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# Agronomic Options for Higher Yield, Soil Microbial Population and Economics of Wheat under New Alluvial Zone

**Dhiman Mukherjee**

Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741235, West Bengal, India.

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***Corresponding author:** Dhiman Mukherjee, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741235, West Bengal, India.
**Email:** dhiman_mukherjee@yahoo.co.in

## Abstract

A field experiment was conducted during the winter season of 2018 and 2019 at district seed farm, under the aegis of Bidhan Chandra Krishi Viswavidyalaya in upland situation. The experiment comprised of twenty four treatments combinations, which was laid out in split- plot design (factorial) with three replications. Treatments include different varieties (viz. HD 2967, DBW 39 and K 1006), and various tillage options (viz conventional tillage (CT), reduced tillage (RT) and zero tillage (ZT)), were allocated to main plots and different dose of recommended dose of fertilizer (viz. 50, 75, 100 and 125 % RDF) to sub-plots. K 1006 registered more grain yield (3,876 kg/ha) and significantly better to other tested cultivars. This cultivar increased grain yield to the tune of 5.59 and 11.23 %, more over HD 2967 and DBW 39. Reduced tillage (3,901 kg/ha) registered more grain yield and statistically superior to other treatments. This tillage practice registered 11.10 and 21.15 %, more grain and straw yield over conventional tillage practices. Highest grain yield achieved with 125 % RDF (4,079 kg/ha) and was at par with the 100 % RDF (3,965 kg/ha), and statistically better to other treatments. Total nutrient uptake highest registered with the 125 % RDF, and was at par only to 100% RDF for phosphorus and potassium uptake only. Economics revealed that, K 1006 gave highest net return (Rs. 45,343 kg/ha) and fetch better B: C ratio (2.12) and was followed by cultivar HD 2967. More net profit (Rs 47,002 kg/ha) and B:C ratio (2.16) observed with reduced tillage option and quite better to other resource conservation techniques. Use of 125 % RDF gave more return of Rs. 52,301 kg/ha and was followed by full dose of recommended fertilizer (Rs. 50,985 kg/ha). Moreover more BCR of 2.18 observed with 100 % RDF and was followed by 125% RDF.

## Keywords

Fertility levels, Genotypes, Nutrient, Soil microbes, Tillage, Yield

## 1. Introduction

Wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is one of the most important cereal crops, occupying the prime position among food crops in the world and important constituent of food security. This is an important crop contributing 40% in the total food grain production, and is next only to rice (*Oryza sativa* L.). Importance of wheat crop may be understood from the fact that it covers about one-fifth of total area under food grains and accounts for about one-third (40%) of the total food grain production in India [1]. After introduction of high yielding varieties wheat became an important crop in west bengal. In West Bengal, wheat is grown around 340 thousand ha with production of 960 thousand tonn with average productivity of 2.8 tonn/ha [2]. Productivity is quite low in west bengal compared to the rest part of

India (3.1 tonn/ha), mainly because lack of suitable cultivars [3]. Recent researches on resource conserving techniques have provided exciting opportunities for improving input-use-efficiency, productivity and sustainability with suitable cultivar under specific agro-ecological zone. Various tillage options play critical role in wheat production particularly in context of delay sowing. Conservation tillage has been called the greatest soil conservation practices in 20th century. This helps to reduce the intensity of tillage operations and allows farmers to manage crop residues on or near the soil surface [4]. Wet soil conditions after harvest of rice, delayed the sowing of wheat in most part of Eastern India, and West Bengal in particulars. Also tillage after rice harvest requires more time, labour and energy. On the other hand zero tillage or minimum tillage helps in minimizing the loss on account of delayed sowing as it advances the wheat sowing by 10-15 days and also save the time and cost involved in field preparation. The reduction in grain yield due to delay in wheat sowing has been recorded 37.5 kg/ha/day and this can be averted with an appropriate tillage system tailored to meet the crop needs [5]. The adoption of resource conservation technologies (RCTs) as no-tillis considered vital for improving the productivity of wheat, and prime driver for zero and reduced tillage are not the water saving or natural resource management but also for the higher monetary gain [6]. In most crop production systems, soil tillage is one of the largest items of expenditure and thus an economically important factor. It influences the physical, chemical and biological processes and also the long term productivity. However, tillage is not a growth factor for plants and its effects are mainly indirect. Soil quality affects micro- and macro-organisms that live in the soil, but ecological factors such as water content, temperature, and aeration of soil modify the intensity of soil microbiological processes [7]. The qualitative and quantitative changes in the population of soil microorganisms reflect the changes in soil quality [8]. Soil tillage practices affect the soil microbial community in various ways, with possible consequences for nitrogen (N) losses, plant growth, and soil organic carbon (C) decomposition. At the same time, soil microorganisms are involved in biochemical processes that include the decomposition of plant residues and the transformations of organic matter, affect the mineralization of plant available nutrients, and influence the efficiency of nutrient cycles [9]. Adoption of zero and reduced tillage for sowing of wheat with zero-till drill or behind country plough advances the sowing time 10-15 days and also saves the time and cost involved in field preparation. In India, the demand for nutrient resources particularly NPK, is exceeding the supply and the competition for this scarce resource, becoming intense in agriculture. Nitrogen is the key input amongst all primary nutrients as it is directly involved in plant photosynthetic system. This is important for all recommended agronomic practices and therefore efficient utilization of nitrogen is essential for wheat. Imbalanced and improper time of use of nitrogen fertilizers warrants their judicious use to maximize fertilizer-use efficiency [10]. Technological advances are needed to reduce excess nutrient application by improving use efficiency and reducing losses in new alluvial region of West Bengal. Recovery of added fertilizer nitrogen is only 50% or less in most of the arable soil sowing to volatilization, leaching and denitrification losses [11]. So, appropriate dose in apposite proportion is become very pertinent under present context. Suitable wheat cultivar under specific agro-ecological zone, with various tillage options in context of appropriate doses of fertilizer become imperative for good crop production particularly in the new niche of further green revolution programme. However, information regarding the above aspect is scanty, keeping the above facts in mind, present investigation was carried out to assess the performance of different wheat genotypes, under different tillage options with correct rate of fertilizer dose to optimize the wheat production under new alluvial zone of West Bengal.

## 2. Materials and Methods

### 2.1. Description of study area

Present investigation was conducted under the aegis of Bidhan Chandra Krishi Viswavidyalaya during winter season of 2017-18 and 2018-19 in upland situation. The farm is situated at approximately 22° 56′ N latitude and 88° 32′ E longitude with an average altitude of 9.75 m above mean sea level. The soil was sandy clay loam in texture (sand 47.2±0.4, silt 30.1±0.1 and clay 22.5±0.1), slightly alkaline (7.75±0.05), tested low in available nitrogen (KMnO4-N, 281.3±2.1 kg/ha), medium in available P (Olsens-P 22.1±0.6 kg/ha) and high in available K (NH4OAC-K 226.8±4.2kg/ha).

### 2.2. Experimental treatments, design and procedure

The experiment comprised of twenty four treatments combinations, which was laid out in split-plot design (factorial) with three replications. Treatment combination of different varieties viz. HD 2967, DBW 39 and K 1006 and various tillage options viz conventional tillage (CT), reduced tillage (RT) and zero tillage (ZT)), were allocated to main plots and different dose of recommended dose of fertilizer (viz. 50, 75, 100 and 125% RDF) to sub-plots. Wheat cultivars were sown 5 x 5 $m^2$ plot size with row spacing of 20 cm apart on 18th and 22nd November, 2015 and 2016, respectively at 5-6 cm seeding depth using 100 kg seed/ha in all main plot treatment except in conventional tillage where sowing was delayed by ten days to conventional practice. Under zero tillage, stubbles were buried before sowing and seed drill were use to allow planting of wheat seed into fields after rice harvest without ploughing the field. In reduced tillage, two discs harrowing was done at 10-15 cm depth in row zone only after harvest of rice. Conventional tillage was prepared by having four ploughings (harrowing and cultivation) with a depth of 40-50 cm followed by planking. Recommended dose of fertilizer was 150 kg N/ha, 60 kg $P_2O_5$/ha and 40 kg $K_2O$/ha. Dose of fertilizer was applied as per treatments in split form, where as phosphorus (diammonium phosphate (DAP), 18% N and 46% $P_2O_5$) and K (muriate of potash, 60% $K_2O$) was drilled uniformly as basal dose across all the treatment. Basal dose of N was applied through DAP, where as remaining N dose was top-dressed as urea (46% N) depending on the treatments. Irrigations and plant protection measures were applied as per the crop need. Pre-emergence application of pendimethalin @1 kg a.i./ha was given 2 days after sowing (DAS) followed by one hand weeding at 30 DAS for complete check of weeds during critical period of crop-weed competition. The enumeration of different micro-organisms was done using standard spread plate technique. The bacterial count was enumerated on nutrient agar [12] media plates, fungi enumerated on glucose yeast extract (GYE) media and diazotrophs enumerated on Burk's agar. Microbial count was made at initial stage and at the time of harvesting. The soil sampling was done by collecting rhizospheric soil (0-15 cm) from four randomly selected points in each plot. At initial stage of experiment, the initial bacterial count, actinomycetes and fungus count was found to be $23.11\times10^5$, $30\times10^5$ and $11.21 \times 10^3$ cfu/g of soil, respectively. The crop was harvested on 01 and 03 April during 2016 and 2017, respectively.

### 2.3. Data collection and analysis

The data on growth and other yield, attributing characters were recorded on 10 selected plants at harvest, whereas leaf area index (LAI) was recorded at 60 days after sowing, as per normal procedure. Leaf area index was recorded by using the sun scan canopy analyzer. The crop was threshed plot-wise and grain yield thus obtained from net plot was converted into kg/ha. Crop samples were analyzed for uptake of nitrogen, phosphorus and potash as per standard laboratory procedures [13]. The experimental data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5 % probability level. Benefit: cost ratio (B: C) was obtained by dividing the gross income with cost of cultivation. The effect of treatments was evaluated on pooled analysis basis on growth, yield attributes and yields.

## 3. Results and Discussions

### 3.1. Growth and yield attributes

With various treatments, maximum plant height registered with the K 1006 and was at par with the HD 2967, and statistically better to other treatments. Various tillage options revealed that, reduced tillage explore more plant height and was statistically better response to all other resource conservation options. Amongst various subplot treatments, highest plant height found with the more doses of fertilizer, i.e., 125% RDF and was significantly better to all other fertility levels except full dose of RDF. Dry weight of plant more observed with the K 1006 and showed parity only with HD 2967 and significantly better to other genotype of tested cultivar under new alluvial zone. Conventional tillage registered more dry weight and statistically better to all other options. More dry weight observed with the 75% RDF and was statistically better to all other fertility levels except full doses of fertilizer application. Leaf area index failed to have any statistical difference with various genotypes, however, HD 2967 gave more LAI. Tillage options revealed that more LAI found with the RT option and was at par only with ZT and significantly better to conventional tillage options. Fertility level gave significant response and was highest registered with the 125% RDF and showed parity only with the 100% RDF, and significantly better to other options. Further, Table 1 revealed that, effective till/$m^2$ was maximum observed with the K 1006 (334.98) and showed parity only with the HD 2967, and significantly better to other tested genotypes. Tillage options revealed that, highest number of effective tiller observed with the RT (345.34) and statistically better to other methods. 125% RDF gave highest number of effective tiller and was statistically similar only with 100% RDF and significantly better to other doses of fertilizers. Pooled data analysis revealed that 34.6% more effective tiller/$m^2$ was recorded with this treatment over the lower level 50% RDF. This might be due to increased cell division and cell expansion with the increased N availability [14]. Tiller conversion index more observed with the K 1006 due to more number of effective tillers and statistically better to all other tested genotype. Further, observation revealed that, various tillage practices failed to produce any statistical difference, however highest tiller conversion index found with the RT options. Fertility levels with full dose of RDF gave significantly more tiller conversion index and significantly better to other doses. Ear length failed to produce any significant response either with genotype or with different tillage options. With various fertility levels highest ear length observed with the 125% RDF and significantly better to other doses of fertilizer. Grain/ear more found with the cultivar K1006, and significantly better to other tested genotype. Various tillage practices failed to produce any significant difference, however more grain/ear found with the RT. Crop used with 125% RDF produced highest grain/ear and showed parity with the full dose of fertilizers and significantly better to other subplot treatments. Grain weight/spike more observed with K 1006 and was at par with the HD 2967 and significantly more effective with other cultivar. The plot with RT registered more grain weight per spike and was statistically better to other resource conservation options. Crop receives with 125% RDF registered more this parameter and statistically superior to all other subplot options. Various cultivars did not differ significantly for 1000 grain weight. Cultivar K 1006 had boldest grains followed by that of HD 2967 and DBW 39, respectively. Tillage practices gave significant response and highest value observed with ZT and significantly better to other options. The plot receive with full dose of fertilizer gave highest 1000 grain weight and was statistically similar with the 125% RDF and significantly better to other levels of nutrients.

**Table 1. Performance of different wheat cultivars under various tillage options and fertility levels on growth parameter, tiller conversion index and yield attributer (Pooled data of two years)**

| Treatment | Plant height (cm) | Dry weight of plant (g) | Leaf area index (60 DAS*) | Effective tiller/m$^2$ (no.) | Tiller conversion index (%) | Ear length (cm) | Grain/ear (no.) | Grain weight/spike (g) | 1000 grain weight (g) |
|---|---|---|---|---|---|---|---|---|---|
| *Cultivars* | | | | | | | | | |
| HD 2967 | 96.38 | 5.11 | 3.88 | 311.33 | 78.09 | 9.11 | 40.33 | 1.65 | 39.54 |
| DBW 39 | 90.11 | 4.41 | 3.76 | 290.82 | 75.12 | 8.73 | 36.91 | 1.41 | 38.04 |
| K1006 | 98.97 | 5.54 | 3.32 | 334.98 | 80.91 | 8.98 | 41.55 | 1.69 | 40.43 |
| SEm ± | 2.06 | 0.16 | 0.19 | 7.65 | 0.64 | 0.24 | 0.15 | 0.03 | 0.76 |
| CD (P=0.05) | 6.14 | 0.49 | NS | 23.07 | 1.78 | NS | 0.43 | 0.08 | NS |
| *Tillage practices* | | | | | | | | | |
| Zero tillage | 94.05 | 4.03 | 3.77 | 319.26 | 77.59 | 8.95 | 40.15 | 1.42 | 41.06 |
| Minimum tillage | 98.00 | 5.11 | 3.92 | 345.34 | 79.65 | 9.15 | 42.36 | 1.79 | 40.14 |
| Conventional tillage | 93.76 | 5.94 | 3.32 | 273.64 | 77.13 | 8.74 | 36.23 | 1.54 | 37.00 |
| SEm ± | 1.29 | 0.29 | 0.08 | 6.73 | 0.77 | 0.11 | 1.97 | 0.05 | 0.23 |
| CD (P=0.05) | 3.87 | 0.81 | 0.23 | 18.11 | NS | 0.26 | NS | 0.14 | 0.64 |
| *Fertility levels* | | | | | | | | | |
| 50% RDF | 87.11 | 3.87 | 2.98 | 256.33 | 69.90 | 8.28 | 30.39 | 1.42 | 36.03 |
| 75% RDF | 94.27 | 5.97 | 3.68 | 286.65 | 78.71 | 8.69 | 36.69 | 1.51 | 38.11 |
| 100 % RDF | 98.17 | 5.72 | 3.93 | 329.54 | 82.54 | 9.18 | 45.33 | 1.61 | 42.07 |
| 125 % RDF | 101.06 | 5.60 | 3.99 | 345.02 | 80.49 | 9.59 | 46.93 | 1.79 | 41.13 |
| SEm ± | 1.06 | 0.12 | 0.08 | 7.98 | 0.56 | 0.10 | 1.07 | 0.06 | 0.28 |
| CD (P=0.05) | 3.21 | 0.36 | 0.27 | 23.66 | 1.33 | 0.29 | 3.11 | 0.17 | 0.80 |

* Days after sowing; NS = Non significant

## 3.2. Yield parameters

The final yield of a crop is net result of growth and developmental activities in individual plant, which in turn would depend upon the genetic potential of the cultivars and the environmental condition to which it is exposed during the course of life cycle. Biomass production showed significant variation with various treatments measure (Table 2). The analysis of grain yield showed differences among the different genotypes. K 1006 registered more grain yield (3,876 kg/ha) and significantly better to other tested cultivars. This cultivar increased grain yield to the tune of 5.59 and 11.23 %, more over HD 2967 and DBW 39. Various conservation practices produced significant difference with yield parameter, and highest grain yield observed with RT (3,901 kg/ha) and statistically superior to other treatments. CT produced lowest grain yield compared to rest of the tillage option. RT registered 11.10 and 21.15 %, more grain and straw yield over conventional tillage practices, this might be due to delayed sowing of wheat under CT exposed to both the extremes of temperature (low temperature during early growth period which restrict the vegetative phase and high temperature during post anthesis period which reduce the duration of grain development) and consequently the grain yield [15, 16]. The significant difference in grain as well as straw yield was recorded with the different fertilizer levels. Highest grain yield achieved with 125 % RDF (4079 kg/ha) and was at par with the 100% RDF (3,965 kg/ha), and statistically better to other treatments. Maximum dose of fertilizer incorporation resulted in 36.31% more grain yield over the least dose of nutrients. Data revealed that significantly better straw yield (6,509 kg/ha) was recorded with HD 2967 and statistically superior to other genotypes except K 1006 (6,394 kg/ha). These cultivars receive 6.54% more grain yield over DBW 39 cultivar. Tillage measures revealed that, highest straw yield observed with RT (7,032 kg/ha) and was significantly better to all other treatments. Further, with fertility levels more stover production observed with the 125% RDF (7,719 kg/ha) and was statistically better to other doses. Highest levels of fertilizer use plot produce 70.65% more stover production compared to lowest fertility levels. The more grain yield and straw production was recorded with increased levels of fertilizer accrued mainly because of more dry matter accumulation and increase in yield attributing traits. Direct relation on rate of fertilizer on biomass production was also reported by Sharma [17]. Harvest index revealed that, K 1006 produced more this component and significantly better to other tested genotypes. Further, CT gave more HI and was statistically superior to other conservation practices. This was followed by ZT treatment. With various fertility levels more HI observed with the 50% RDF and showed notably improved response to other levels of fertilizers.

**Table 2. Performance of different wheat cultivars under various tillage options and fertility levels on yield, harvest index and economics (pooled data of two years)**

| Treatments | Grain yield (kg/ha) | Straw yield (kg/ha) | Harvest index (%) | Cost of cultivation (Rs/ha) | Net return (Rs/ha) | Benefit: cost ratio |
|---|---|---|---|---|---|---|
| | | | *Cultivars* | | | |
| HD 2967 | 3671 | 6509 | 36.06 | 40426 | 43051 | 2.06 |
| DBW 39 | 3466 | 6098 | 36.24 | 41477 | 41521 | 2.00 |
| K1006 | 3876 | 6394 | 37.74 | 40578 | 45343 | 2.12 |
| SEm ± | 62.08 | 53.76 | 0.21 | - | - | - |
| CD (P=0.05) | 172.65 | 161.33 | 0.63 | - | - | - |
| | | | *Tillage practices* | | | |
| Zero tillage | 3601 | 6165 | 36.87 | 36541 | 42004 | 2.15 |
| Minimum tillage | 3901 | 7032 | 35.68 | 40660 | 47002 | 2.16 |
| Conventional tillage | 3511 | 5804 | 37.69 | 45282 | 40909 | 1.90 |
| SEm ± | 58.98 | 71.43 | 0.27 | - | - | - |
| CD (P=0.05) | 169.08 | 206.22 | 0.76 | - | - | - |
| | | | *Fertility levels* | | | |
| 50% RDF | 2991 | 4522 | 39.81 | 34987 | 29059 | 1.83 |
| 75% RDF | 3649 | 6053 | 37.61 | 38026 | 40875 | 2.07 |
| 100 % RDF | 3965 | 7041 | 36.03 | 43198 | 50985 | 2.18 |
| 125 % RDF | 4079 | 7719 | 34.57 | 47099 | 52301 | 2.11 |
| SEm ± | 67.29 | 76.43 | 0.36 | - | - | - |
| CD (P=0.05) | 181.02 | 223.67 | 0.91 | - | - | - |

## 3.3. Soil microbial population

Soil microorganisms indicate the living and dynamic component of soil organic matter. Microbial population showed higher bacterial and actinomycetes population as compared to fungi in wheat rhizosphere after harvest of the wheat during the experimentation. Various cultivar failed to produce any significant different on bacterial population, however highest population found with the DBW 39. More actinomycetes population observed with the cultivar K 1006 and was statistically similar only with the HD 2967. Further, table 3 revealed that, highest fungal population recorded in the rhizosphere of DBW 39 and significantly better to all other cultivars. Various tillage option revealed that, minimum disturbance of soil, registered more microbial population compared to conventional practices. Highest all three microbial populations observed with the RT option and was at par only ZT for actinomycetes population, and significantly superior to other tillage options. This might be due to increases in the amount of plant residues on the soil surface, which help to grow helpful microorganism. The accumulation of plant debris in soil or on its surface may increase the biodiversity of agroecosystems, and help to enhance yield attributing character and yield of wheat. Greonigen *et al.* [18] have noted that reduced tillage treatment increased the biomass of important microbial groups in the soil layer compared to zero and other till options. The observed differences may be explained by a higher degree of soil disruption in reduced tillage systems compared to strict no-till systems. Further, fertility levels play significant role on various microbial population and highest number of all microbes under study observed with 125% RDF, and was significantly better to all other fertilizer levels. Application of increasing levels of fertilizer increased the bacteria and fungi population in rhizosphere soil significantly upto full dose of recommended dose of fertilizer, further increase to 125% NPK although resulted in slightly increase in population. The increase in microbial population might be due to increasing levels of N, P and K which increases the biomass, root exudates and ultimately provides carbon and energy to the soil microbes resulting into multiplication of microbial population [19]. The results are harmony with the finding of Chand *et al*. [20].

**Table 3. Effect of different treatments on population dynamics of soil microbes (pooled data of two years)**

| Treatments | Bacteria population ($10^5$ cfu/g soil) | Actinomycetes population ($10^5$ cfu/g soil) | Fungal population ($10^4$ cfu/g soil) |
|---|---|---|---|
| | *Cultivars* | | |
| HD 2967 | 34.73 | 47.25 | 20.12 |
| DBW 39 | 35.25 | 44.25 | 23.54 |
| K1006 | 33.52 | 47.40 | 22.36 |
| SEm ± | 0.54 | 0.97 | 0.21 |
| CD (P=0.05) | NS | 2.81 | 0.74 |
| | *Tillage practices* | | |
| Zero tillage | 35.11 | 47.00 | 22.01 |
| Minimum tillage | 37.14 | 49.25 | 24.00 |
| Conventional tillage | 31.26 | 42.65 | 20.03 |
| SEm ± | 0.47 | 0.84 | 0.30 |
| CD (P=0.05) | 1.21 | 2.44 | 0.86 |
| | *Fertility levels* | | |
| 50% RDF | 25.44 | 35.21 | 17.00 |
| 75% RDF | 33.85 | 46.54 | 22.36 |
| 100 % RDF | 38.36 | 50.12 | 23.54 |
| 125 % RDF | 40.35 | 53.36 | 25.11 |
| SEm ± | 0.53 | 0.98 | 0.26 |
| CD (P=0.05) | 1.63 | 2.81 | 0.92 |

### 3.4. Nutrient uptake pattern

Highest nutrient uptake recorded with K 1006 owing due to more biomass production of wheat. NPK uptake by grain and straw was highest observed with K 1006 and significantly better to other genotype except nitrogen uptake for straw content of HD 2967 (Table 4). However, uptake of phosphorus and potassium failed to produce any significant response with straw and grain, respectively. Total nutrient uptake produced statistical difference only with nitrogen and phosphorus. Total uptake of nitrogen and phosphorus was more observed with K 1006 and was at par with the cultivar HD 2967 and significantly better to other tested genotypes. With various tillage practices, maximum NPK uptake was registered with reduced or minimum tillage than rest other main plot treatments. This treatment showed significantly better response compared to other treatment regarding major nutrient uptake, however it failed to produce any significant difference with uptake of phosphorus uptake by straw. Total nutrient uptake was highest observed with RT and was comparable to phosphours uptake of ZT only. This corroborate with the findings of Yadav *et al.* [21]. With this study, we can conclude that RT was found to be the best for nutrient mining as compared to other conservation practices. This perhaps was due to more dry matter production by crop and less nutrient (N, P, K) depletion by better management practices and subsequently more availability of nutrients to crop. Nutrient uptake pattern varied significantly with respect to different fertility levels. With various fertility levels, 125% RDF registered highest nitrogen uptake by grain and straw and significantly better to other levels of fertilizer. Phosphorus uptake by grain was more observed with high dose of fertilizer, i.e., 125% RDF and was comparable to 100 and 75% RDF for grain, and only with 100% RDF for straw. Further Table 3 revealed that potassium uptake by grain and straw, was highest observed with 125% RDF and was comparable only with 100% RDF for grain only. Total nutrient uptake also followed similar trends, and highest uptake registered with the 125% RDF, and was at par only to 100% RDF for phosphorus and potassium uptake only. The higher uptake of nutrient with high fertilizer levels might be due to better plant growth and higher yield per unit area.

**Table 4. Performance of different wheat cultivars under various tillage options and fertility levels on yield, harvest index and economics (pooled data of two years)**

| Treatments | Nutrient uptake (kg/ha) | | | | | | Total nutrient uptake (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | | P | | K | | N | P | K |
| | Grain | Straw | Grain | Straw | Grain | Straw | | | |
| *Cultivars* | | | | | | | | | |
| HD 2967 | 57.33 | 31.86 | 13.98 | 7.23 | 5.82 | 57.62 | 89.19 | 21.21 | 63.44 |
| DBW 39 | 50.65 | 29.51 | 12.05 | 6.13 | 5.07 | 55.45 | 80.16 | 18.18 | 60.52 |
| K1006 | 62.99 | 32.19 | 14.65 | 7.99 | 6.44 | 61.89 | 95.18 | 22.64 | 68.33 |
| SEm ± | 0.73 | 0.83 | 0.44 | 0.78 | 0.56 | 0.93 | 2.43 | 0.67 | 2.33 |
| CD (P=0.05) | 2.18 | 2.57 | 1.09 | NS | NS | 2.88 | 6.91 | 1.89 | NS |
| *Tillage practices* | | | | | | | | | |
| Zero tillage | 55.87 | 31.43 | 13.57 | 7.03 | 5.53 | 56.81 | 87.30 | 20.60 | 62.34 |
| Minimum tillage | 62.83 | 34.31 | 14.91 | 7.73 | 6.98 | 65.03 | 97.14 | 22.64 | 72.01 |
| Conventional tillage | 52.23 | 29.88 | 12.41 | 6.81 | 4.82 | 53.13 | 82.11 | 19.22 | 57.95 |
| SEm ± | 0.81 | 0.82 | 0.34 | 0.81 | 0.36 | 0.77 | 2.63 | 0.78 | 2.54 |
| CD (P=0.05) | 2.33 | 2.55 | 0.93 | NS | 1.07 | 2.43 | 7.43 | 2.11 | 7.83 |
| *Fertility levels* | | | | | | | | | |
| 50% RDF | 25.91 | 15.65 | 8.41 | 4.98 | 3.06 | 29.72 | 41.56 | 13.39 | 32.78 |
| 75% RDF | 58.56 | 32.21 | 14.51 | 6.33 | 5.37 | 55.01 | 90.77 | 20.84 | 60.38 |
| 100 % RDF | 64.98 | 37.15 | 15.11 | 8.05 | 7.11 | 75.33 | 102.13 | 23.16 | 84.44 |
| 125 % RDF | 78.54 | 42.42 | 16.23 | 9.18 | 7.58 | 82.41 | 120.96 | 25.41 | 89.99 |
| SEm ± | 1.11 | 0.95 | 1.37 | 0.41 | 0.71 | 0.98 | 3.22 | 0.83 | 2.32 |
| CD (P=0.05) | 3.07 | 2.90 | 3.91 | 1.06 | 1.98 | 2.92 | 8.21 | 2.36 | 7.16 |

NS = Non significant

## 4. Economics

In modern agriculture viability of any treatment can be judged by benefit cost ratio (BCR). Table 2 revealed that amongst various treatments, K 1006 gave highest net return (Rs. 45,343 kg/ha) and B: C ratio (2.12) and was followed by cultivar HD 2967. Further table revealed that, RT fetch more net profit (Rs 47,002 kg/ha) and B:C ratio (2.16), this was closely followed by ZT. Further, it was observed that 125% RDF gave more return of Rs. 52,301 kg/ha and was followed by full dose of recommended fertilizer (Rs. 50,985 kg/ha). Moreover more BCR of 2.18 observed with 100% RDF and was followed by 125% RDF.

## 5. Conclusion

This study has shown that cultivar K 1006 and HD 2967 gave good economic as well as biological yield and very remunerative for the arming community. Application of twenty five percent more of normal doses of fertilizer gave more return and quite economical to growers for enhancing wheat productivity. It is observed that, under various resource conservation options revealed that, minimum and zero tillage option become good for soil microflora and fetch more return to the farming community with effective ecological balance as a whole.

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