental site was sandy clay loam in texture (68.592% sand, 11.216% silt and 20.192% clay),rated as low in organic carbon (0.39%), low in available nitrogen (236 kg/ha), medium in available phosphorus (16 kg/ha) and medium in available potassium (273 kg/ha).

**2.2 Experimental design and treatments**

The experiment was plan with 18 treatments in spilt-split plot design with three factors where three wheat cultivars (sub-plots) i.e.HD 3226, HD 3249 and DBW 187 were grown by two methodologies (main plots) viz. conventional tillage and zero tillage with three NPK levels (sub-sub plots) e.g. 100% NPK, 125% NPK and 150% NPK. The recommended dose of nutrients were 120 kg/ha N, 60 kg/ha P2O5 and 40 kg/ha K2O. The treatment are: T1-Conventional Tillage + HD 3226+ 100 % NPK; T2-Conventional Tillage + HD 3226+ 125 % NPK; T3-Conventional Tillage + HD 3226 +150 % NPK; T4-Conventional Tillage + HD 3249+ 100% NPK; T5-Conventional Tillage + HD 3249+ 125% NPK; T6-Conventional Tillage + HD 3249+ 150% NPK; T7-Conventional Tillage + DBW 187+ 100% NPK; T8-Conventional Tillage + DBW 187+125% NPK; T9-Conventional Tillage + DBW 187+150% NPK; T10-Zero Tillage + HD 3226+ 100% NPK; T11-Zero Tillage +HD 3226+125% NPK; T12-Zero Tillage +HD 3226+150% NPK; T13-Zero Tillage + HD 3249+100% NPK; T14-Zero Tillage +HD 3249+125% NPK; T15-Zero Tillage + HD 3249+150% NPK; T16-Zero Tillage + DBW 187+100% NPK; T17-Zero Tillage + DBW 187+125% NPK; T18-Zero Tillage +DBW 187+150% NPK.

**3. Result and discussion**

**3.1 Yield (tonnes/ha)**

 At the 5% level of significance, the yield values for grain and straw of wheat cultivars for both the years were included in the study based on the analysis of variance. In 2023-24, zero tillage, among the tillage systems, produced higher grain yield and straw yield of 5.06 t/ha and 5.94 t/ha, respectively. Out of three wheat cultivars, DBW 187 was noted to produce significantly higher grain yield (5.13 t/ha) and stover yield (6.06 t/ha) over HD 3226 and HD 3249. In nutrient management practices, significantly higher grain (5.21 t/ha) and straw yield (5.93 t/ha) were received with 150% of recommended doses of NPK.

 In crop year 2024-25, slightly lower grain and straw yield were obtained than that of crop year 2023-24. In 2024-25, 4.91 t/ha grain and 5.93 t/ha straw yield were received in zero tillage system which was higher to conventional tillage system. Among the wheat cultivars, DBW 187 produced 4.93t/ha grain and 5.98 t/ha stover yield which was significantly superior to the other cultivars under study. Amid the various nutrient management practices, 150% recommended dose of NPK produced significantly higher grain (5.01 t/ha) and straw (6.07 t/ha) yield over 125% and 100% recommended doses of NPK. The yield was attained proportionally with respect to the increasing dose of nutrients. The similar findings were observed by **Kumar *et al.* (2018), Dhaker *et al.* (2022).** The system of zero tillage improvise the soil organic carbon, water holding capacity, aeration, permeability and nutrient recycling that gives yield advantages over the conventional tillage. Improved soil properties related to increased or maintained good infiltration, root penetration and adequate nutrient supply was congenial to better growth attributing and yield attributing characters and ultimately yield.

**3.2 Economics**

 Results pertaining to economics of cultivation of various wheat cultivars with different NPK levels under zero tillage and conventional tillage systems are cited in Table (1) and Fig. (1, 2, 3 & 4). Total cost of cultivation, gross monetary returns, net monetary return and benefit cost ratio were influenced by different treatments under study. However, the interaction of wheat cultivars with NPK levels under zero tillage and conventional tillage remains unaffected during both the cropping seasons.

**3.2.1 Total cost of cultivation (**₹**ha-1)**

During both the years of study, cost of cultivation was recorded higher in conventional tillage system while zero tillage offered cost effective cultivation of wheat. In 2023-24, cost of wheat cultivation through conventional tillage system was ₹46382.00/ha while, it was 5.24% (₹43950.00/ha) lesser in zero tillage. In 2024-25 also, zero tillage offered 5.14% (₹44892.00/ha) lesser cost of wheat cultivation while conventional tillage remains costlier with ₹47325.00/ha (Fig 1). This might be due to the higher cost involved in cultivation through conventional tillage as more number of ploughing were carried out that consumed more fuel, more labor and depreciation of machines. The results are in the line of **Raju *et al.* (2012),Gupta *et al.* (2019), Kaur *et al.* (2022).**

Although, no variation was seen in total cost of cultivation among wheat cultivars but yearly difference was recorded due to hike in prices. In 2023-24, the cost was ₹ 45166.00/ha while it was ₹46108.00/ha in 2024-25. In case of nutrient management practices, the cost of 150% recommended dose of NPK was recorded higher with ₹47011.00/ha followed by NPK 125% (₹45166.00) and NPK 100% (₹43322.00) in 2023-24. In 2024-25 also, NPK 150% recorded higher cost of cultivation with ₹48141.00/ha followed by NPK 125% (₹ 46108. 00/ha) and NPK 100% (₹44075.00/ha). Higher cultivation cost in 150% NPK level was due to the increased prices of fertilizers used. Since, fertilizers are major components of cost in crop production, leads to an increase in input expenditure.

 **Fig. 1** Effect of tillage and nutrient management practices on cultivation cost of wheat cultivars.

**3.2.2 Gross return (₹ha-1)**

Table 1 and Fig 2 illustrates that various wheat cultivars with different NPK levels under zero tillage and conventional tillage systems affect gross economic returns in both the years of study. Both wheat cultivars and nutrient management practices had significant effect on gross return of crop in both seasons. Among the wheat cultivars, DBW 187 recorded significantly higher gross returns of ₹139306.00/ha in 2023-24 and ₹142111.00/ha in 2024-25. Among the nutrient management practices, application of 150% recommended dose of NPK registered ₹141603.00/ha gross returns in 2023-24 and ₹144444.00/ha gross returns in 2024-25 which were significantly higher than 125% recommended dose of NPK and 100% recommended dose of NPK. These results are in the line of **Singh *et al.* (2021), Prajapati *et al.* (2020).**This might be due to higher yield of wheat in respective treatments which led to proportionally higher gross return. Zero tillage wheat attained higher gross returns than conventional till sown wheat during both cropping seasons. The gross return of ₹137127.00/ha was received in 2023-24 and ₹141294.00/ha in 2024-25 in zero tillage system while this figure was ₹125619.00/ha in 2023-24 and ₹126654.00/ha in 2024-25 in conventional tillage system. Gross return was higher 9.16 % in 2023-24 and 11.56% in 2024- 25 in zero tillage as compared to conventional tillage. This might be due higher yield and lower input cost in zero tillage. The similar findings were reported by **Kaur *et al.* (2022), Abhineet *et al.* (2021), Sahu (2024).**

**3.2.3 Net returns (₹ha-1)**

 In the course of investigation, the net returns was found marginally higher with ₹ 93177.00 in 2023-24 and ₹ 96402.00/ha in 2024-25 under zero tillage compared to conventional tillage where net returns was ₹ 79237.00 in 2023-24 and ₹ 79330.00/ha in 2024-25. This represents an increase of 17.59 % and 21.52% in net returns under zero tillage than conventional tillage in 2023–24 and 2024–25, respectively (Table 1 & Fig 3). Similar findings were recorded by the **Gupta *et al.* (2019), Kaur *et al.* (2022), Khan *et al.* (2017) and Kushwah *et al. (*2019).** Among the different wheat cultivars, DBW 187 achieved the significantly highest net returns of ₹94140.00 in 2023-24 and ₹96003.00/ha in 2024–25 than HD 3226 and HD 3249. Regarding nutrient management practices, application of 150% of the NPK resulted in significant higher net returns of ₹94592.00 during 2023-24 and ₹96303.00/ha during 2024–25. These values were significantly higher than those recorded with application of 125% NPK (₹86096.00 in 2023-24 and ₹87889.00/ha in 2024-25) and 100% NPK, which yielded the lowest net returns of ₹77933.00 in 2023-24 and ₹79406.00/ha in 2024-25. These results are in the pattern of findings of **Dhaker *et al.* (2022), Gupta *et al*. (2011), Singh *et al.* (2017), and Singh *et al.* (2021).** The maximum net returns by DBW 187 with 150% recommended dose of NPK under zero tillage system might be due to lower cost of tillage practices and higher yields of wheat cultivar led to proportionally higher net returns.

**Fig. 2** Effect of tillage and nutrient management practices on gross return of wheat cultivars.

**Fig. 3** Effect of tillage and nutrient management practices on net return of wheat cultivars.

**3.2.4 Benefit cost (B: C) ratio**

 Benefit cost (B:C) ratio was also influenced by different treatments under investigation (Table 1& Fig 4). Among tillage practices, zero tillage sown wheat showed numerically higher B: C ratio of 2.12 in 2023-24 and 2.14 in 2024–25 compared to conventional tillage which scored 1.71 and 1.67 in the corresponding years. Similar findings was observed by **Singh *et al.* (2025)** **Sahu (2024), Yadav (2021),Gupta *et al.* (2019), Kaur *et al.* (2022), Kumar *et al.* (2020),** and **Latif *et al.* (2020).** Wheat cultivars had significant effect on B:C ratio during both years. Significantly higher B: C ratio was yielded by DBW 187, with 2.08 in both 2023–24 and 2024–25 crop years followed by HD 3226, which recorded 1.87 B:C ratio in both years. The lowest B: C ratio was registered in wheat cultivar HD 3249, which was 1.78 in 2023-24 and 1.77 in 2024-25. Regarding nutrient management practices, 150% NPK level resulted in maximum B: C ratio of 2.02 followed by RDF 125% and 100% during 2023–24. During 2024-25, application of 150% NPK level produced significantly higher B: C ratio of 2.01 to 1.81 of 100% NPK level but it was statistically at par with 1.91 B:C ratio of 125% NPK level. These findings were observed by **Singh *et al.* (2017), Singh *et al.* (2021), and Usman *et al.* (2013).** The possible reason behind higher B:C ratio under zero tillage, DBW 187 and 150% NPK level is the higher economic yield, gross monetary return and net monetary returns outputted by these treatments.

**Fig. 4** Effect of tillage and nutrient management practices on B:C ratio of wheat cultivars.

**Table 1** Effect of tillage and nutrient management practices on economics of wheat cultivars.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Total cost of cultivation** **(₹ha-1)** | **Gross return (₹ ha-1)** | **Net Return (₹ha-1)** | **B:C ratio** |
| **Tillage methods** | **2023-24** | **2024-25** | **2023-24** | **2024-25** | **2023-24** | **2024-25** | **2023-24** | **2024-25** |
| T1: CT | 46382 | 47324 | 125619 | 126654 | 79237 | 79330 | 1.71 | 1.67 |
| T2: ZT | 43950 | 44892 | 137127 | 141294 | 93177 | 96402 | 2.12 | 2.14 |
| SEM± for Tillage | -- | -- | 3022 | 3481 | 3022 | 3481 | 0.0701 | 0.08 |
| C.D.(0.05) | -- | -- | NS | NS | NS | NS | NS | NS |
| **Varieties (V)** |
| V1: HD3226 | 45166 | 46108 | 129426 | 132225 | 84260 | 86117 | 1.87 | 1.87 |
| V2: HD3249 | 45166 | 46108 | 125387 | 127585 | 80220 | 81477 | 1.78 | 1.77 |
| V3: DBW187 | 45166 | 46108 | 139306 | 142111 | 94140 | 96003 | 2.08 | 2.08 |
| SEM± for V | -- | -- | 2387 | 2588 | 2387 | 2588 | 0.05 | 0.06 |
| C.D.(0.05) | -- | -- | 7783 | 8440 | 7783 | 8440 | 0.1636 | 0.18 |
| **Nutrient Management (N)** |
| N1: 100% RDF | 43322 | 44075 | 121255 | 123481 | 77933 | 79406 | 1.80 | 1.81 |
| N2: 125% RDF | 45166 | 46108 | 131262 | 133997 | 86096 | 87889 | 1.91 | 1.91 |
| N3: 150% RDF | 47011 | 48141 | 141603 | 144444 | 94592 | 96303 | 2.02 | 2.01 |
| SEM± for NM | -- | -- | 3226 | 1739 | 3226 | 1739 | 0.072 | 0.04 |
| C.D.(0.05) | -- | -- | 9417 | 5076 | 9417 | 5076 | NS | 0.11 |
| **Interaction effect**  | NS | NS | NS | NS | NS | NS | NS | NS |

**4. Summery & conclusion**

 NPK levels and tillage systems i.e. zero tillage and conventional tillage practices influenced the economics of cultivation of different wheat cultivars. The results revealed that among the tillage practices, zero tillage offered less cost of production and resulted better in terms of gross return, net return and B:C ratio. Among wheat cultivars DBW 187 recorded significantly higher gross return, net return and B:C ratio followed by HD 3226 and HD 3249. Amid various doses of NPK, 150% registered significantly higher gross return, net return and B:C ratio over 100% and 125% recommended doses of NPK. In conclusion, wheat cultivar DBW 187 with 150% recommended dose of NPK under zero tillage system was performed better in terms of gross monetary return, net monetary return and B: C ratio and can be recommended for irrigated conditions under rice-wheat cropping system.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Disclaimer (Artificial intelligence)

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

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