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Effect of Rice Straw on Weed Populations, Biomass and Yield of Wheat under Zero and Conventional Tillage Practices

Nesar Ahmad Nesar[1*], R. Puniya[1], B.R. Bazaya[1], Vikas Sharma[2], B.K. Sinha[3], Tuhina Dey[4] and B.C. Sharma[1]

[1]Division of Agronomy, Faculty of Agriculture, Sher-e Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu (J&K), India.

[2]Division of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Sher-e Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu (J&K), India.

[3]Division of Plant Physiology, Faculty of Agriculture, Sher-e Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu (J&K), India.

[4]Division of Genetics and Plant Breeding, Faculty of Agriculture, Sher-e Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu (J&K), India.

(Corresponding author: Nesar Ahmad Nesar)*

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ABSTRACT: Weeds are unwanted and undesirable plants that absorb nutrients faster and in greater quantities than crop plants, reducing crop yield even at higher fertilizer rates. Consequently, promising weed management approaches are required to enhance wheat productivity. Keeping this in mind, afield experiment was conducted at Research Farm, Division of Agronomy, SKUAST- Jammu during *Rabi* season of 2020-21 to study the effect of rice straw on weed populations, biomass and wheat yield under zero and conventional tillage practices. The experiment was conducted in a factorial RBD comprising zero and conventional tillage as factor A and five paddy straw treatments *viz.*, S_1: 6t /ha paddy straw, S_2: 6 t/ha paddy straw plus 25kg/ha extra nitrogen over recommended dose, S_3: 6t/ha paddy straw plus PUSA decomposer, S_4: 6t/ha paddy straw plus 25kg/ha extra nitrogen over recommended dose plus PUSA decomposer and S_5: no straw (control) as factor B. The results revealed that zero tillage recorded considerably lower total weed population and biomass and higher grain and straw yield than conventional tillage. However, among paddy straw treatments, all straw containing treatments noted significantly inferior weed population and biomass as compared to no residue (control). Treatment S_4: 6t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer recorded significantly higher gain and straw yield as compared to other treatments but it was statistically at par with S_2: 6 t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose. Hence, it concluded that use of rice straw as mulch as is promising options for management of weeds and realizing higher wheat productivity instead of residue burning which cause numerous environmental and health issues.

Keywords: Wheat productivity, weed population, Weed biomass, straw retention, straw incorporation and Tillage.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the utmost essential grain crop and play a significant role in nutrition security of nationals across the globe, particularly in developing countries. However, it is India's primary staple food and largest grain crop. Despite the concrete efforts of governments, agronomists and farmers in many countries, such as India, still the average national yield per hectare of wheat remains far below than potential yield.

The presence of weeds is widely recognized as a significant biotic barrier to food production in wheat field. Weeds are in competition with wheat, which decrease crop yield and quality by making agricultural maintenance tasks like irrigation, fertilization, and harvesting more difficult and by providing a home for pathogens and insects (Pala and Mennan 2021). The losses caused by weeds vary depending on the type, intensity, period of infestation, crop competition, and climatic conditions (Kaur *et al*., 2021). After harvest, weeds mixed with the crop may be spread to other locations or combined with processed foods to produce food poisoning (Bajwa *et al*., 2018; Pala *et al*., 2018). Wheat crop is threatened by weeds, which are responsible for 20-40% of yield losses (Kumar *et al*., 2008). Mixed infestations of *P. minor*, *Avena ludoviciana*, pimpernel scarlet (*Anagallis arvensis* L.), and *C. album* have been linked to a loss of wheat crop yield of up to 35%. (Pandey and Verma 2004; Sharma 2005).

Conventional tillage practices cause losses of soil, reduction of soil organic matter, compaction of soil and also favors weed germination and growth. Zero tilled sown is becoming popular in recent years due to its environmental benefits, including reduced run-off, improved nutrient cycling, reduced soil deterioration, reduced water and soil pollution, and increased soil biota activity (Holland *et al*., 2004). It also saved fuel, water, production costs, and enhanced productivity (Saharawat *et al*., 2010). Further, it ensures timely sowing and reduce weed infestation.

Chemical weed control measures with use of imbalanced and extensive herbicides resulted in many environmental issues and resistance of weeds against many herbicides. Consequently, it is fairly obvious from this scenario that new weed management tactics and strategies are required for long-term weed management (Kaur *et al*., 2021).

Weeds can be managed in a sustainable and cost-effective manner by using paddy straw. All elochemical studies on paddy straw revealed the presence of several metabolites that have an all elopathic effect on weeds. Paddy straw contains many phenols, including p salicyclic acid, pcoumaric acid, vanillic acid, syringic acid, ferulic acid, and mandelic acid (Bhandari and Guru 2017). Along with chemical and mechanical management, agronomic interventions such as altering sowing dates, tillage, field leftover management is an effective weed control strategy.

In combine harvested rice, farmers have two options: in situ use or burning. Due to short sowing window of wheat after harvest of rice crop, farmers prefer to burin rice residue in the field which is a harmful practice for human, environments as well as soil biota. Open burning causes the release of a variety of dangerous gases, including methane, sulfur dioxide, nitrous oxide, and carbon monoxide (Singh *et al*., 2010).

By preventing weed seeds from being exposed to light and creating a physical barrier for the emerging weed seedlings, rice straw plays significant role in suppressing the growth of weeds (Malik *et al*., 2002). Paddy straw retention on the soil surface as mulch is preferable than incorporation because it result in low weed seed germination and weed smothering. Use of rice residue mulch in zero tilled sown wheat appreciably decreased weed species over time as compared to conventional tilled sown wheat. In order to manage paddy straw inside the field it can either be spread on the soil's surface or chopped and spread with loose straw from a previous crop that had been combined harvested. As reported mulching of 7 t/ha rice straw decreased weed seed germination by 30.5% (Sharma *et al*., 2010).

Several reports confirms that incorporation of rice residue also cause reduction in weed density. Common tillage operations that incorporation of residues into the soil involve the use of a cultivator, followed by a rotavator, a moldboard plough, followed by a rotavator, or just a rotavator. The distribution of weed flora throughout the soil profile is affected differently by each of these techniques. Incorporating rice residue led to weed density and biomass reductions by 32.6% and 31.3%, respectively, in comparison to its removal (Khankhane *et al*., 2009). When residue was incorporated weed density was reduced by 18.9% (Singh *et al*., 2013). The dynamics of weeds under paddy straw measures with conventional and zero tillage is rarely studied in agro-climatic conditions of Jammu. Thus, this study aims to study weed populations and biomass under zero and conventional tillage with reference to different paddy straw management measures.

MATERIALS AND METHODS

The experiment was conducted during *rabi* season 2020-21 at Research Farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K, India. The subtropical Shivalik Himalayan foothills are home to the experimental site, which is located in the Union Territory of Jammu and Kashmir The topsoil in the experimental field was a sandy clay loam with a slightly alkaline pH, low amounts of organic carbon and available nitrogen, and moderate amounts of phosphorus and potassium.

The experiment was carried out in a Factorial Randomized Block Design (FRBD) consisting of two tillage (zero and conventional) as factor A and five paddy straw treatments *viz*., S_1: 6t /ha Paddy Straw, S_2: 6 t/ha Paddy Straw plus 25kg/ha extra nitrogen over recommended dose, S_3: 6t/ha Paddy Straw plus PUSA decomposer, S_4: 6t/ha Paddy Straw plus 25kg/ha extra nitrogen over recommended dose plus PUSA decomposer and S_5: no Straw (control) as factor B. In zero-tilled residue retention plots rice was harvested at 30 cm height and wheat was sown with happy seeder. Whereas, in conventional tillage full paddy straw (6t/ha) was incorporated in the soil after application of treatment ingredients and one surface irrigation was applied and kept for 20 days for decomposition of straw. After 20 days, conventional tilled plot was ploughed with two-time rotavator. In no residue (control) under both zero and conventional tillage rice crop was harvested from ground level. The recommended dose NPK was 100:50:25 kg/ha and seed rate were 100 kg/ha. However, in zero tillage 25 per cent extra nitrogen and seed was used over recommended dose in zero tilled plot. Nitrogen was divided into three equal splits. One split of N along with full dose of P and K was applied ad a basal dose while the remaining two splits was applied at CRI stages and before booting stages. In conventional tillage extra N was applied in soil with PUSA decomposer on rice residue and incorporated by rotavator. But in zero tillage additional N and PUSA decomposer was sprayed as per treatment after sowing of wheat by happy seeder. The data was analyzed with R version 4.1.3 and Duncan Multiple Range Test (DMRT) was used for comparison of treatments.

RESULTS AND DISCUSSION

Total weed populations (no./m^2) and biomass (g/m^2). The perusal of data depicted in Table 1 revealed that zero tillage found to be more effective in reduction of total weed population (no./m^2) and biomass (g/m^2) as it obtained significantly lower weed population and biomass as compared to conventional tillage. This in agreement with findings of Yadav *et al.* (2005); Brar and Walia (2007). Similarly, Nath *et al.* (2016**)** also reported lees weed populations and biomass in wheat field under zero tillage with rice reside retention as compared to conventional tillage.

Table 1: Effect of paddy straw and tillage on total weed density, biomass and weed control efficiency at 90 DAS.

Treatment	Total weed Populations (no./m^2) at 90 DAS	Total weed biomass (g/m^2) at 90 DAS	Weed control efficiency (per cent)
Tillage			
Zero tillage	3.63 b (12.26)	4.00b (14.99)	-
Conventional tillage	7.57a (56.26)	6.94a (47.19)	-
Paddy Straw			
Paddy Straw@ 6t/ha	5.32 b (27.33)	5.26b (26.66)	51.33
Paddy Straw @ 6t/ha plus 25 kg/ha extra nitrogen over recommended dose	5.16b (27.33)	5.03b (25.95)	52.62
Paddy Straw @ 6t /ha plus PUSA decomposer	5.32b (25.66)	5.19b (24.33)	55.58
Paddy Straw @ 6t /ha plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer	5.13b (25.33)	4.97b (23.74)	56.66
No residue (control)	8.16a (65.66)	7.47a (54.78)	-

Among residue management practices, 6/ha Paddy Straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer noted lowest total weed population and biomass which was statistically at par with 6 t/ha Paddy Straw, 6 /ha Paddy Straw plus 25kg/ha extra nitrogen over recommended dose, 6/ha Paddy Straw plus PUSA decomposer but all recorded remarkably lower weed populations and biomass than no straw (control). The highest total weed population and biomass was observed in no residue (control). The reduction in weed population and biomass in paddy straw containing treatments may happen as result of paddy straw on the surface of soil which helps to reduce weed seed emergence by avoiding light exposure and mechanical impedance of weed seedlings. This in collaboration with findings of Malik *et al.* (2002). Similarly, revealed paddy straw treated with PUSA decomposer reduced weed density and biomass significantly than no residue treatment.

The interactive effect among tillage and paddy straw, revealed that all zero-tilled paddy straw containing treatments was statistically at par with each other's but recorded significantly inferior weed populations and biomass than no straw (control) under both tillage and conventional tillage with residue incorporated treatments. Further, conventional tillage with paddy straw incorporation treatments was also found statistically comparable with each other's but obtained lower weed population and density than control treatment under both tillage system (Fig. 1 and 2). Our results showed that zero tillage plus paddy straw mulch at 6 t/ha achieved significantly less weed populations and biomass which could due to paddy straw mulch on the soil surface which limited light, prevented weed seed development and containing phytotoxic chemicals, resulting in lower weed density and biomass. This is in agreement with results of Kumar *et al.* (2013); Nath *et al*. (2016). In addition, in zero till sown wheat paddy straw was used as mulch on the soil's surface, slows the emergence of weed seedlings, gives the crop a competitive edge, and ultimately benefits wheat growth. The same was confirmed by Cristoforetti *et al.* (2007). As a result, combining zero-till with crop residue management is a crucial multi-tactic strategy for controlling weed populations. The results of our experiment also revealed reduction in weed population and dry weight in conventional tillage with paddy straw incorporation, which might be due to all elopathic effect of rice residue which diminished the germination and growth of weeds. This is in conformity with findings of Khankhane *et al*. (2009). Khankhane *et al*. (2009) reported 32.6% and 31.3% reduction on weed populations and biomass as a result of paddy straw incorporation in the soil under conventional tillage system.

Grain and straw yield. The data with respect to grain and straw yield of wheat is presented in Fig. 3 which indicates that zero tillage recorded significantly greater grain and straw yield (3803 and 4504 kg/ha, respectively) than conventional tillage (3400 kg/ha and 4133 kg/ha, respectively). The highest grain yield observed under zero tillage was due to better weed control, which resulted in less soil turning, more space for individual plants, better utilization of nutrients, moisture, and solar radiation, and thus higher photosynthesis activity, which resulted in higher plant yield. This is in conformity with results of Rani *et al*. (2017); Nandan *et al*. (2018).

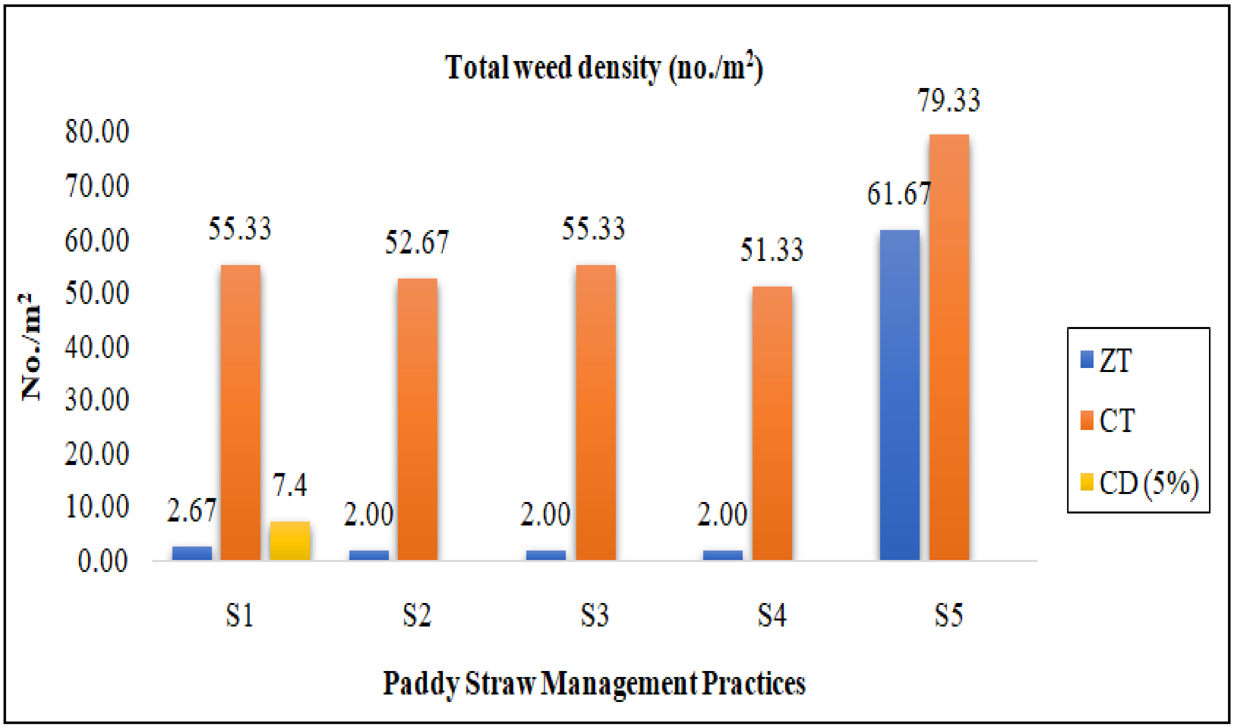

Fig. 1. Interaction effect of paddy straw and tillage on total weed populations (No./m^2) at 90 DAS.

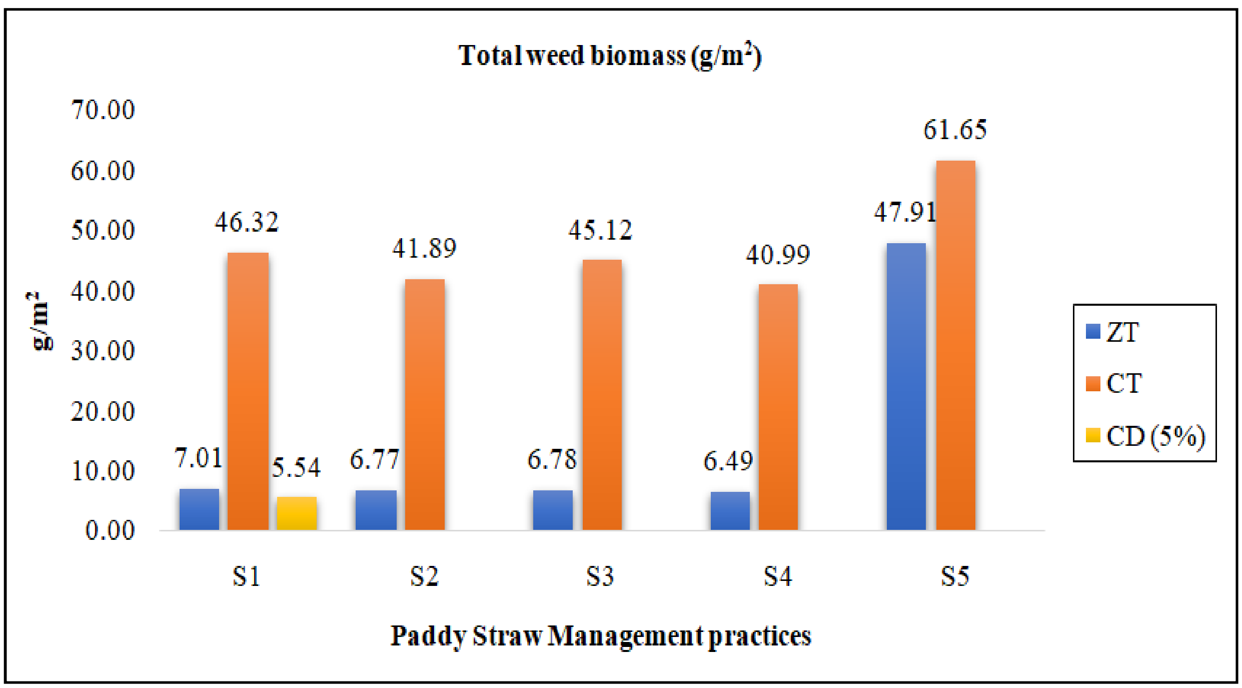

Fig. 2. Interaction effect of paddy straw and tillage on total weed biomass (g/m^2) at 90 DAS.

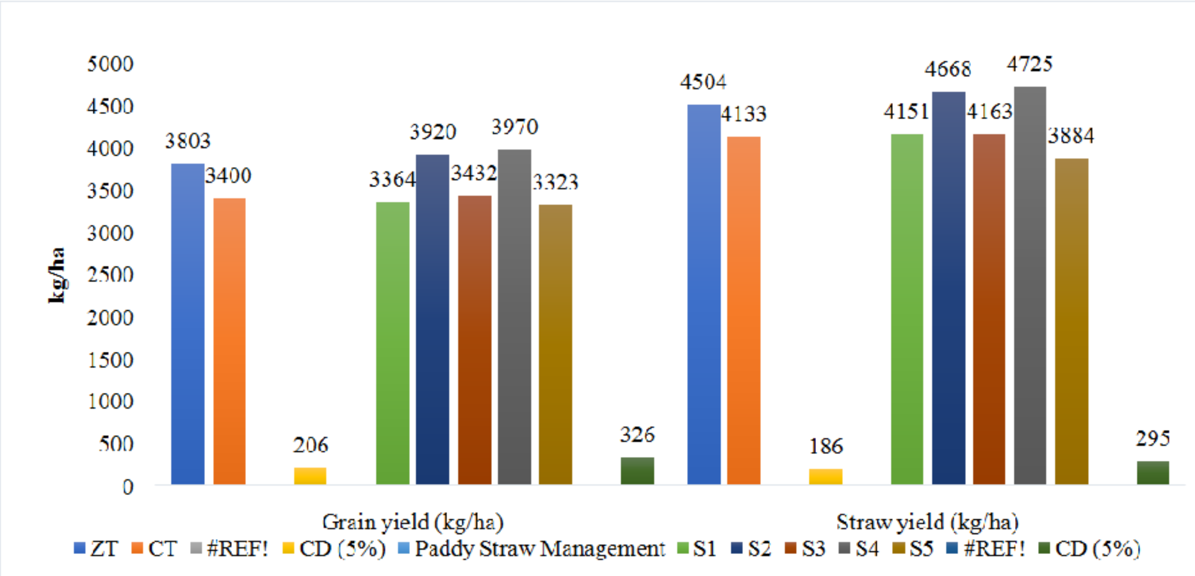

Fig. 3. Effect of paddy straw and tillage on grain and straw yield of wheat.

Among residue management measures, the highest grain and straw yield (3960 and 4725 kg/ha, respectively) was recorded by 6/ha Paddy Straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer which was statistically at par with 6/ha Paddy Straw plus 25 kg/ha extra nitrogen over recommended dose (3920 and 4668 kg/ha, respectively) and significantly higher as compared to 6t/ha paddy straw, 6t /ha paddy straw plus PUSA decomposer and no residue (control). The extent of increment in grain and straw yield was to the tune of (16.29 and 15.30%, respectively) in 6/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer and 15.22 and 14.25 in 6/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose, respectively as compared to no straw (control) treatment.

The interaction among paddy straw with tillage showed that zero tillage with 6t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer recorded highest grain and straw yield of wheat which was found statistically at par with zero tillage with 6t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose, conventional tillage with 6t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose plus PUSA decomposer and conventional tillage with 6t/ha paddy straw plus 25 kg/ha extra nitrogen over recommended dose, but recorded significantly higher grain and straw as compared to all other treatments (Fig. 4, 5).

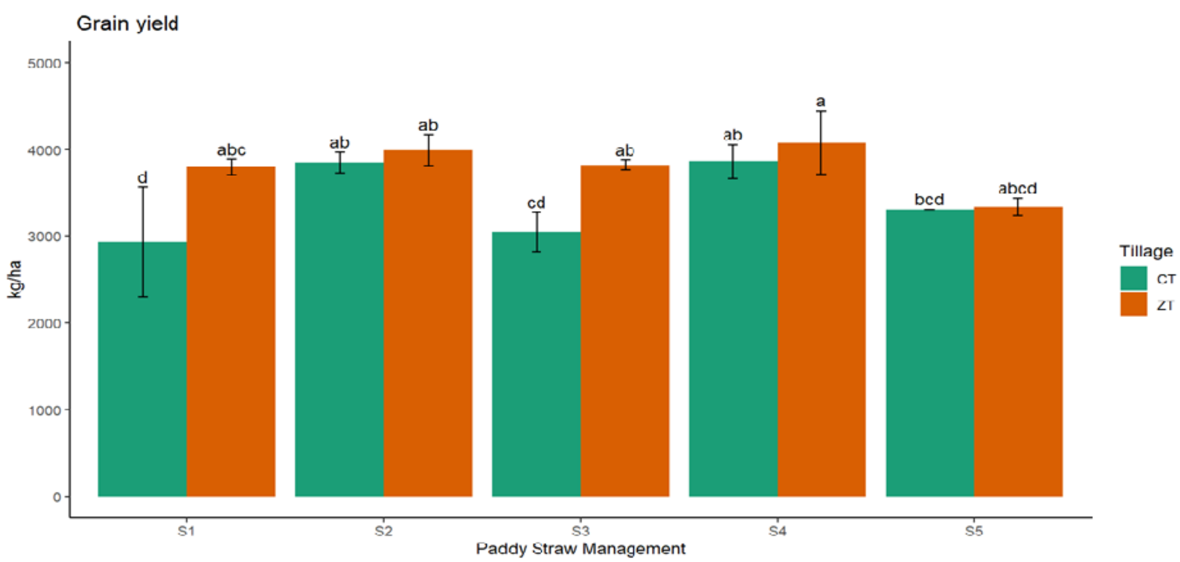

Fig. 4. Interaction effect of paddy straw and tillage on grain yield of wheat.

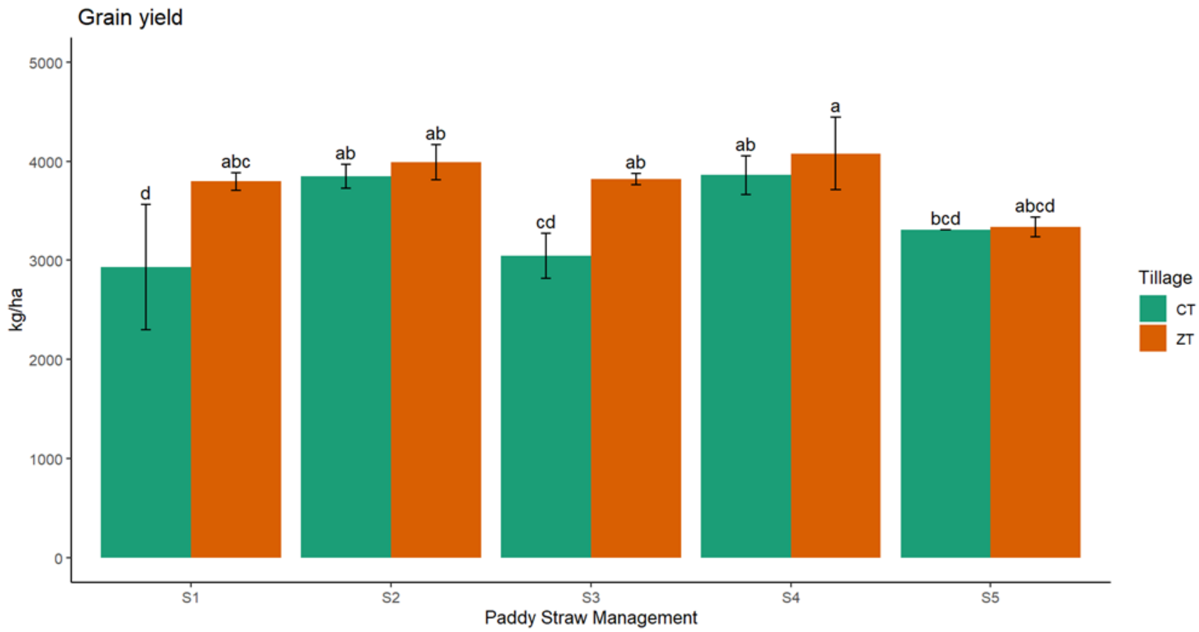

Fig. 5. Interaction effect of paddy straw and tillage on straw yield of wheat.

The increase in grain and straw yield with zero tillage might be due to less weed infestation, application of extra dose of nitrogen and decomposer which accelerated the decomposition of paddy straw, enhanced availability of nutrients in soil solutions, increased nutrient uptake by crop which improved wheat growth, yield attributes and economic yield**.** Besides, moderation of soil temperature, suppression of weeds and effective plant use of water and nutrients (Kahlon and Singh 2014; Kumar *et al*. (2017), may enhanced photosynthesis, crop growth and assimilate translocation from source to sink Verma and Pandey (2013) leads to higher yield component and yield. However, the decrease in grain production after residue removal under both zero tillage was caused by poor crop growth due to increased weed competition, which, in turn, led to a lower value of yield attributes as a result reduced grain and straw yield (Kumar and Singh (2017).

CONCLUSIONS

Based on a one-year study, it was concluded total weed populations and biomass was significantly reduced under zero tillage as compared to conventional tillage. while, among residue management use of 6 t/ha paddy straw with 25 kg/ha extra nitrogen and PUSA decomposer observed significantly lower total weed populations and biomass and provided highest grain and straw yield. Therefore, use of paddy straw as mulch with zero tillage or incorporation with conventional tillage along with extra nitrogen and PUSA decomposer is an eco-friendly option for weed management in wheat, which increased wheat productivity. On other hand, it could be safe and environmentally friendly alternative to burning paddy straw, which has negative environmental and health consequences.

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Conflict of Interest. None.

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