Effect of tillage and crop residue management practices on yield and economics of wheat (*Triticum aestivum* L.) under conservation agriculture

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Abstract

A field experiment was conducted at Experiment farm of Agronomy Department, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during seasonal *rabi* 2019, to study the effect of tillage and crop residue management practices on yield and economics of wheat (*Triticum aestivum* L.) under conservation agriculture. The experimental plot was laid out in split plot design of fifteen treatment combinations replicated thrice. Where in main plot consist of three tillage practices viz., Zero tillage (T1), Reduced tillage (T2) and Conventional tillage (T3) and sub plot to five crop residue management practices viz., crop residue @ 2.5t/ha (R1), crop residue @ 5t/ha (R2), crop residue @ 2.5t/ha + consortia @ 5kg/ha (R3), crop residue @ 5t/ha + consortia @ 5kg/ha (R4) and without crop residue (R5). The study of experiment showed that reduced tillage and crop residue application @ 5t/ha + consortia @ 5kg/ha was found significantly higher grain yield. Gross returns, net returns and B:C ratio were recorded highest with reduced tillage and crop residue application @ 5t/ha + consortia @ 5kg/ha. Each increment of tillage and crop residue application correspondingly improved yield as well as gross returns, net returns and B:C ratio of wheat.

Keywords: Conservation agriculture, tillage practices, crop residue management, yield and economics

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop next to the rice. Its crop belongs to family Gramineae (Poaceae) and sub family Pooidae widely cultivated for its seed, a cereal grain. Being winter crop. Which is a word wide staple food around 2.5 billion people around 36 per cent of the world population. In India wheat is most important food after rice in terms of both area and production which contributes 12% of the world wheat pool. In India during 2017-18 area under wheat cultivation was 309.60 Lakh hectare with annual production of 98.38 Lakh Tons with an average productivity 31.72 q/ha. Maharashtra it occupies as area of 12.72 Lakh hectare with production of 22.14 Lakh tons and average productivity is 17.40 q/ha. [Ministry of Agriculture, New Delhi, Economics Times, Fourth Estimates 2017-18](https://www.indiastat.com/agriculture/). The productivity of wheat depends on the used proper inputs, appropriate production technology and by encouraging the appropriate tillage practices. Conservation agriculture maintains a permanent or semi-permanent organic soil cover. This can be a growing crop or dead mulch. Its function is to protect the soil physically from sun, rain and wind and to feed soil biota. The soil micro-organisms and soil fauna take over the tillage function and soil nutrient balancing. Mechanical tillage disturbs this process. Therefore, zero or minimum tillage and direct seeding are important elements of CA (FAO website). The technologies of CA provide opportunities to reduce the cost of production, save water and nutrients, increase yields, increase crop diversification, improve efficient use of resources, and benefit the environment (Bhadu *et al.*, 2018) [2]. Adoption these practices permits the management of soil for crop production without excessively disturbing soil. Conservation Agriculture maintains a permanent or semi-permanent organic soil cover. This can be a growing crop or dead mulch. Its function is to protect the soil physically from sun, rain and wind and to feed soil biota. The soil micro-organisms and soil fauna take over the
tillage function and soil nutrient balancing. Mechanical tillage disturbs this process. Therefore, zero or minimum tillage and direct seeding are important elements of CA. A varied crop rotation is also important to avoid disease and pest problems (FAO website). Reduced or minimum tillage deals with the reduction of total number of tillage operations required for sowing of a particular crop. Zero tillage deals with the manipulation of soil in narrow strip where seeds are placed. All these practices leave at least 30% stubbles on soil as mulch or add these into soil as source of organic matter (Khan et al., 2017). Zero tillage seeding offers the benefits of retaining surface residues and reduces soil-water losses. With zero-tillage technology, farmers can harvest higher yields and production cost is reduced up to 10% with also improves soil condition and its fertility status (Ghosh et al., 2010) [3]. Conservation agriculture offers an opportunity for arresting and reversing the downward spiral of resource degradation, decreasing cultivation costs and making agriculture more resource use efficient, competitive and sustainable. Keeping this background in view, an attempt was made to study the effect of tillage and crop residue management practices on yield and economics of wheat (Triticum aestivum L.) under conservation agriculture.

Material and Method
A field experiment was conducted at Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during season rabi-2019. The soil of experimental field was deep black, clay in texture, medium in organic carbon, low in available nitrogen (178.00 kg ha⁻¹), phosphorus (12.15 kg ha⁻¹) and high in potash (488 kg ha⁻¹) and pH was 7.80. The field experiment set up in a split plot design with three tillage treatments consisted of zero tillage (T₁), reduced tillage (T₂) and conventional tillage (T₃). While the subplot treatments were five crop residue management practices, consist of crop residue @ 2.5t/ha (R₁), crop residue @ 5t/ha (R₂), crop residue @ 2.5t/ha + consortia @ 5kg/ha (R₃), crop residue @ 5t/ha + consortia @ 5kg/ha (R₄) and control (without crop residue) (R₅). Under zero tillage direct sowing of seed without tilling the land with the help of tractor driven specially designed zero-till-see-drill. In reduced tillage direct sowing operation was done with BBF planter. The conventional tillage consisted of one deep ploughing, followed by two passes of cultivator with planking in the last pass, after this sowing of seeds was done with tractor driven normal seed drill. Crop residue management practices, in this treatment was done by using chopped soybean crop residues. It was applied 20 DAS and treatments consisting an application of decomposing microbial consortia was applied as spraying after sown crop as surface mulch. Five plants in each treatment in the net plot area were selected at random and tagged for biometric observations. The economics of treatments were calculated using existing market prices. The input and output costs were compared treatment wise and different parameters, viz., net returns and the B: C ratio were calculated. Data were statistically analyzed as suggested by Panse and Sukhatme (1967) [11].

Result and Discussion
Effect of tillage on yield and economics of wheat
The grain yield were significantly influenced by different tillage practices. The treatment reduced tillage obtained significantly higher grain yield (2207 kg ha⁻¹) was found with reduced tillage which was at par with conventional tillage (T₃) (2032 kg ha⁻¹) and lowest yield was found in zero tillage (T₁) (1775 kg ha⁻¹). This might be due to more favoured overall growth and yield attributing characters due to favourable seed bed, better aeration, scope for more space, light interception, benefit of more conserved moisture in furrows and its support at critical growth stages like tillering, panicle initiation and development. This resulted in higher values of yield attributing characters and which in turn resulted in higher yields of wheat crop. Similar results were reported by Ozpinar S. (2004) [12] and Singh et al., (2020) [16]. However, highest gross return (42501 Rs ha⁻¹), net returns (21839 Rs ha⁻¹) and benefit cost ratio (2.05) were recorded with reduced tillage among all tillage practices. Lower gross return (34174 Rs ha⁻¹), net returns (15012 Rs ha⁻¹) and benefit cost ratio (1.77) was observed with zero tillage practices. Increase in gross returns, net returns and benefit cost ratio due to higher crop production with reduced tillage (T₂), irrespective of greater cost of cultivation value. Similar results were reported by Ozpinar (2004) [12], Singh et al., (2013) [15] and Shivanth (2016) [14]. Conventional tillage resulted highest cost of cultivation (24777 Rs ha⁻¹), while zero tillage and reduced tillage resulted in lowest cost of cultivation (19162 Rs ha⁻¹ and 20662 Rs ha⁻¹) This might be due in conventional tillage consists more number of operation which are necessary and that charges high rates for tillage operation, which reflect into high cost of cultivation in conventional tillage than zero and reduced tillage.

Effect of crop residue application on yield and economics of wheat
The grain yield were significantly influenced by different crop residue management practise. The treatment application of crop residue @ 5 t/ha + consortia @ 5 kg/ha (R₅) obtained significantly higher grain yield (2303 kg ha⁻¹) was found with application of crop residue @ 5 t/ha + consortia @ 5 kg/ha (R₃) over the rest of treatments and lowest yield was found with control (R₃). This increase in yields might be due to improvement in yield attributes with application of crop residue @ 5 t ha⁻¹ + consortia @ 5 kg ha⁻¹ in addition to its multiple roles in favoured overall growth and yield attributing characters due to favorable seed bed, better aeration, scope for more space, light interception, higher microbial activity benefit of more conserved moisture in crop residues treatments. This ultimately resulted in higher values of yield attributing characters and which in turn resulted in higher yields of wheat crop. This result correlate with earlier work conducted by Ram et al., (2010) [13], Dhar et al., (2014) [4, 5] and Kumar and Singh (2018) [9]. However, highest gross return (44350 Rs ha⁻¹), net returns (21927 Rs ha⁻¹) and benefit cost ratio (1.99) were recorded with reduced tillage among all tillage practices. Lower gross return (31020 Rs ha⁻¹), net returns (10746 Rs ha⁻¹) and benefit cost ratio (1.53) was observed with zero tillage practices. This might be due to favoured early growth and conservation of moisture in treatment over the rest of treatments and which ultimately resulted in higher yield and thus ultimately gave higher GMR, NMR and B: C ratio.

Interaction effect
The interaction effect of all the treatment combination i.e. tillage and crop residue management was found non significant.
Table 1: Grain yield (kg ha\(^{-1}\), cost of cultivation (Rs ha\(^{-1}\)) gross monetary returns (Rs ha\(^{-1}\)), net monetary returns (Rs ha\(^{-1}\)) and B:C ratio as influenced by various treatments.

| Treatments                      | Grain yield (kg ha\(^{-1}\)) | Cost of cultivation (Rs ha\(^{-1}\)) | Gross monetary returns (Rs ha\(^{-1}\)) | Net monetary returns (Rs ha\(^{-1}\)) | B:C ratio |
|---------------------------------|------------------------------|-------------------------------------|----------------------------------------|--------------------------------------|-----------|
| Tillage practices (T)           |                              |                                     |                                        |                                      |           |
| T₁ - Zero tillage               | 1775                         | 19162                               | 34174                                  | 15012                                | 1.77      |
| T₂ - Reduced tillage            | 2207                         | 20662                               | 42501                                  | 21839                                | 2.05      |
| T₃ - Conventional tillage       | 2032                         | 24777                               | 39130                                  | 14352                                | 1.58      |
| S.E. ±                          | 82                           | -                                   | 1591                                   | 1591                                 | -         |
| C.D. at 5%                      | 248                          | -                                   | 4775                                   | 4775                                 | -         |
| Residue management (R)          |                              |                                     |                                        |                                      |           |
| R₁ - crop residue @ 2.5t/ha     | 1877                         | 21273                               | 36132                                  | 14858                                | 1.71      |
| R₂ - crop residue @ 5t/ha       | 2235                         | 22723                               | 43042                                  | 20768                                | 1.96      |
| R₃ - crop residue @ 2.5t/ha + consortia @ 5kg/ha | 1998 | 21423 | 38464 | 17040 | 1.81 |
| R₄ - crop residue @ 5t/ha + consortia @ 5kg/ha | 2303 | 22423 | 44350 | 21927 | 1.99 |
| R₅ - without crop residue (control) | 1611 | 20723 | 31020 | 10746 | 1.53 |
| S.E. ±                          | 69                           | -                                   | 1308                                   | 1308                                 | -         |
| C.D. at 5%                      | 2031                         | -                                   | 3925                                   | 3925                                 | -         |
| Interaction (T × R)             |                              |                                     |                                        |                                      |           |
| S.E. ±                          | 120                          | -                                   | 2329                                   | 2329                                 | -         |
| C.D. at 5%                      | NS                           | -                                   | NS                                     | NS                                   | -         |
| G. mean                         | 2005                         | 21533                               | 38602                                  | 17068                                | 1.80      |

Conclusion

All tillage and crop residue management practices showed significant influence on wheat crop. The results revealed that among different tillage and crop residue management practices, the reduced tillage recorded significantly higher grain yield, GM_R, NMR and B: C ratio followed by conventional tillage and lowest in zero tillage. Application of crop residue @ 5t/ha + consortia @ 5kg/ha recorded significantly higher grain yield, GM_R, NMR and B: C ratio over rest of the treatments.

References

1. Bartaula S, Panthi U, Adhikari A, Mahato M, Joshi D, Aryal K. Effect of different tillage practices and nitrogen level on wheat production under inner terai of Nepal. Journal of Agriculture and Natural Resources, 2020;3(1):233-239.
2. Bhardwaj K, Choudhary R, Poonia T, Patidar P, Choudhary KM, Kakrailya SK. A review paper on concept, benefits and constraints of conservation agriculture in India. International Journal of Chemical Studies 2018;6(4):36-40.
3. Breiman A, Graur D. Wheat Evaluation. Israel Journal of plant sciences 1995;43:58-95.
4. Dhar D, Datta A, Basak N, Paul N, Badole S, Thomas T. Residual effect of crop residues on growth, yield attributes and soil properties of wheat under rice-wheat cropping system. Indian Journal of Agricultural Research 2014;48(5):373-378.
5. Dhar D, Datta A, Basak N, Paul N, Badole S, Thomas T. Residual effect of crop residues on growth, yield attributes and soil properties of wheat under rice-wheat cropping system. Indian Journal of Agricultural Research 2014;48(5):373-378.
6. FAO: Conservation agriculture website 2006.
7. Ghosh PK, Das A, Saha R, Kharkrangel E, Tripathi AK, Munda GC et al. Conservation agriculture towards achieving food security in North East India. Current Science, 2010, 915-921.
8. Khan HZ, Shabir MA, Akbar N, Iqbal A, Shahid M, Shakoor A, Sohail M. Effect of different tillage techniques on productivity of wheat (Triticum aestivum L.). J Agric Basic Sci, 2017;2(1):44-49.
9. Kumar R, Singh UP. Performance of zero-till wheat (Triticum aestivum L.) with residue and weed management techniques under rice-wheat cropping system. Agricultural Science Digest-A Research Journal 2018;38(2):113-117.
10. Ministry of Agriculture, New Delhi, Economics Times, Fourth Estimates, 2017-18.
11. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers. ICAR, New Delhi 1967.
12. Ozpinar S. Influence of Tillage Systems on Wheat Yields and Economics in Clay Loam Soil under the Mediterranean Dryland Conditions. Journal of Agronomy 2004;3(2):81-87.
13. Ram H, Kler DS, Singh Y, Kumar K. Productivity of maize (Zea mays)–wheat (Triticum aestivum) system under different tillage and crop establishment practices. Indian Journal of Agronomy 2010;55(3):185-190.
14. Shivnath D. Studies on Tillage and Nutrient Management for Enhancing Productivity and Profitability of Wheat (Triticum aestivum L.). International Journal of Agriculture Sciences 2016 ISSN, 0975-3710.
15. Singh YP, Singh D, Tomar SS, Gupta RK. Effect of time of pre-irrigation and tillage practices on wheat (Triticum aestivum) under pigeonpea (Cajanus cajan)–wheat cropping sequence. Indian Journal of Agricultural Sciences 2013;83(12):1317-1321.
16. Singh YP, Singh S, Singh AK, Panwar B. Influence of Wheat Establishment Techniques and Previous Kharif Season Crops on Productivity, Profitability. Water Use Efficiency, Energy Indices and Soil Properties in Central India. Agricultural Research 2020;9(2):203-212