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Productivity, profitability and nutrient uptake as influenced by tillage practices and nutrient strategies in wheat (*Triticum aestivum* L.) under subtropical climatic conditions

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Abstract
In the present investigation, we investigated the effects of conservation tillage and nutrition levels on productivity, profitability, and nutrient uptake of wheat (*Triticum aestivum* L.) during *rabi* season of 2020-21 at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, U.P., India. Soil of the experimental plot was sandy loam in texture, medium in organic carbon and available NPK with neutral pH (7.4). Experiment was laid out in split-plot design with three replications. The main plots consisted of four crop establishment methods, i.e. Furrow Irrigated Raised Beds, Roto tillage, Reduced tillage, and Conventional tillage and six nutrient levels viz. Control, 100% RDF, 100% RDF + NPK consortia + Bio-stimulant, 75% RDF + NPK consortia + Bio-stimulant, 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation, and 75% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation were allotted in sub-plot. Results revealed that among the tillage methods, yield of wheat (grain, straw, and biological qha^{-1}) differ significantly. Treatment furrow irrigated raised beds was recorded 21.21, 9.96 and 14.24% more grain, straw, and biological yield, respectively over conventional flood irrigation. Among the nutrition levels, after II irrigation, the crop fertilized with 100 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray had the most effective tillers m^{-1} (156.21), ear length (12.40 cm), number of grains per spike (49.66), grain yield kg ha^{-1} (4751), and test weight (40.12g) in comparison to the prescribed NPK nutrition management method, the number of effective tillers m^{-1} was 127.17, the ear length was 7.20 cm, the number of grain per spike was 37.91, the grain yield kg ha^{-1} was 3214kg/ha, and the test weight was 36.23g.The crop fed with 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation and 100% RDF + NPK consortia + Bio-stimulant recorded highest nitrogen, phosphorus and potassium content in grain as 1.62 & 1.64%, 0.31 & 0.31% and 0.68 & 0.70% while in straw as 0.56 & 0.59%, 0.11 & 0.12 % and 1.33 & 1.35%. Higher nutrient uptake (NPK) by grain and straw as well as total uptake were recorded under furrow irrigated raised beds followed by roto tillage and reduced tillage. Cost of cultivation, being lowest in control plots which ranged between Rs. 27324ha^{-1} while highest cost of Rs. 34795 and 35803 ha^{-1} was incurred with the application of 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation and 100% RDF + NPK consortia + Bio-stimulant. Therefore, tillage methods sowing of wheat on FIRB with application of 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation were proved the most ideal approach to achieve the higher productivity, profitability and nutrient uptake under the irrigated ecosystem of Uttar Pradesh.

Keywords: Tillage practices, productivity, profitability, nutrient management

1. Introduction
Wheat (*Triticum aestivum* L.) is the most widely grown as it is the staple food for 40 per cent human population across the globe and second most important cereal after rice. Wheat provides 21 per cent of the food calories and 20 per cent of the protein for more than 4.5 billion people in 94 countries. It is very important and remunerative Rabi crop of North India and second most important cereal crop after rice, grown under diverse agro-climatic conditions. Globally wheat was grown in an area about 215.48 million ha, production 764.5 million tons and productivity 3.39 t ha^{-1} USDA (2019-20). In India also wheat play a key role in food and nutritional security with an area 29.65 m ha and production 99.9 million tonnes with an average productivity 3371 kg ha^{-1} USDA (2019-20) and contributes nearly one third of

the total food grain production. In India, Uttar Pradesh is leading Wheat growing state with an area of about 9.65 million ha (36.6%), production of 26.87 million tonne (39.3%) and productivity 2785 kg ha^{-1} (Anonymous, 2019) [3]. Wheat productivity in the state is far lower than that in Punjab (4.3 t ha^{-1}) and Haryana (4 t ha^{-1}) accounted to late sowing after long duration rice varieties and harvest of sugarcane, lack of quality seed, imbalanced fertilization, unscientific water management and poor mechanization etc. In western Uttar Pradesh wheat sowing is delayed up to end of December and sometimes even to first week of January leading to severe yield reduction. To meet the demand of wheat, the global productions need a 1.6 to 2.6% annual growth rate, which can be mainly achieved through improvement in input use efficiency. However, under the current production practices, crop productivity and input use efficiency has declined. The improvement of input use efficiency in wheat crop can be achieved through two main strategies by adopting precise and more efficient crop management practices.

Soil tillage is among the important factors affecting soil properties and crop yield. Among the crop production factors, tillage contributes up to 20% and affects the sustainable use of soil resources through its influence on soil properties (Lal and Stewart, 2013) [20]. The judicious use of tillage practices overcomes edaphic constraints, whereas inopportune tillage may cause a variety of undesirable outcomes, for example, soil structure destruction, accelerated erosion, loss of organic matter and fertility, and disruption in cycles of water, organic carbon, and plant nutrient (Lal, 1993) [19]. Conservation tillage positively influences several aspects of the soil whereas excessive and unnecessary tillage operations give rise to opposite phenomena that are harmful to soil. Therefore, currently there is a significant interest and emphasis on the shift from extreme tillage to conservation and no-tillage methods for the purpose of controlling erosion process (Iqbal *et al*., 2005) [14]. Raised bed planting systems has been used since time immemorial by farmers in many parts of the world (Govaerts *et al*., 2007) [19]. Their application has traditionally been associated with water management issues, to reduce the adverse impact of excess water on crop production or to irrigate crops in semiarid and arid regions (Sayre, 2004) [30]. There are several reports showing savings in irrigation water, labor and production costs, and higher net economic returns in no tillage and reduced tillage compared with conventional tillage systems. Thus, proper nutrient strategies are essential for wheat to optimize nutrient use without sacrificing the yield. This study investigated the effects of amount and time of nutrient application on yield, and nutrient productivity of tillage crop establishment methods compared with conventional method with an objective of defining an appropriate nutrient management practices matching with particular planting technique.

2. Materials and Methods

The present investigation was undertaken at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture &Technology, Meerut (U.P.). Meerut lies in the heart of Western Uttar Pradesh (latitude of 29^0 40′ North, longitude of 77^0 42′ East and at an altitude of 237 meter above mean sea level) with sub-tropical climate. The experimental field had an even topography with good irrigation and drainage facilities. The climate of this region is semi-arid and sub-tropical with extreme hot in summer and cold in winter season. There is gradual decrease in daily temperature as low as 5.6ºC & 2.9ºC in December, 2020 & January 2021. The relative humidity was found to be maximum 96.7%, and minimum in 38.9 % in the month of December 2020 & April 2021. The experimental soil was sandy loam in texture, low in available nitrogen and organic carbon while, medium in available phosphorus and potassium and slightly alkali in reaction.

2.1 Treatments detail

The treatments consists of four tillage practices [T_1 Furrow irrigated raised beds, T_2, Roto tillage T_3 Reduced tillage, T_4 Conventional tillage] and six nutrient management [N_1 Control, N_2 100% RDF, N_3 100% RDF + NPK consortia + Bio-stimulant, N_4 75% RDF + NPK consortia + Bio-stimulant, N_5 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation, and N_6 and 75% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation].The study was made in split plot design with three replication during 2020-21.

2.2 Cultural Practices

Conventional practices in conventional flood irrigation (CT) of two harrowing, three ploughing (using a cultivator) thereafter planking (using a wooden plank) that followed pre-sowing irrigation and wheat was seeded in rows 20 cm apart using a seed drill with a dry fertilizer attachment. In case of furrow irrigated raised bed tillage (FIRB) soil was tilled by harrowing and ploughings followed by one field leveling with a wooden plank, and raised beds were made using a tractor-drawn multi crop raised bed planter with inclined plate seed metering devices. The dimension of the furrow irrigated raised beds was 90cm (top of the bed) x 12 cm height x 30 cm furrow width (at top) and the spacing from center of the furrow to another center of the furrow was kept at 120 cm. Six rows of wheat were sown on each raised bed. Reduced-till and roto till systems of planting crops with minimum of soil disturbance was performed with multti crop seed drill. By this equipment, seeds were placed directly into narrow slits 2-4 cm wide and 4-7 cm deep made with a drill fitted with chisel, inverted T" with land preparation.

2.3 Fertilizer Application and Crop Management

In order to raise ideal crop, all the plots received recommended dose of N: P: K @ 150:60:60 kg ha^{-1}, respectively. Full dose of phosphorus, potassium and half dose of nitrogen were applied uniformly as a basal (at the time of sowing) dose by using seed-cum-fertilizer drill at the time of seeding operation. N: P: K were applied through combination of Urea, DAP and MOP. Rest dose of N was applied as per treatments in form of urea synchronizing with irrigation application. Weed infestation was checked through application of post emergence herbicide Sulfosulfuron @ 33.3 g a.i. ha^{-1} at 30 DAS in standing crop followed by one hand weeding was done at 45 DAS.

2.4 Yield (kg ha^{-1})

Grains were separated with the help of mini plot thresher from biological yield obtained from net area in each plot. The grain yield obtained from net plot area was recorded in kg plot^{-1} was standardized to 14 per cent moisture and then weight was converted into kg ha^{-1}. After harvesting of the net plot area, the bundles of wheat crop was sun dried for four days and then weight recorded and converted into kg ha^{-1} for calculating the biological yield q ha^{-1}. Straw yield was worked out by subtracting the grain yield from total biological yield of net plot area and expressed in q ha^{-1}. Harvest index, which is the ratio of economic yield to biological yield expressed in per cent, was worked out by using the following formula given below.

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

2.5 Plant Analysis

The nutrients content were analyzed in grains and straw at harvest and estimated separately from the selected plants of each plot. The plant samples for estimating the dry matter production (grains and straw) from each plot at harvest is thoroughly washed with distilled water and dried in hot air oven at 60 ± 1ºC as dry matter accumulation. Dried samples were powdered in a willey mill to considerable fineness before storing them in polythene bags for further analysis.

2.6 Nutrient Uptake (kg ha^{-1})

Uptake of individual nutrients i.e. N, P and K were worked out by multiplying the grain yield and straw yield with their respective nutrient content (%) as follows:

Nutrient uptake (kg ha^{-1}) = Content (%) in grains/straw × grains/straw yield

Total uptake (kg ha^{-1}) = Uptake from grains + nutrient uptake from straw

2.7 Statistical Analysis

All the observations recorded during the course of investigation were analyzed by analysis of variance technique (ANOVA) using the statistical analysis (OPSTAT). The comparison of treatment means were made by the least significant difference at 5% probability (p=0.05).

3. Results and Discussion

3.1 Physio-chemical properties of the soil of experimental site

The laboratory analysis result of selected physical and chemical properties experimental site is presented in Table 1. The site has sandy loam textural class with a particle size distribution of 17.2% clay, 8.7% silt and 74% sand. Soil pH was 8.47 which is under slightly alkaline (7.6–8.8) (Piper, 1966) [28] and suitable for wheat (Mengel and Kirkby 2001) [22]. The OC content was 0.44% which was low (< 4%) (Jackson, 1973) [15]. The available nitrogen (TN) was 0.14% and categorized under low level (0.1–0.2%) (Subbiah and Asija, 1956) [35]. Olsen available P was 16.7 mg kg^{-1} which is medium (10–20 mg kg^{-1}) (Jackson, 1973) [15]. The available K was 0.24 Cmolc kg^{-1}which is under low category (EthioSIS, 2014).

Table 1: Physico-Chemical properties of the experimental field

S. No.	Particulars	Value	Methods adopted
Physical and Chemical properties			
1	Mechanical analysis		Bouyoucos hydrometer method (Piper, 1966) [28]
	a) Sand (%)	74%	
	b) Silt (%)	8.8%	
	c) Clay (%)	17.2%	
	Textural class	Sandy loam	
2	pH (Soil: Water = 1:2.25)	8.47	Electrode pH meter Suspension method (Page *et al*., 1982)
3	EC (ds m^{-1})	0.22	Conductivity meter Suspension method (Page *et al*., 1982)
4	Organic carbon (%)	0.44	Walkley and Black wet oxidation Method (Jackson, 1973) [15]
5	Available N (kg ha^{-1})	222.8	Alkaline potassium permanganate method (Subbiah and Asija, 1956) [35]
6	Available P (kg ha^{-1})	16.7	Olsen ‘s method (Jackson, 1973) [15]
7	Available K (kg ha^{-1})	241.5	1 N NH_4OAC extraction method (Jackson, 1973) [15]

3.2 Yield

3.2.1 Grain yield

Tillage crop establishment methods significantly affect yield (grain, straw and biological q ha^{-1}) and harvest index % Table 2. Significantly higher grain yield (44.28 q ha^{-1}) of wheat was recorded in treatment T_1 than other treatments which was statistically at par with T_3 and T_4. However, the treatment T_3 was recorded superior over rest of the treatments and at par with each other. Though, the per cent increment in grain yield of wheat was recorded with the tune of 11.84, and11.34 and 11.05% in relation to T_1, T_4 and T_3, respectively as compared to T_2 (Roto tillage). The yield per ha was improved due to improve in moisture supply and its beneficial effect on the per plant yield. The grain yield per plant improve with increase moisture supply mainly through improvement in number of effective tillers, number grains per spike, and test weight. Similar trend have been observed by Singh *et al*. (2010) [32]; Sepat *et al*. (2010) [31]; Naresh *et al*. (2012) [25, 26]; Mollah *et al*. (2015) [24]; Singh *et al*. (2017) [33].

The result showed that grain yield was significantly affected by the interactions of N and organic fertilizer. Grain yield as affected by interaction of N by organic rates ranged from 25.65 to 47.10 qha^{-1}. All fertilized plots had higher grain yield as compared to plots without fertilization. Grain yield tended to increase with increasing N rate up to 100% RDF ha^{-1} and then declined above that rate of N across all levels of organic fertilizers substitutes (Table 2). The highest grain yield (47.10 qha^{-1}) was achieved from combination of 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation followed by the 100% RDF + NPK consortia + Bio-stimulant. The lowest grain yield (25.65 qha^{-1}) was achieved from unfertilized plots. This result was agreed by Inamullah and Muhammad (2014) [13] who reported that on average, the plots where N and organic nutrients were applied produced higher grain yields as compared to the plots where no N and K nutrients.

Table 2: Performance of Wheat under Crop Establishment Methods and Organic Fertilizer Complemented with Chemical N Fertilizer on yield (q ha^{-1}) and harvest index (%) of wheat

Treatments	Yield (q ha^{-1})			Harvest index (%)
	Grain	Straw	Biological	
(A) Crop Establishment Methods				
T_1 Furrow Irrigated Raised Beds	44.28	68.18	112.46	39.37
T_2 Roto tillage	37.40	60.26	97.66	38.29
T_3 Reduced tillage	41.34	62.52	103.86	39.80
T_4 Conventional tillage	42.40	65.58	107.98	39.26
C.D (5%)	*3.08*	*3.69*	*4.95*	*NS*
(B) Nutrient Management				
N_1 Control	25.65	42.25	67.90	37.77
N_2 100% RDF	41.34	63.60	104.94	39.40
N_3 100% RDF + NPK consortia + Bio-stimulant	45.54	70.22	115.76	39.34
N_4 75% RDF + NPK consortia + Bio-stimulant	42.53	65.96	108.49	39.20
N_5 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation	47.10	72.66	119.76	39.32
N_6 75% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation	44.06	68.27	112.33	39.22
C.D (5%)	*3.58*	*4.01*	*5.98*	*NS*

3.2.2 Straw yield

Straw yield of wheat was varied from 60.26 to 68.18 q ha^{-1}. The maximum straw yield (68.18 q ha^{-1}) was recorded under the treatment T_1 than other treatments being statistically at par with T_4. However, the treatments T_4 was recorded superior over rest of the treatments. Though, the minimum straw yield was recorded into the treatment T_2 followed by T_3 (Table 2). The increase in straw yield of crop could be attributed to the significant effect of moisture supply on the vegetative growth of the crop plant. Thus the straw yield increase because of enhancement of vegetative growth under improved moisture supply. Atikullah *et al*. (2014) [15]; Kumar *et al*. (2013); Kumar *et al*. (2014) were observed similar trend.

Data on straw yield shows that it was significantly affected by main effect of N but not by organic fertilizers and the interactions of N and organics. The highest straw yield (72.66 qha^{-1}) was recorded at 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation followed (70.22 qha^{-1}) by the 100% RDF + NPK consortia + Bio-stimulant whereas the lowest straw yield (42.25 qha^{-1}) was seen on unfertilized plots (Table 2). Similarly, Gul *et al*. (2011) and Tilahun *et al*. (2017) reported that N application has more contribution towards production of higher straw yield. Though the straw yield was not statistically significant due to organic fertilizers application, relatively higher straw yield was observed at 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation then declined.

3.2.3 Biomass yield

Among the tillage crop establishment methods, treatment T_1 was found to be significantly superior to all other treatments except T_3 followed by T_4.The treatments T_2 and T_4 were recorded at par with each other. However, treatment T_2 was recorded minimum biological yield 97.66 q ha^{-1}. Significant increase in grain, straw and biological yield with increased in tillage practices (Table 2). FIRB and reduced tillage fulfill timely crop water requirement, which resulted into better growth in terms of dry matter accumulation. The higher growth finally resulted into significant increase in grain yield through yield attributed namely number of effective tillers, number of grains per spike and test weight. The maximum harvest index (39.80%) of wheat was recorded in the treatment T_3 than other treatments being statistically at par with T_1 and T_3. Though, the treatment T_2 was recorded least harvest index (38.29%) followed by T_4, and T_1.

Analysis of variance revealed that above ground biomass yield was significantly affected by the interactions of fertilizer rates and crop establishment methods. Above ground biomass yield ranged from 67.90 to 119.76 qha^{-1}. The highest biomass yield (119.76 qha^{-1}) was recorded at 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation followed (115.76 qha^{-1}) by 100% RDF + NPK consortia + Bio-stimulant. The lowest biomass yield (67.90 qha^{-1}) was achieved from unfertilized plots. All fertilized plots out yielded the unfertilized plots (Table 2). As this investigation clearly indicated that biomass yield of wheat responded differently to variable combination rate of chemical N fertilizer with organic fertilizers. Biomass yield changed with increasing N rates at respective organic substitutes. This strongly suggests that N rate above 75% RDF ha^{-1} the utilization by plants were very little or nearly negligible and exposed to different losses of N such as leaching, volatilization and immobilization. This illustrated that combination of 75% RDF ha^{-1} N with organic stimulant increased the ability of plants for capturing resources which was reflected as evident in their increased dry matter accumulation. Biomass yield had increased with increase in N rate from control to the highest level. This result is in line with Allam (2003); Solomon and Anjulo (2017) who reported that N application enhanced the vegetative growth of wheat crop, which ultimately increased biological yield with increase in straw yield. However, with increased level of N increase in number of total tillers m^{-2} results in biological yield of wheat.

3.3 N, P and K uptake

Wheat cultivated on furrow irrigated raised beds (T_1) had significantly higher nitrogen uptake by wheat grain and straw during the experimental year, but was statistically comparable to wheat put on reduced till and conventional till, respectively. During the experimentation, the roto tillage approach (T_2) had the lowest nitrogen uptake in wheat grain and straw (Fig.1). However, Fig.2 shows that grain contained 2.2 times the amount of phosphorus as straw. Different tillage strategies had a substantial impact on the phosphorus content of grain and straw. The highest phosphorus content in grain (0.16 and 0.37 percent) was recorded under tillage practice on wheat sown on furrow irrigated raised beds (T_1), which was significantly higher than those for the rest of the tillage practices treatments except reduced till and conventional tillage practices (T_3 & T_4), and the lowest (0.12 and 0.32

percent) under T_2 “roto tillage.” Therefore, wheat grown on furrow irrigated raised beds (T_1) had considerably higher total phosphorus uptake by wheat grains and straw (27.29 kg ha^{-1}) than T_4 (wheat sown on conventional tillage plots) and T_3 (wheat sown on reduced till). During the study year, total phosphorus intake was considerably lower (19.20 kg ha^{-1}) in T_2 “roto tillage” plots.

Wheat sown on furrow irrigated raised beds (T_1) had considerably greater potassium content in grains and straw, and was statistically comparable to wheat sown on reduced till plots (T_3). During the trial, roto tilled plots (T_2) had the lowest potassium concentration, followed by grains and straw (Fig.3). A comparison between wheat sown on furrow irrigated raised beds (T_1) and traditional tilled plots (T_4) revealed that wheat put on furrow irrigated raised beds (T_1) absorbed considerably more potassium than wheat sown on reduced till (T_3). Reduced tilled planted wheat (T_3) and roto tilled wheat (T_2) both had similar levels of potassium uptake in grains and straw. Higher potassium concentration in furrow irrigated raised beds may cause higher potassium uptake by grains and straw compared to other planting strategies.

The increased nitrogen and phosphorus intake in grains is due to the chemical composition of the grain, which requires more nitrogen and phosphorus due to the higher amino acid and protein content. Higher potassium amount in straw is required for providing strength to the stem by producing cellulose, lignin, and pectin, whereas lower potassium content is required for providing strength to the stem by forming cellulose, lignin, and pectin. Tillage crop establishment strategies enhanced NPK uptake in grains, straw, and overall uptake by a significant amount. The largest uptake of NPK in grains, straw, and total uptake (T_1) in furrow irrigated raised beds was attributable to better availability of these nutrients due to appropriate moisture availability in the root zone, which encouraged nutrients uptake and ultimately higher grain and biomass yield. Idnani and Kumar (2013) [12], Rajanna *et al.* (2014b) all support these findings.

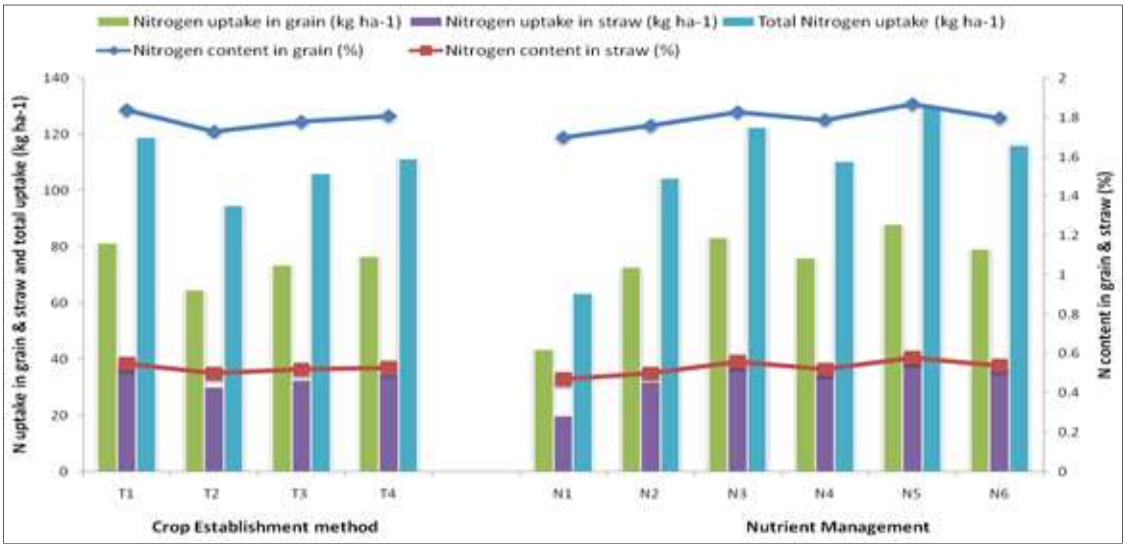

Fig 1: Performance of Wheat under Crop Establishment Methods and Organic Fertilizer Complemented with Chemical N Fertilizer on content grains, straw (%), uptake in grains, straw (kg ha^{-1}) and total nitrogen uptake (kg ha^{-1}) of wheat

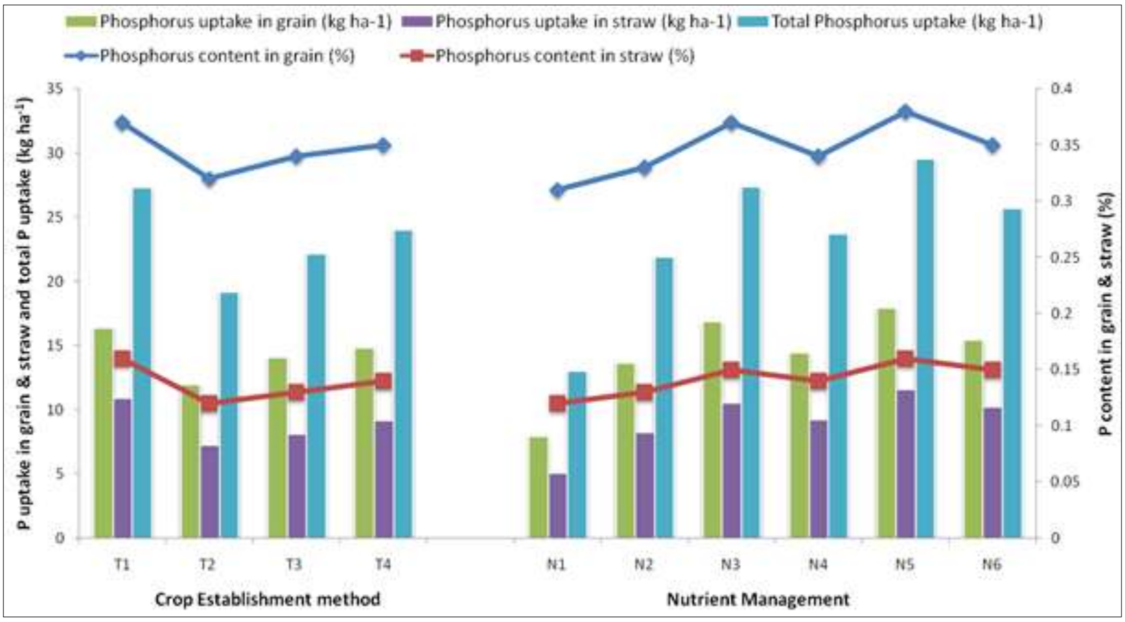

Fig 2: Performance of Wheat under Crop Establishment Methods and Organic Fertilizer Complemented with Chemical N Fertilizer on content grains, straw (%), uptake in grains, straw (kg ha^{-1}) and total phosphorus uptake (kg ha^{-1}) of wheat

Nutrient uptake by wheat was significantly influenced by interaction effect of N and K fertilizer (Fig.1, 2 & 3). Overall, the amount of nutrient uptake was in the order of N > K > P. Grain was found to have higher content of N and P than the straw. Conversely, straw of wheat contained higher K than grain yield. The maximum N uptake by the straw (42.14 kg ha^{-1}) that was recorded from 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation had 212.19% more N than the lowest (19.86 kg ha^{-1}) from unfertilized plots.

The result further displayed that combined application of N and organics at increasing rates resulted in higher uptake of N, P and K (straw and grain). On the other hand, interaction of 46 kg ha−1 N and 30 kg ha−1 K gave 344.9% and 288.5% higher grain and total N uptake respectively, over unfertilized plot. The grain N uptake increased with the interaction of 100% RDF and NPK consortia + Bio-stimulant beyond it the grain N uptake decreased. This result was supported by the findings by Hailu *et al*. (2012) [11] who reported that N uptake by wheat was significantly improved by integrated application of N, P and K. It is observed that N and K fertilizers had positive response on P uptake. It was supported by the findings by Amare *et al*. (2013) [2] who reported that P uptake by grain of wheat increased by increasing N level and in the presence of K at 50 kg than in its absence.

Application of 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation result highest K uptake by straw and total and the lowest K uptake on straw and total were recorded from unfertilized plot (Fig.3). The maximum K uptake by grain (22.14 kg ha^{-1}) was obtained from 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation. Overall, the maximum K uptake with N and K application resulted 184.80% (straw), 210.46% (grain) and 188.24% (total) more K uptake than unfertilized plots. The result was agreed with Mesele (2019) [23] who reported that the highest K uptake of straw, grain and total at 30 kg K ha^{-1} and the lowest from the control.

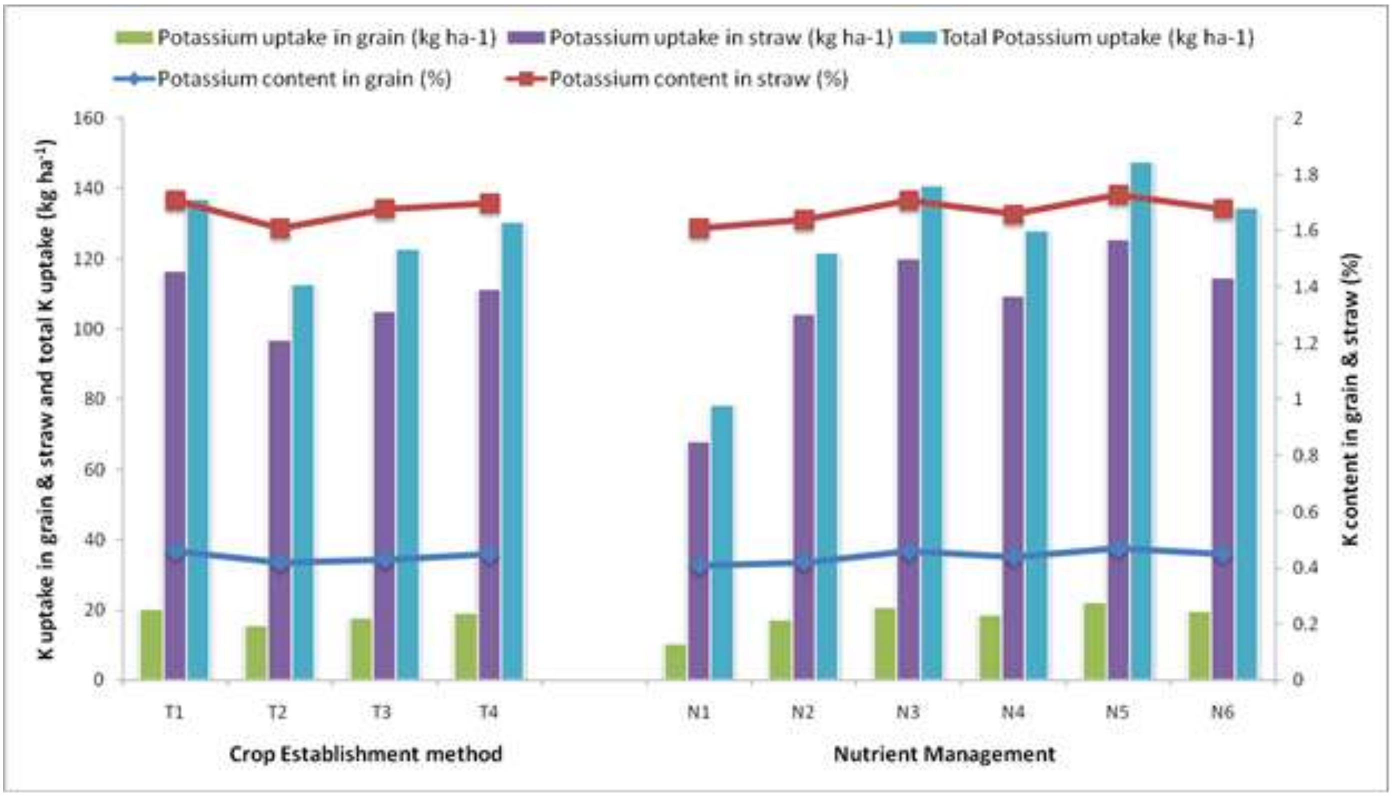

Fig 3: Performance of Wheat under Crop Establishment Methods and Organic Fertilizer Complemented with Chemical N Fertilizer on content grains, straw (%), uptake in grains, straw (kg ha^{-1}) and total potassium uptake (kg ha^{-1}) of wheat

Profitability

The economic analysis was carried out by using the methodology described in CIMMYT (1988) in which considering all variable costs and all benefits of grain yield. Variable cost includes cost of plant protection, harvest and threshing, as well as time required to complete a single field operation per hectare were all taken into account when calculating the cost of cultivation. Water costs are evaluated by calculating how much time (h) and diesel (h^{-1}) the pump consumes to water a certain plot, and how much diesel costs. Gross income is the name given to the minimum support price for wheat set by the Indian government. Net income was calculated using the difference between gross income and total expense.

Maximum cost of cultivation (Rs.34240) was calculated using 100 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (T_5), 100 percent RDF + NPK consortia + Bio-stimulant (N_3), and 75 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (N_6). Moreover, the lowest cost of cultivation was computed in the control plot (Rs. 24030). Tillage costs were highest in T_1 (Rs. 30500) as furrow irrigated raised bed tillage, followed by conventional tillage (T_4) (Rs. 29950), and lowest in roto tillage methods in T_2 (Rs. 28265) respectively [Table 3]. Moreover, the highest gross return (Rs.108933) was found with the application of 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (T_5), followed by 100% RDF + NPK consortia + Bio-stimulant (N_3), and 75 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (N_6).

Among the various tillage techniques, the FIRB tillage technique produced the highest gross income. This could be due to higher water use efficiency than other tillage strategies, as well as a higher grain yield gain than the other treatments throughout the research year. Nutrient management strategies had a considerable impact on wheat crop net returns (Table 3). The highest net returns and B: C ratios were found in furrow irrigated raised beds seeded wheat among the various tillage techniques (T_1). However, maximum net returns (Rs. 73798) were estimated with higher fertilizer doses, such as 100 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (T_5), followed by 100 percent RDF + NPK consortia + Bio-stimulant (N_3), and 75 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation (N_6). During the investigation period, the control plot (Rs. 35797) produced the lowest net returns. Crops fertilized with 100 percent RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation had the highest B: C ratio (2.15), whereas control plots had the lowest B: C ratio (1.48). Reduced tillage seeded wheat had the highest B: C ratios among the various tillage techniques (T_3). However, roto tillage treatment (T_2) had the lowest B: C ratio. Naresh *et al.* 2012 [25, 26]; Jat *et al.* 2013 [16] found similar results. Higher net benefits were recorded under conservation agriculture than conventional agriculture during study season. This could be associated to the lower production costs under conservation agriculture than conventional agriculture. Similarly, Gathala *et al.* (2011) [8] reported higher wheat net returns under conservation agriculture (FIRB) compared to conventional agriculture.

Table 3: Performance of Crop Establishment Methods and Organic Fertilizer Complemented with Chemical N Fertilizer on profitability of wheat

Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
(A) Crop Establishment Methods Treatments				
T_1 Furrow Irrigated Raised Beds	30500	102372	70142	2.26
T_2 Roto tillage	28265	87268	59208	2.09
T_3 Reduced tillage	29186	95235	66285	2.30
T_4 Conventional tillage	29950	98114	68534	2.22
C.D (P=0.05)	-	3664	3058	0.40
(B) Nutrient Management				
N_1 Control	24030	59827	35797	1.48
N_2 100% RDF	31260	95559	65236	2.08
N_3 100% RDF + NPK consortia + Bio-stimulant	33585	105315	71630	2.13
N_4 75% RDF + NPK consortia + Bio-stimulant	31950	98468	67113	2.10
N_5 100% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation	34240	108933	73798	2.15
N_6 75% RDF + NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation	32870	101992	69758	2.12
C.D (P=0.05)	-	4365	3748	0.67

4. Conclusions

The study indicated an improvement in yield of wheat under FIRBS as compared to other method of planting. In case of nutrient strategies100 percent RDF+ NPK consortia + Bio-stimulant + NPK (18:18:18) spray after II irrigation gave higher yield as compared to other nutrient options in subtropical climatic conditions of northern India i.e. western Uttar Pradesh condition. The same reason could be ascribed to this as well.

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