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Effect of conservation tillage and precision nitrogen management techniques on soil health and soil available N, P and K in wheat in rice-wheat cropping system

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Abstract
The present investigation entitled "Effect of conservation tillage and precision nitrogen management techniques on soil health and soil available N, P and K in wheat in rice-wheat cropping system" study was carried out at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, (U.P.) during rabi season of 2021-22 and 2022-23. The experiment was conducted under split plot design with three replications, treatments comprising of three conservation tillage treatments {C_1-Conventional tillage (CT), C_2- Reduced tillage (RT) and C_3- Furrow irrigated raised bed (FIRB)} as main plots and four precise nitrogen treatments (N_1- Control, N_2- State recommendations, N_3- LCC based nitrogen Application and N_4- SPAD based treatments) as sub plot treatments. Among conservation tillage treatments, the maximum value of Available N, P and K in soil was observed in FIRB treatments while precision nitrogen treatments did not show statistically significant result. When soil parameters like Organic Carbon (%) (OC), pH and Electrical Conductivity (EC) was concerned it showed that precision nitrogen management resulted in better soil health parameters and reduced tillage resulted in better soil health parameters.

Keywords: Conservation tillage, precision nitrogen management techniques, soil health, soil, N, P, K, rice-wheat

Introduction

The world's most significant food crop is wheat. It is grown throughout 122 nations and takes up 217 million acres of land, yielding 781.7 million tonnes of wheat between 2021 and 22. Around 777 million tonnes of wheat is consumed worldwide annually, and this number is predicted to rise in the future (Anonymous, 2022) [1].

The most significant limiting element affecting wheat output is nitrogen. Since nitrogen is a component of protoplasm, protein, chlorophyll, alkaloids, hormones, and vitamins, it is essential for good crop production. However, excessive nitrogen application in wheat causes low nitrogen recovery efficiency and increases the risk of NO_3 ground water pollution. Detailed site-specific information is used in a precise nutrient management approach to regulate crops' nutrient requirements. For efficient use, farmers can assess the plant's nitrogen (N) demand in real time using leaf colour charts (LCCs). Fertiliser nitrogen is often applied by Indian farmers in a series of split applications, although the quantity of nitrogen applied per split, the number of splits, and the timing of the application all vary significantly. The LCC approach, which helps manage nitrogen for vast areas, results in better fertiliser use efficiency. On average, nitrogen was saved by utilising the LCC method at a rate of 25 kg ha^{-1} without any impact on yield (Balasubramanian, 2002) [2]. LCC is a tool that farmers can use that is environmentally beneficial. Wheat crop nitrogen needs can be predicted with the help of leaf color charts, which increases the effectiveness of N fertilizer at different yield levels (Jat *et al*., 2012) [3].

The relative chlorophyll content of leaves can be determined using a simple, portable diagnostic tool called a SPAD meter or Chlorophyll meter. However, this association changes depending on crop growth stage and/or variety. There is a strong linear link between SPAD values and leaf nitrogen content. The adaption of the SPAD meter to measure crop nitrogen status and calculate the plant's demand for more nitrogen fertilizer is the result of the linear relationship between nitrogen and SPAD values.

According to SPAD readings, the physiological nitrogen needs of crops at various growth stages dictate plant nitrogen status and the amount of nitrogen to be applied. It is an easy, rapid, and non-destructive in-situ method for determining the relative chlorophyll content of leaves, which is directly proportional to the amount of nitrogen in the leaf.

For the timely planting of crops, the lack of labour and rising costs are important challenges (Jat *et al*., 2014) [4]. Multiple researchers have established that the land quality in this area is declining as a result of various types of soil degradation and excessive residue burning (Das *et al*., 2013) [5]. In order to conserve resources, slow down soil degradation, adjust cropping systems to climate extremes, and increase agricultural sustainability over the long term, conservation agriculture (CA), which involves minimizing soil disturbances and retaining an appropriate quantity of crop residues, is widely supported. Farmers leading the transformation of agricultural production systems based on CA principles is already happening internationally (157 M ha) and gaining speed as a new paradigm for the 21st century, according to global empirical evidence (Kassam *et al*., 2015) [6]. According to Sapkota *et al*. (2016) [7], the changes in the physical and biological characteristics of the soil brought on by CA practices are anticipated to alter the kinetics and direction of the chemical and biochemical processes, changing the dynamics of nutrients in the soil.

Better inputs, appropriate production technologies, and appropriate tillage techniques can all help to increase wheat productivity. Due to their impact on the chemical and physical features of the soil and water conservation, these field operations have an impact on crop output (Bonfil *et al*., 1999) [9]. Wheat yield is impacted by significant factors like manure application and soil tillage. According to Ahmad *et al*. (1996) [10], tillage can account for up to 20% of all crop production parameters. Soil is frequently harmed by the use of extensive, unneeded traditional tillage techniques. When planted following puddled rice as opposed to non-puddled rice, wheat has shown a yield decrease of 8–9% (Kumar and Ladha, 2011) [11].

Raised beds are used for sowing in a type of tillage called a furrow-irrigated raised-bed planting system (FIRBs), which optimizes tillage operations, conserves water, and lowers lodging. (2017) Monsefia *et al*. The typical bed width is 45-50 cm, the furrow width is 25-30 cm, and the bed height is 15-20 cm. The establishment of the crop and plant vigour, which are the main contributors to crop development, have an impact on crop yield, according to Amanullah *et al*. (2009) [13]. In this approach, elevated beds and furrows are prepared manually or with a raised bed planting machine after the soil is normally prepared. Raised beds are covered with rows of crops, and irrigation water is applied in the furrows in between the beds; the water then spreads horizontally into the beds. A cutting-edge method for conserving water and improving the productivity of other inputs is to plant wheat on beds (FIRBs).

Material and Method

Experimental Details

The experiment was conducted under split plot design with three replications, treatments comprising of three conservation tillage treatments {C_1-Conventional tillage, C_2-Reduced tillage and C_3- Furrow irrigated raised bed (FIRB)} as main plots and four precise nitrogen treatments (N_1-Control, N_2- State recommendations, N_3- LCC based nitrogen Application and N_4- SPAD based treatments) as sub plot treatments. Gross plot size was 5 x 4.8 and net plot size was 4 x 4 and row spacing was kept at 20 cm. Seed rate of 100 kg ha^{-1} was used and recommended NPK dose (kg ha^{-1}) was 150:75:60. The variety DBW-222 was used. LCC readings starting from 15 DAS. Five plants from each plot were chosen at random to receive LCC readings. By matching the colour shade of the LCC and the average score, observations were made from the topmost, fully extended, and healthy leaf of each of the 5 plants. Readings were obtained by comparing the centre of the leaf with the LCC's colour strips. Leaf shouldn't be broken off. Readings were taken every day from 8:00 to 10:00 a.m. When readings are taken, the LCC won't be in direct sunlight. The first through last LCC readings will all be conducted by the same individual. N was administered according to treatments if the average measurement falls below the crucial LCC value. The same 5 plants were identified when LCC readings were taken again after 7 days. 20 kg N ha^{-1} was administered when the colour of the leaves was lighter than the threshold colour of the strip (4). Readings of SPAD began at 15 DAS. Five plants from each plot were chosen at random to receive SPAD readings. Observations were made on the top three healthy, fully developed leaves of each of the five tagged plants. After calibrating the device, readings were taken by placing the sample to be tested into the measuring head's sample slot.It was carefully ensured that the sample covered the receiving window entirely. The measurement of extremely thick sections, such as leaf veins, was not tried. For optimum results, multiple measurements were collected and averaged for leaves with numerous fine veins. No leaf was to be broken off. Readings were taken every day between 8 and 10 AM. N was administered at 20 kg ha^{-1} to the fields when the SPAD values were less than 45 if the average SPAD value fell below the critical value. Precision nitrogen treatments got nitrogen at a rate of 135 kg ha^{-1} compared to 150 kg ha^{-1} for the SR treatment.

Field preparation

Crop will be grown following the recommended package of practices, crop production measures shall be applied on need basis and crop will be established using following tillage systems.

1. **Reduced- tillage (RW):** In this approach, there is still some tillage *per se*, but there are far fewer preliminary tillage operations. Using a zero-till drill and an inclined planting plate, seeds are sown in rows 20 cm apart.
2. **Furrow irrigated raised bed (FIRB):** Using a tractor-drawn multi-crop raised bed planter with inclined plate metering for planting wheat, the soil is tilled by two harrowing, followed by one field levelling (using a wooden board). The furrows separating the beds, which have a top width of 140 cm and a height of 12 cm, are each 30 cm broad. Each bed contains seven rows of wheat, spaced 20 cm apart.
3. **Conventional tillage (CTW):** This system uses two harrowing, two ploughing (using a cultivator), and one planking (using a wooden plank) after the harvest of the rice to achieve good tilth. Wheat is then seeded in rows 20 cm apart using a seed drill with a dry fertiliser attachment.

Table 1: Treatment details of experiment

S.N.	Treatments	Symbols
C	Conservation tillage (Main plot)	
1.	Conventional tillage	C_1
2.	Reduced tillage	C_2
3.	Raised bed	C_3
N	Precise Nitrogen management(Sub-plot)	
1.	Absolute Control	N_1
2.	State recommendation of N (SR) @ 150:75:60	N_2
3.	LCC Based N application	N_3
4.	SPAD Based N application	N_4

Statistical analysis

The experiment's results were subjected to statistical analysis using the Split Plot Design method, which was recommended by Cochran and Cox (1970). The critical difference (C.D. at 5%) will be calculated when comparing the treatment means whenever the "f" test is found to be significant. The standard error of the mean was calculated.

Results and Discussion

Soil health

Soil pH

The data related to Soil pH after harvest of wheat crop as influenced by conservation tillage and precise nitrogen management treatment is given in Table 2.Soil pH was significantly influenced by conservation tillage practices and significantly minimum and maximum values of Soil pH were noticed in FIRB and CT practices during both the years. Better drainage in FIRB resulted in near neutral pH in wheat crop during both the years. Similar findings were also reported by Mahajan (2020) [15]. Similarly, precise nitrogen management treatments did cause significant effect on Soil pH however, minimum and maximum values were observed in SPAD based nitrogen application and SR treatment during both the years. pH values for LCC treatments were statistically at par with pH values for SPAD treatments during both the years of experimentation. Application of nitrogen (urea) was less in SPAD and LCC treatments by the tune of 15 kg ha^{-1} and since urea is an acidic fertilizer SR treatment recorded lowest pH. These results are in conformity with Gawdiya (2020) [16].

Electrical Conductivity (EC)

The data related to EC after harvest of wheat crop as influenced by conservation tillage and precise nitrogen management treatment is given in Table 2. The electrical conductivity exhibited significant variation due to tillage and nutrient management practices during both the year. The electrical conductivity in context of conservation tillage practices was recorded significantly highest with conventional tilled (C_1) plots and lowest value was observed in FIRB (C_3) plots during both the years. Better drainage in FIRB treatments must have resulted in runoff of soluble salts from soil in wheat and hence electrical conductivity in soil was lower for FIRB treatments. In case of nitrogen management practices highest value of EC was observed for SR plots and was significantly higher than LCC (N_3) and SPAD (N_4) based treatments while lowest value of EC was observed in control plots during both the years.

Organic carbon (OC) (%)

The data related to organic carbon of soil after wheat influenced by conservation tillage and precise nitrogen treatments are given in Table 2. The organic carbon was influenced significantly due to tillage and nutrient management practices during both the years. The organic carbon was recorded significantly highest in reduced tillage (C_2) treatments while FIRB (C_3) and conventional tilled (C_1) plots remained at par with each other during both the year of experiment. RT resulted in slightly higher OC during both the years and increase in OC during second year was higher in RT as compared to FIRB and CT. In precise nitrogen management treatments control plot which received zero nitrogen had significantly lowest amount of organic carbon during both the years. SR, SPAD and LCC based nitrogen application treatment remained at par with each other in terms of organic carbon percentage during both the years. Similar findings were also reported by Gawdiya (2020) [16].

Table 2: Effect of conservation tillage and precise nitrogen management techniques on pH, EC and organic carbon of soil at harvest

Treatments	pH		EC (dSm^{-1})		Organic carbon (%)	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Conservation tillage (Main plot)						
CT	6.76	6.88	0.25	0.28	0.50	0.51
RT	7.15	7.17	0.23	0.24	0.52	0.54
FIRB	7.04	7.06	0.20	0.21	0.49	0.50
SEm±	0.03	0.04	0.01	0.009	0.004	0.004
C D (P=0.05)	0.13	0.15	0.03	0.03	0.02	0.02
Precise nitrogen management (Sub plot)						
Control	7.16	**7.18**	0.17	0.19	0.48	0.47
SR @ 150:75:60	6.89	6.81	0.28	0.30	0.51	0.52
LCC Based N	7.02	7.00	0.21	0.23	0.52	0.53
SPAD Based N	7.01	7.02	0.22	0.25	0.52	0.52
SEm±	0.04	0.05	0.01	0.009	0.004	0.003
C D (P=0.05)	0.15	0.19	0.03	0.03	0.02	0.01

Available N in soil

Table 3 provides information about soil nitrogen availability. During both the experimentation years, tillage and nitrogen management techniques had a considerable impact on the amount of accessible N in the soil. The highest nitrogen status among the various tillage techniques was found in FIRB (C_3) after wheat crop harvest, which was noticeably greater than the other treatments during both of the experimentation years. Reduced tillage (C_2) was shown to have the significantly lower value of accessible nitrogen in soil following harvest of the wheat crop than the other tillage strategies during both research years. In comparison to reduced tillage experiments, conventionally tilled (C_1) plots displayed significantly increased nitrogen availability. During both of the test years, a clear impact of precise nitrogen delivery was seen on the nitrogen status following wheat crop harvest. After wheat crop harvest, the SPAD (N_4) based nitrogen application treatment showed the greatest nitrogen status, which was at par with LCC based nitrogen application treatments but much higher than other treatments in both years. After the harvest of the wheat crop, the control treatment showed the noticeably lowest value of nitrogen status over the course of the two years.

Table 3: Effect of conservation tillage and precise nitrogen management techniques on available N, P and K of soil in wheat at the time harvest

Treatments	Available N		Available P		Available K	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Conservation tillage (Main plot)						
CT	216.5	216.1	15.5	15.1	243.1	245.4
RT	215.2	212.7	14.9	14.4	240.7	241.9
FIRB	220.2	219.7	16.1	15.9	244.8	245.6
SEm±	0.69	0.75	0.09	0.08	0.52	0.41
C D (P=0.05)	2.15	2.34	0.29	0.26	1.58	1.29
Precise nitrogen management (Sub plot)						
Control	199.4	201.8	14.9	14.7	239.7	237.8
SR	213.1	211.7	15.0	15.1	240.9	239.5
LCC Based N	215.8	214.3	15.6	15.5	246.5	244.1
SPAD Based N	216.6	216.1	15.9	15.7	247.1	246.3
SEm±	0.35	0.62	0.09	0.07	0.46	0.82
C D (P=0.05)	1.01	1.79	0.31	0.22	1.40	2.36

Available P in soil

The data of available phosphorus in soil is given in Table 3. The available P in soil was influenced significantly by tillage and nutrient management practices during both the year of experiment.

The highest phosphorus status among the various tillage techniques was attained after wheat crop harvest in FIRB (C_3) treatments, which was noticeably greater than the rest of the treatments during both the experimentation years. After harvesting the wheat crop, reduced tillage (C_2) treatments had considerably lower phosphorus levels than the other tillage methods during both research years. Phosphorus availability was substantially higher in conventionally tilled (C_1) plots than in reduced tillage (C_2) plots.

During both of the test years, a clear impact of precise nitrogen treatment was seen on the availability of phosphorus after wheat crop harvest. The SPAD (N_4) based nitrogen application treatment, which stayed at par with LCC treatment but significantly higher than rest of treatments during both years of study, showed the highest value of accessible phosphorus in soil following harvest of wheat crop. Following the harvest of the wheat crop, the control treatment showed the noticeably lowest value of phosphorus that was still available in the soil during both years.

Available K in soil

Table 3 provides information on the potassium that is present in soil. During both the experimentation years, tillage and fertiliser management techniques had a considerable impact on the amount of K that was accessible in the soil. The highest potassium status among the various tillage techniques was found in the FIRB (C_3) treatments after wheat crop harvest, which was considerably greater than the rest of the treatments during both the testing years. Following wheat crop harvest, reduced tillage (C_2) treatments were found to have considerably lower potassium status than other tillage approaches during both research years. Reduced tillage (C_2) plots showed considerably lower potassium availability than conventionally tilled (C_1) plots.

During both of the trial years, a clear impact of precise nitrogen delivery was seen on the availability of potassium. After wheat crop harvest, the SPAD (N_4) based nitrogen application treatment showed the greatest level of soil-available potassium, which remained on par with LCC treatment but much higher than other treatments throughout both years of study. After the harvest of the wheat crop, the control treatment had the noticeably lowest value of potassium that was still available in the soil during both years.

Conclusion

Result shows soil pH after wheat crop harvest is significantly influenced by conservation tillage and precise nitrogen management treatment. Better drainage due to FIRB and precise nitrogen management results in near neutral pH values. Experiment shows significant variation in electrical conductivity after wheat harvest, with conservation tillage and precision nitrogen management affecting it. Conventional tilled plots had higher conductivity, while precision nitrogen management treatments led to higher conductivity. It shows organic carbon in wheat soil was influenced by conservation tillage and precise nitrogen treatments, with reduced tillage having the highest organic carbon. Precision nitrogen management did not seem to have much effect on OC %. Result shows that available N, P and K in soil was significantly influenced by tillage and nutrient management practices. FIRB (C_3) had the highest N, P and K status after wheat crop harvest, while reduced tillage (C_2) had the lowest. SPAD (N_4) based nitrogen application treatment had the highest N, P and K status.

References

1. Anonymous. Cereal Supply and Demand: Crop Prospects and Food Situation, Food and Agricultural Organisation, Geneva, Switzerland; c2022.
2. Balasubramanian V, Morales AC, Torres R, Gines G, Collado W, Redona E. Response of rice hybrid and an inbred variety to urea briquette deep placement in the Philippines. Journal of Agricultural Research Manage. 2002;1:50-60.
3. Jat Ram A, Wani Suhas P, Sahrawat Kanwar L, Singh

Piara, Dhaka SR, Dhaka BL. Recent approaches in nitrogen management for sustainable agricultural production and eco-safety. Archives of Agronomy and Soil Science. 2012;58(9):1033-1060.
4. Jat ML, Bijay-Singh, Gerard B. Nutrient management and use efficiency in wheat systems of South Asia. Advances in Agronomy. 2014;125:171-259.
5. Das TK, Bhattacharyya R, Sharma AR, Das S, Saad AA. Pathak H. Impacts of conservation agriculture on total soil organic carbon retention potential under an irrigated agro-ecosystem of the western Indo Gangetic Plains. European Journal of Agronomy. 2013;51:34-42.
6. Kassam A, Friedrich T, Derpsch R, Kienzle1 J. Overview of the worldwide spread of conservation agriculture. Field Actions Science Reports, 2015, 8.
7. Sapkota TB, Majumdar K, Khurana R, Jat RK, Stirling CM, Jat ML. Precise nutrient management under conservation agriculture based cereal systems in South Asia. Chapter. 2016;7:132-161.
8. Lal R. A system approach to conservation agriculture. Journal of Soil and Water Conservation. 2015;70(4):82-88.
9. Bonfil DJ, Mufradi I, Klitman S, Asido SS. Wheat grain yield and soil profile water distribution in a no till arid environment. Agronomy Journal. 1999;91:368-373.
10. Ahmad N, Rashid M, Vaes AG. Fertilizer and their use in Pakistan, NFDC. Publication, No. 4/96, 2nd Edition, Islamabad, 1996.
11. Kumar V, Ladha JK. Direct seeding of rice: recent developments and future research needs. Advances in Agronomy. 2011;111:297-313.
12. Monsefia A, Sharma AR, Zan, Rang N. Weed management and conservation tillage for improving productivity, nutrient uptake and profitability of wheat in soybean (*Glycine max*)-wheat (*Triticum aestivum*) cropping system. International Journal of Plant Production. 2016;10(1):1-12.
13. Ammanulah, Hafeez, Ishfaq Muhammad, Rashid Fayyaz Muhammad, Rehman Abdur, Waheed Abdul. Effect of Different Nitrogen Levels on Growth, Yield and Yield Contributing Attributes of Wheat. International Journal of Scientific & Engineering Research. 2009;9(9):212-218.
14. Cochran WG, GM Cox. Experimental Designs. John Wiley; c1970.
15. Mahajan NC. Improving wheat (*Triticum aestivum* L.) and soil productivity through precise nitrogen management practices and efficient planting system. M.Sc. Thesis. SVPUAT, Meerut; c2020.
16. Gawdiya Sandeep. Precise nutrient management in conservation agriculture-based wheat production, nutrient use efficiency, soil health and profitability in western Uttar Pradesh. MSc Thesis. SVPUAT, Meerut; c2020.