



Effect of Various Tillage Practices and Residue Retention on N, P and K Content in Seed and Straw of Different Wheat Varieties in Rice-wheat System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field trial was conducted at rice research station, Kaul (Kaithal) of CCSHAU, Hisar during the *Rabi* season to study the effect of tillage practices and residue retention on nutrient content in seed and straw of different wheat varieties. The six wheat varieties viz; HD 2967, HD 3086, WH 1105, WH 711, WH 1124 and WH 1142 were grown under four tillage systems: turbo seeder with full residue retention, turbo seeder with intact residue, zero tillage with no residue and conventional tillage with no residue methods. The nitrogen (N), phosphorus (P) and potassium (K) content in seed and straw were not influenced by different sowing techniques during both the years but nitrogen content was significantly affected during second year of study. However, the maximum N, P and K content (%) in seed and straw of wheat was achieved with turbo seeder sowing wheat under full residue retention and minimum content was recorded in conventional tillage with no residue retention during both years. Among varieties, significant difference was observed in term of nitrogen and potassium content in seed and straw. WH 1105 recorded significantly higher N content (%) in grain while more N content (%) in straw was found in WH 1124 during 2018 and 2019. While K content (%) in seed was more in WH 711 which was at par with WH 1142 and WH

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1105 whereas, K content(%)in straw was more in WH 1124 variety being at par with WH 1142 in both years of study. However, Phosphorus content (%) in grain and straw of different wheat varieties was not differed significantly during 2 years of experiment. In conclusion, the different sowing methods had non- significant effects on the nutrient content but varietal genotype of wheat had more influence nutrient content in seed and straw under different sowing techniques.

Keywords: Wheat; seed; straw; nitrogen; phosphorous; potassium; tillage; residue.

1. INTRODUCTION

Rice- wheat cropping system is the largest producing system which cultured on 10.4 million per hectare area in Indo Gangetic Plains in India [1]. RWS reported around 40 percent areas in IGP (known as food bowl) state of Punjab, Haryana, UP, Bihar and WB [2] Farmers generally practice this cropping system due to availability of MSP along with other facilities (fertilizer, irrigation). RWS popular among farmers in Haryana and Punjab because of its more profitable nature but now a days, disturbance in climate situation and degrade of soil condition and production of huge amount of crop residue due to mechanized harvesting of rice which farmers burnt in the field may be the possible reason for make it sustainability at risk [3,4]. Rice residue is burnt in the fields for timely planting of succeeding wheat crop and secondly, Farmers think, it is the easy and cheapest option. But burning of that residue cause loss of organic matter (OM) and N, P (25%), K (21 %) , 50 percent of S, health issues, heat production, microbial loss, smog and pollution problems [5-7]. There is necessitate to manage paddy residue which is precious resources of nature and find a better solution, which is economical and environmentally acceptable [8]. Therefore, modern machinery called "Turbo Seeder" which helps in chopping of straw and deposits on soil upper surface as mulch along with wheat crop sowing in rice residue [9]. The surface retention of rice residue (RR) in wheat crop sowing with turbo seeder enhanced and improves soil health [10-12]. Turbo seeder also helps early sowing of wheat in standing and loss rice straw and increase wheat production because delay in sowing per day causes 1 to 1.5 percent less yields after 15th Nov. [13]. Different varieties may differ in growing behavior in response to available agronomic practices. The growing of high yielding varieties of wheat under improved agronomic methods may enhance wheat

nutritional condition and productivity. But, the major limitation that farmers burn the rice residue in field for early sowing of wheat instead of using turbo seeder because they think that yield under turbo seeder was achieved lower than conventional method of sowing. So, the varieties which are popular among farmers are taken under experiment Therefore, comparative study of promising wheat varieties was carried out in order to screen the most promising wheat under different tillage system and residue retention. Keeping above in view, the present investigation was undertaken in *rabi* season for two years.

2. MATERIALS AND METHODS

A field study entitled was carried out during *Rabi* season of the year 2017-18 and 2018-19 at RRS station (Kaul, Kaithal) of CCSHAU, Hisar which is situated at elevation of 241 m above the MSL with north latitude of 29° 51' and east longitude 76° 41'. The region also called as rice bowl of Haryana. The experimental site has sub-tropical climate condition with hot desiccating winds and moderate to severe cold during summer and winter season, respectively. Temperature rise high up to 40-45°C during the months of May-June in summer, whereas fall very low up to 3-5°C during the months of Dec- Jan in winter. Annual rainfall of 700 mm is received from which 80 percent was available between the July to September month.

Before sowing of wheat, representative soil samples from 0-15 cm depth were collected randomly from 5 places to determine the soil physical and chemical properties. The soil of the experimental field during both years was loamy in texture containing sand (41.2 and 43 %), silt (32.5 and 33 %) and clay (26.1 and 27 %) with bulk density and electrical conductivity was 1.62 g/cm³, 0.21dSm⁻¹ and 1.63g/cm³, 0.26dSm⁻¹ respectively.

Table 1. Cropping history of the experimental field

Year	Kharif Season	Rabi Season
2014-15	Rice	Wheat
2015-16	Rice	Wheat
2016-17	Rice	Wheat
2017-18	Rice	Wheat (Experiment)
2018-19	Rice	Wheat (Experiment)

2.1 Experimental Details

The treatments comprised of 4 sowing techniques viz., 1) S₁: Sowing wheat with turbo seeder (TS) machine in residue of combine harvested rice crop, 2) S₂: Sowing wheat with turbo seeder (TS) machine in intact/standing rice residue (remove the loose straw of combine harvested rice crop), 3) S₃: Sowing wheat with zero till (ZT) seed cum fertilizer drill machine in manually harvested rice field, 4) S₄: Sowing with conventional tillage (CT) conditions in manually harvested rice field which placed in main plots and 6 wheat varieties viz., V₁: HD 2967, V₂: HD 3086, V₃: WH 1105, V₄: WH 711, V₅: WH 1124, V₆: WH 1142 carried in sub plots during the year of 2017-18 and 2018-19. The variety HD 3086 and HD 2967 released from Delhi and WH 1105, WH 711, WH 1142 released from Hisar, Haryana are timely sown varieties. WH 1124 is late sown variety release from Hisar, Haryana.

During both years, leaving loose straw and standing paddy straw (20-25 cm height) of previous rice crop which was harvested with combine harvester in S₁ treatment while only standing rice straw was retained after manual removal of loose straw in S₂ treatment. However, rice was harvested manually in S₃ and S₄ with no standing or loose straw. The field was plough twice with disc harrow machine and then planking was done in S₄ treatment while these practices were not carried out in S₁, S₂ and S₃. The different cultivars viz., HD2967, HD 3086, WH 1005, WH 711, WH 1142 and WH 1124 were sown according to treatments mentioned above. Wheat varieties were sown at 3-5 cm

depth at 20 cm row spacing. Seed rate of 100 kg/ha were taken for all varieties during both the years. Nitrogen and Phosphorus was applied at the rate of 150 and 60 kg per hectare in all treated plot. Phosphorus was applied through DAP fertilizer which was drill with seed whereas, nitrogen was applied through urea in to splits. Half dose was applied at the time of sowing and second half was applied after 25 days of sowing. All other cultural practices were carried out according to university recommendation.

2.2 NPK Content and Uptake by Grain and Straw

Nitrogen, phosphorus and potassium content and uptake in grain and straw of wheat crop were determined after harvest of wheat crop during both years. For analysis, firstly oven dried plant material (both grain and straw procedure were followed for analyzed of NPK content in wheat seed and straw sample given below:

2.3 Digestion of Samples

0.2 to 0.5 g plant material (seed and straw) were weighted in a 100 ml conical flask. Then 10 ml of di-acid mixture (H₂SO₄ and HClO₄) in a ratio of 9:1 was added and keep all for overnight. After that all conical flask were placed on a hot plate until a clear colorless solution resulted and fumes ceases to come out. A total of 4-5 ml volume was retained then make volume 50 ml with distilled water, then cool and transfer it to 50 ml volumetric flask then filter all with what man filter paper (No. 42) and used for NPK analysis.

Table 2. Details of experimental design

Design	Strip Plot Design (SPD)
Total no. of treatments	4 x 6 = 24
Replications	3
Total no. of plots	3 x 24 = 72
Plot size	10.0 x 2.2 m ²
Season	Rabi 2017 and 2018

2.4 Nitrogen Content

Nitrogen content estimation was done by Nessler's reagent method [14]. Take 1 ml of digested sample (seed and straw) in a volumetric flask (25 ml) and then add 5 ml of distilled water. Add 2 ml of 10% NaOH followed by 1 ml of 10% sodium silicate and then make the volume 20 ml with distilled water. After that, add 2 ml of Nessler's reagent which gave orange color then make final volume 25 ml with distilled water. Read the intensity of color at 440 nm wavelength on spectrophotometer with blue filter. Calculate nitrogen content using standard curve against transmittance.

2.5 Phosphorus Content

Phosphorus content estimation was done by Vanadomolybdo-phosphoric acid yellow colour method [15]. Take 5 ml of aliquot/digested sample in a volumetric flask (25 ml). Then put 2-3 drops of 2,4 di-nitrophenol indicator in it followed by ammonia solution (yellow colour developed) then add drop wise 6 N HCl till solution become colorless. Then 5 ml of vanadomolybdate solution was added and make final 25 ml volume with distilled water. Read the intensity of yellow color at 440 nm wavelength on spectrophotometer by using blue filter. Run a blank simultaneously. Calculate P content of with standard curve against transmittance.

2.6 Potassium Content

Potassium content was estimated by Flame photometer method [16]. Take 5 ml of aliquot in a 25 ml of volumetric flask then make the volume up to mark and record the K concentration given by flame photometer. Calculate K content using the standard curve.

3. RESULTS AND DISCUSSION

3.1 N, P and K content in grain

The perusal of data on nitrogen, phosphorus and potassium content in the grain are presented in Table 2. The result of two year experiment revealed that the nitrogen content (%) in grain did not during second year of experimental study. The maximum nitrogen content in seed was obtained under S₁ treatment of sowing during both the years, respectively followed by S₂, S₃ and S₄ treatment. During 2018-19, maximum nitrogen content in seed was recorded in S₁ treatment which was significantly higher than S₃ and S₄ treatment but statistically at par with S₂ treatment. Whereas, there was non-significant significant difference in phosphorus and potassium content in grain both the years but maximum P & K content in seed was registered in S₁ treatment followed by S₂, S₃ and S₄ treatment. Minimum N, P, K content was recorded in S₄ treatment.

Table 3. Effect of different sowing techniques and varieties on NPK in grain of different wheat varieties

Treatments	NPK content in Seed (%)					
	2017-18			2018-19		
	N	P	K	N	P	K
Sowing methods (S)						
S ₁ : Sowing wheat with turbo seeder (TS) machine in residue of combine harvested rice crop	1.78	0.47	0.25	1.81	0.47	0.25
S ₂ : Sowing wheat with turbo seeder (TS) machine in intact/standing rice residue	1.73	0.45	0.24	1.78	0.46	0.25
S ₃ : Sowing wheat with zero till (ZT) seed cum fertilizer drill machine in manually harvested rice field	1.72	0.44	0.23	1.76	0.46	0.24
S ₄ : Sowing with conventional tillage (CT) conditions in manually harvested rice field	1.70	0.42	0.23	1.74	0.44	0.24
SEM±	0.03	0.02	0.01	0.01	0.02	0.01
CD (p = 0.05)	NS	NS	NS	0.03	NS	NS
Wheat varieties (V)						
V ₁ : HD 2967	1.77	0.45	0.22	1.80	0.47	0.22
V ₂ : HD 3086	1.59	0.47	0.22	1.62	0.48	0.23
V ₃ : WH 1105	1.92	0.43	0.24	1.94	0.45	0.25

Treatments	NPK content in Seed (%)					
	2017-18			2018-19		
	N	P	K	N	P	K
V ₄ : WH 711	1.86	0.41	0.26	1.89	0.42	0.27
V ₅ : WH 1124	1.84	0.45	0.23	1.86	0.47	0.24
V ₆ : WH 1142	1.42	0.44	0.25	1.53	0.45	0.26
SEm±	0.05	0.02	0.01	0.04	0.02	0.01
CD (p = 0.05)	0.12	NS	0.02	0.08	NS	0.02

Table 4. Effect of different sowing techniques and varieties on NPK in straw of different wheat varieties

Treatments	NPK content in Straw (%)					
	2017-18			2018-19		
	N	P	K	N	P	K
Sowing methods (S)						
S ₁ : Sowing wheat with turbo seeder (TS) machine in residue of combine harvested rice crop	0.42	0.15	0.84	0.44	0.16	0.86
S ₂ : Sowing wheat with turbo seeder (TS) machine in intact/standing rice residue	0.42	0.13	0.82	0.43	0.16	0.85
S ₃ : Sowing wheat with zero till (ZT) seed cum fertilizer drill machine in manually harvested rice field	0.41	0.13	0.81	0.43	0.15	0.84
S ₄ : Sowing with conventional tillage (CT) conditions in manually harvested rice field	0.40	0.12	0.79	0.42	0.14	0.82
SEm±	0.01	0.01	0.02	0.01	0.01	0.01
CD (p = 0.05)	NS	NS	NS	NS	NS	NS
Wheat varieties (V)						
V ₁ : HD 2967	0.40	0.12	0.79	0.42	0.14	0.81
V ₂ : HD 3086	0.43	0.14	0.77	0.45	0.16	0.79
V ₃ : WH 1105	0.41	0.11	0.81	0.43	0.13	0.83
V ₄ : WH 711	0.41	0.15	0.82	0.43	0.17	0.85
V ₅ : WH 1124	0.46	0.13	0.86	0.47	0.15	0.89
V ₆ : WH 1142	0.38	0.13	0.84	0.39	0.16	0.87
SEm±	0.02	0.01	0.01	0.02	0.01	0.01
CD (p = 0.05)	0.04	NS	0.03	0.04	NS	0.02

Among various varieties, the WH 1105 variety had significantly more nitrogen content in grain than HD 2967, HD 3086 and WH 1142 during 2017-18 and 2018-19, respectively but at par with WH 711 and WH 1124 wheat varieties during both the years. Minimum nitrogen content in seed was obtained in WH1142 wheat variety. Whereas, phosphorus content in seed did not differed significantly among different varieties however, maximum P content in seed was recorded with HD 3086 variety and minimum in WH711 variety during both 2018 and 2019. However, potassium content in seed was affected significantly by different varieties of wheat. WH 711 wheat variety recorded maximum K content in seed which was significantly higher than HD 2967, HD 3086 and WH 1124 but at with WH 1105 and WH 1142 wheat varieties during both the year of experiment. This was

because of different genotypic characters of different varieties. Previous rice crop residue had more nutrient concentration which released out after mineralization might help in improving chemical, biological condition and nutrient uptake by crops [17,18]. Residues are good source of food to soil microbes [19] resulting in increasing nutrient concentration in plants. More nutrient (N, P and K) content and uptake in zero till sowing was observed than conventional method of sowing [20].

3.2 N, P and K Content in Straw

The result of the experiment was presented in Table 3 revealed that sowing techniques had non-significant effect on nitrogen, phosphorus and potassium content in straw of wheat during both the years. However maximum N, P and K

content was registered with S₁ treatment followed by S₂, S₃, and S₄ treatments during 2018 and 2019. Among various varieties, significantly more N content was found in WH 1124 during both the seasons but it was statistically at par with HD 3086 variety during first year and with varieties HD 3086, WH 1105 and WH 711 during second year. Whereas, phosphorus content in straw did not differ significantly during both the years but maximum content in straw was registered in HD 3086 and WH 711 varieties during both the years. While potassium content in straw was significantly affected by different varieties. Maximum content of potassium in straw was achieved with WH 1124 which was statistically at par with WH 1142 during the both year of 2018 and 2019. This result obtained was due to different environment condition and treatment in which different varieties exposed and gave their performances. Research results of Kharia et al. [21] and Gill et al. [22] were also similar with present study who also reported that N, P and K content in straw were differed among different wheat varieties.

4. CONCLUSION

On the basis of results of two year of experiment study it can be concluded that nutrient content (N, P and K) in seed and straw did not get influenced by different sowing treatments. Among wheat varieties, P content in grain and straw was not differed significantly during both years. Higher N content in seed was found of WH1105 variety and in straw of WH 1124 during both the years. While WH 711 had more K content in seed and in straw, K content was more in WH 1124.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Bhatt R, Kukal SS, Arora S, Busari MA, Yadav M. Sustainability issues on rice-wheat cropping system. *International Soil and Water Conservation Research*. 2016;4(1):68-83.
- Panigrahy S, Upadhyay G, Ray SS, Parihar JS. Mapping of cropping system for the indo-gangetic plain using multi-date SPOT NDVI-VGT data. *Journal of the Indian Society of Remote Sensing*. 2010;38(4):627-632.
- Bhattacharyya R, Ghosh BN, Dogra P, Mishra PK, Santra P, Kumar S, Fullen MA, Mandal UK, Anil KS, Lalitha M, Sarkar D, Mukhopadhyay D, Das K, Pal M, Yadav R, Chaudhary Prakash V, Parmar B. Soil Conservation Issues in India. *Sustainability*. 2016;8:1-37.
- Sandhu BS, Dhaliwal NS, Sandhu GS. Production potential and economics of wheat, *Triticum aestivum* as influenced by different planting methods in Punjab, India. *Journal of Applied and Natural Science*. 2016;8(2):777-781.
- Pal R, Kumar R, Jalal RK, Sohane RK. Assessment of happy seeder for direct sowing of wheat without burning of rice residue. *Current Journal of Applied Science and Technology*. 2019;37:1-4.
- Thorat TN, Agrawal KK, Kewat ML, Jha G, Silawat S. Crop residue management with conservation agriculture for sustaining natural resources. *Research paper crop residue management with conservation agriculture for sustaining natural resources*. 2015;125-136:125.
- Naresh RK, Singh SP, Kumar D, Pratap B. Experience with managing rice residues in intensive rice-wheat cropping system in North-Western India. *International Journal of Life Sciences Biotechnology and Pharma Research*. 2013b;2(2):85-96.
- Rafiq MH, Ahmad R, Jabbar A, Munir H, Hussain M. Influence of different no-till techniques at varying heights of standing rice stubbles on the wheat performance. *Int. J. Agr. Biol*. 2017. ISSN Print: 1560–8530.
- Sidhu HS, Singh M, Singh Y, Blackwell J, Lohan SK, Humphreys E, Jat ML, Singh V, Singh S. Development and evaluation of the turbo happy seeder for sowing wheat into heavy rice residues in NW India *Field Crops Res*. 2015;184:201–212.
- Goswami SB, Mondal R, Mandi SK. Crop residue management options in rice–rice system: A review. *Archives of Agronomy and Soil Science*. 2020;66(9):1218-1234.
- Choudhury SR, Prasad S, Pathak SK. Impact of conservation tillage with residue retention on soil physico-properties and yield of rice and wheat under rice-wheat cropping system. *Current Journal of Applied Science and Technology*. 2019;1-6.
- Jat HS, Datta A, Sharma PC, Kumar V, Yadav AK, Choudhary M, McDonald A.

- Assessing soil properties and nutrient availability under conservation agriculture practices in a reclaimed sodic soil in cereal-based systems of North-West India. Archives of Agronomy and Soil Science, 2018;64(4):531-545.
13. Brar NK, Condon J, Evans J, Singh Y. Nitrogen management in wheat sown in rice straw as mulch in North West India. 19th World Congress of Soil Science, Soil Solutions for a Changing World, August 2010, Brisbane, Australia. 2010;11-6.
 14. Lindner RC. Rapid analytical method for some of the more common inorganic constituents of plant tissues. Plant Physiol. 1944;19:76-89.
 15. Jackson ML. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi; 1973.
 16. Richards LA. Diagnosis and improvement of saline and alkaline soils. USDA Hand Book No.60, Washington, D.C; 1954.
 17. Kumar N, Kamboj BR, Thakral SK, Singh M. Growth parameters and productivity of wheat as influenced by crop establishment methods and different seed rate. Int. J. Pure App. Biosci. 2017;5:2134-2140.
 18. Choudhary KM. Diversification with sustainable intensification options for cereal systems of Western Indo-Gangetic plains through conservation agriculture and water management. Ph.D Thesis.CCS Haryana Agricultural University, Hisar, India; 2016.
 19. Quadros PDD, Zhalnina K, Richardson AD, Fagen JR, Drew J, Bayer C, Camargo FAO, Triplett EW. The effect of tillage system and crop rotation on soil microbial diversity and composition in a subtropical Acrisol. Diversity. 2012;4:375-95.
 20. Youjun L, Ming H. Effects of tillage managements on soil rapidly available nutrient content and the yield of winter wheat in west Henan province, China. Procedia Environmental Sciences. 2011;11:843-49.
 21. Kharia SK, Thind HS, Sharma S, Sidhu HS, Jat ML, Singh Y. Tillage and rice straw management affect soil enzyme activities and chemical properties after three years of conservation agriculture based rice-wheat system in north- western India. International Journal of Plant & Soil Science. 2017;15:1-13.
 22. Gill MS, Pal SS, Ahlawat IPS. Approaches for sustainability of rice (*Oryzasativa*) wheat (*Triticum aestivum*) cropping system in Indo-Gangetic plains of India. Indian Journal of Agronomy. 2008;53(2):81-96.

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