

Effect of different tillage systems and cultivars on yield and yield attributes of rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during *Kharif* 2019 at the Experimental Farm of the Department of Agronomy of CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur (H.P.) to investigate the effect of different tillage systems and varieties on yield of rice. The treatments consist of three rice varieties (HPR 1156, HPR 2656 and HPR 2795) which were tested under three tillage systems viz., conventional tillage, and minimum tillage without residue and minimum tillage with residue retention. The experiment was set up in a split plot design, with the tillage system in the main plot and rice cultivars in the sub plots, and it was triple replicated. The texture of the soil at the test site was silty clay loam in texture, acidic in reaction and in terms of nitrogen, phosphorus, and potassium, it was evaluated as medium. Significantly higher no. of panicles per meter square were observed in minimum tillage without residue though this treatment was at par with conventional tillage while significantly lower number of panicles m^{-2} were recorded with minimum tillage with residue retention. Significantly greater number of grains per panicle and panicle length were recorded in conventional tillage while minimum tillage with residue retention recorded lower values of number of grains per panicle and panicle length. Different tillage practices had no effect on the test weight of rice. Among different varieties tested, HPR 2656 recorded greater number of panicles per square meter which was at par with variety HPR 1156. Significantly higher number of grains per panicle and panicle length were recorded with HPR 2795 while the other two varieties were at par with each other. Rice variety HPR 1156 produced grains that had significantly greater test weight while the other two varieties (HPR 2795 and HPR 2656) were at par with each other with respect to this parameter. In terms of yield, conventional tillage produced much larger grain yield, straw yield, and biological yield and was at par with minimum tillage without residue. Among different varieties tested, HPR 2795 recorded much greater grain, straw and biological yields.

Introduction

Rice (*Oryza sativa* L.) is a staple meal for half of the earth population, and it plays a critical role in the food and nutritional security of the world's poorest and malnourished people. The importance of this crop in the global food security scenario can be judged from the fact that this grain supplies more than 50% of the world's staple food while also making up for 20 % of the world's dietary energy supply, which is more than 19 % and 5 % that is contributed by wheat and maize, respectively (Schatz *et al.*, 2014). In India rice is cultivated on an area of 43.78 million hectare with the total production of 118.43 million tonnes with the average productivity of 27.05 q/ha (Anonymous, 2020) Even in the state of Himachal Pradesh rice is one of the most important *kharif* crop (second only to maize) which was cultivated on an area about 71 thousand hectare with the production of 114.8 thousand tonnes and productivity of about 16 q/ha (Anonymous, 2018).

The conventional tillage methods are easy to adopt and provide clean cultivation. However it leads to high erosion hazard as it completely inverts the soil and buries crop residues, making the land much more exposed to erosive forces of wind and water. Erosion eventually reduces the productivity of land (Mathew *et al.*, 2012). The alternate for all these problems is conservation tillage. Tillage systems such as ridge-till, minimum tillage and no-till leave more crop residues and offer greater erosion control. Conservation agriculture aims to increase agricultural yields and also provide economic and environmental advantages. It is referred as "future agriculture" (Pretty *et al.*, 2011). Minimum soil disturbance, rational organic soil cover utilising crop residues or cover crops, and the adoption of innovative and economically feasible farming methods, as well as steps taken to decrease soil compaction through regulated traffic, are all important components. Fuel and labour requirements are also reduced with conservation tillage. Further plant residues used as mulch not only cover the soil surface but help to supply plant nutrients on decomposition by micro-organisms. As a result it's critical to discover technologies that may generate larger yields with less resource, lowering cultivation costs and increase farmers profit margins (Singh *et al.*, 2006).

Adoption of conservation agriculture practices alters the microclimate of soil leading to better crop growth. However the varieties may differ in their suitability for cultivation under conservation agriculture system. Also specific genotypes have been recommended for no-till cultivation all over the world. However, very little work has been done in Himachal Pradesh for the identification of rice genotypes for conservation agriculture. Thus it is important to test this new concept in one of the most important cereal crop grown in the state. Keeping the above facts in view, the present study was conducted to identify varieties suitable for conservation agriculture.

Material and Methods

The current study took place in the Experimental Farm of the Department of Agronomy, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur (32°09' N latitude, 76°54' E longitude, at an altitude of 1290 m above mean sea level) during the kharif of 2019. The region reflects Himachal Pradesh's mid-hills sub-humid zone, which has moderate summers and chilly winters. The soil at the test location had a silty clay loam texture, was acidic in response, and had a medium amount of accessible nitrogen, phosphate, and potassium.

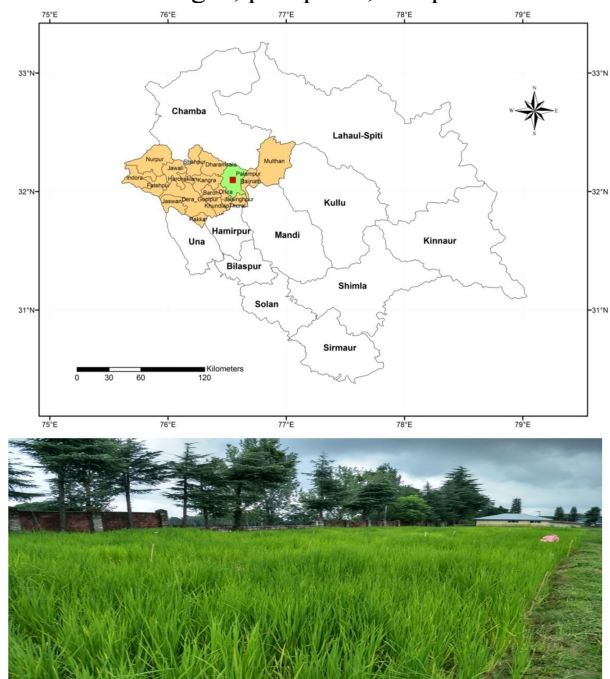


Figure 1: Sampling locations (32°09' N, 76°54' E)

There were nine treatment combinations in the trial, including three tillage techniques (conventional tillage, minimum tillage without residue, and minimum tillage with residue retention) and three cultivars (HPR 1156, HPR 2656, and HPR 2795). The experiment was conducted out in a split plot design, with tillage techniques in the main plot and varieties in the sub plot, and was repeated three times. The crop was planted on June 13th, 2019. The crop was grown with recommended package of practices and was supplied with 60:30:30 kg NPK. The complete amount of phosphorus and potassium, as well as half of the prescribed nitrogen, was administered at the time of sowing, with the remaining nitrogen applied in two equal splits during the tillering and panicle initiation stages. Mustard straw @ 3t/ha was used as mulch material and applied as per treatment.

The data on different yield attributes (number of panicles per meter square, number of grains per panicle, panicle length and test weight) as well as on grain and straw yield and harvest index was recorded. The data obtained was statistically analysed using the method educated by Gomez and Gomez (1984). The critical difference (CD) was estimated for parameters with significant impacts at the 5% probability level.

Results and Discussion

The data on different treatments effect on yield attributes of different rice varieties has been given in Table 1 while that on yield has been given in Table 2. A perusal of data (Table 1) reveal that significantly higher number of panicles per square meter were recorded in the minimum tillage without residue treatment which was at par with conventional tillage while significantly lower number of panicles per square meter was recorded in minimum tillage with residue. However in case of number of grains per panicle and panicle length significantly higher values for both these parameters were recorded in conventional tillage which was comparable to minimum tillage without residue. Significantly lower number of grains per panicle and panicle length were recorded in minimum tillage with residue retention. Tillage practices had no effect on the weight of 1000 grains. The higher values of yield attributes (number of panicles m^{-2} , number of grains panicle $^{-1}$

and panicle length) observed in conventional tillage can be attributed to the effect of tillage in loosening the soil, increasing porosity thereby allowing good air exchange and root growth. This better root growth allows the plant to absorb nutrients and water from a wider soil profile resulting in better crop establishment and early growth which results in higher values of yield and its attributes (Gupta and Seth, 2007; Seth 2019). The treatment in which residue was retained on the soil led to the immobilization of nitrogen particularly during the initial stages of crop growth resulting in poor growth and yield attributes. The 1000 grain weight is more of a genetic character and hence was not influenced by different tillage practices.

Among rice varieties significantly higher number of panicles per square meter was observed in the variety HPR 2656 which was at par with HPR 1156 and lowest count was recorded in HPR 2795. In case of grains per panicle significantly higher value was recorded in HPR 2795 which was followed by HPR 2656 and HPR 1156 in that order, the latter two varieties being at par with each other. The data on panicle length revealed that significant longer panicle was observed in variety HPR 2795, while the lowest panicle length was recorded in variety HPR 2656 though it was at par with HPR 1156. 1000-grain weight is an important yield attribute which affect yield of any crop. The data on 1000-grain weight reveals that variety HPR 1156 produced grains having significantly higher 1000-grain weight while the other two varieties were at par with each other.

The data on yields and harvest index of rice has been presented in Table 2. Results revealed the significant influence of both tillage practices and varieties on grain yield, straw yield and biological yield. Significantly higher grain yield was recorded in conventional tillage which was at par with minimum tillage without residue while lowest yield was recorded in treatment in which the minimum tillage was practiced alone with residue retention. As discussed earlier the conventional tillage improved porosity as well as air circulation in the soil enabling better root and shoot growth and better nutrient availability and uptake resulting in better yield. In minimum tillage with residue higher immobilization of nitrogen could be the cause of the reduced yield. Similar results have also been

Table 1: Effect of tillage practices and varieties on yield attributes of rice

Treatments	No. of panicles m ⁻²	No. of grains panicle ⁻¹	Panicle length (cm)	1000 grain weight (g)
Tillage practices				
Conventional tillage	219.4	91.0	22.74	26.31
Minimum tillage without residue	222.2	87.3	22.41	25.91
Minimum tillage with residue	211.7	83.8	22.06	25.56
SEM ±	2.4	1.1	0.08	0.16
LSD (P= 0.05)	9.4	4.2	0.33	NS
Varieties				
HPR 1156	226.6	76.1	22.04	26.41
HPR 2656	230.9	82.7	21.43	25.58
HPR 2795	195.8	103.3	23.73	25.79
SEM ±	5.1	2.8	0.25	0.13
LSD (P= 0.05)	15.6	8.5	0.78	0.41

Table 2: Effect of tillage practices and varieties on yield of rice

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
Tillage practices				
Conventional tillage	28.53	54.96	83.49	34.17
Minimum tillage without residue	28.05	52.48	80.53	34.83
Minimum tillage with residue	26.28	49.68	75.96	34.59
SEM ±	0.40	0.88	1.10	0.14
LSD (P= 0.05)	1.52	3.28	4.32	NS
Varieties				
HPR 1156	24.04	47.83	71.87	33.43
HPR 2656	28.53	53.44	81.97	34.79
HPR 2795	30.29	55.85	86.13	35.15
SEM ±	0.64	1.04	1.82	0.18
LSD (P= 0.05)	2.08	3.20	5.60	0.60

reported by (Singh *et al.*, 2006; Seth, 2019; Seth 2020; Mitra and Patra, 2019 and Pandey and Kandel, 2020). Among the varieties tested significantly higher grain yield was recorded in variety HPR 2795 which was comparable to HPR 2656 and lowest grain yield was recorded in HPR 1156. The higher yield in HPR 2795 was due to significantly longer panicle and due to higher number of grains panicle per square meter. The data on straw yield and biological yield revealed that significantly higher values of both parameters were recorded in conventional tillage which was 9.6 and 9.0 % higher over minimum tillage without residue, respectively. The higher straw yield obtained in conventional tillage was due to better root growth and enhanced nutrient availability and uptake which resulted in better initial growth and higher photosynthetic activity. Among the varieties tested significantly higher straw yield and biological yield was recorded in variety HPR 2795 which was at par with HPR 2656 while lowest straw yield and biological yield was recorded in variety HPR 1156.

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- The harvest index of rice was not significantly influenced by tillage practices with all the treatments exhibiting almost similar harvest index. Contrary to this harvest index of different rice varieties varied significantly with HPR 2795 showing significantly higher harvest index while HPR 1156 showed significantly lower harvest index.

Conclusion

It is possible to draw a conclusion from the current research that conventional tillage gives better productivity of rice as compared to minimum tillage with residue on short term basis. Also amongst different varieties HPR 2795, a new red rice variety, gave better results under direct seeding.

Conflict of interest

The authors declare that they have no conflict of interest.

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