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# Effect of tillage along with herbicides on weed control and performance of wheat

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## Abstract
An experiment was undertaken to examine the influence of various tillage practices in conjunction with herbicides and mulching on weed density and grain yield of wheat at the Agricultural Farm of the Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati, Sriniketan, Birbhum, and West Bengal. With three replications, the experiment was set up in a split-plot design. The main plot was divided into two tillage methods: zero tillage (ZT) and conventional tillage (CT), as well as eight weed control practises viz, Straw mulching alone at 4.0 t $ha^{-1}$ at 20 DAS, Pendimethalin at 0.75 kg $ha^{-1}$, Clodinafop propargyl 15% + Metsulfuron methyl 1% WP at 0.40 kg ha-$^{1}$ at 30 DAS, Pendimethalin at 0.75 kg $ha^{-1}$ straw mulching at 4.0 t $ha^{-1}$ at 20 DAS, Pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop propargyl 15% + metsulfuron methyl 1% WP at 0.40 kg at 35 DAS, Straw mulching alone at 4.0 t $ha^{-1}$ at 20 DAS *fb* clodinafop propargyl 15% + metsulfuron methyl 1% WP at 0.40 kg at 35 DAS , Weed free and Weedy check were assigned to the sub-plot. There was a significant difference in density and biomass of grassy weeds between zero and conventional tillage, but no significant difference in growth and yield parameters or wheat yield among tillage methods. Maximum weed density were recorded in weedy check while maximum grain yield was observed in weed free and pendimethalin at 0.75 kg $ha^{-1}$ *fb* straw mulching at 4.0 t $ha^{-1}$ ($W_4$) plots. The lowest grain yield was in CT due to highest weed density and biomass. Pendimethalin at 0.75 kg $ha^{-1}$ and clodinafop propargyl 15% + metsulfuron methyl 1% WP proved to be effective herbicide against the control of total weeds.

**Keywords:** tillage, herbicides, density, weed biomass, wheat yield

## Introduction
Wheat (*Triticum aestivum* L.) is the second most significant food crop in the country occupying 43.78 Mha. To guarantee proper seed bed preparation, traditional tillage procedures include many tractor operations and planking. This traditional paddy field wheat sowing practise is further delaying wheat sowing, resulting in a low wheat yield. In addition to soil and water conservation, zero tillage (ZT) or reduced tillage (RT) technology decreases field preparation costs, saves energy, equipment, and labour, and assures good crop stand (Mann *et al*., 2002) [4]. However, this technological shift may have an impact on weeds. Wheat planting with ZT is becoming a new technique in integrated weed management. It minimises weed population by eliminating tillage (Mehla *et al*., 2000) [5] and provides effective weed control at reduced rates when used in combination with new herbicides (Ali and Tunio, 2002) [1]. The prime goal of this research was to determine the effects of tillage and herbicides along with mulching on weed density, dry weed biomass, and wheat grain yield.

## Materials and Methods
A field experiment was carried out in 2017 -18 rabi season at Agricultural farm of the Institute of Agriculture, Visva-Bharati, Sriniketan. The experiment had a split plot design with eight treatments and three replicates. The treatments selected for this study are, i.e., (1) Straw mulching alone at 4.0 t $ha^{-1}$ at 20 DAS; (2) Pendimethalin at 0.75 kg $ha^{-1}$ at 1 DAS (3) Clodinafop propargyl 15% + metsulfuron methyl 1% WP at 0.40 kg $ha^{-1}$ at 35 DAS (4) Pendimethalin at 0.75 kg $ha^{-1}$ at 1DAS fb straw mulching at 4.0 t $ha^{-1}$ 20 DAS (5) Pendimethalin at 0.75 kg $ha^{-1}$ at 1 DAS followed by clodinafop propargyl 15% + metsulfuron methyl 1% WP at 0.40kg at 35 DAS (6) Straw mulching alone at 4.0 t $ha^{-1}$ at 20 DAS fb clodinafop propargyl 15% + metsulfuron methyl 1% WP at 0.40kg at 35 DAS (7) Weed free (8) Weedy Check. The wheat variety HD 2824 was selected to grow. The experimental field was prepared according to the treatments. The row to row spacing for wheat was 20cm in case of both zero and conventional tillage.

Wheat seed at the rate of 120 kg $ha^{-1}$ was sown both in zero and conventional tillage. A recommended dose of 120 kg N, 60 kg $P_2O_5$ and 60 kg $K_2O$ $ha^{-1}$ were applied to the crop. Irrigations were applied at critical growth stages of crops. Wheat was manually harvested. The weed density was counted as the total plants of all the weed species per square meter. Data were analysed using analysis of variance (ANOVA) and square root transformation was used.

## Results and Discussion

### Total weed density at 90 DAS

**Table 1:** Effect of tillage and weed management practices total on weed density at 90 DAS

| Treatments | Weed density (No. $m^{-2}$) at 90 DAS |
|---|---|
| | Total weed |
| **Tillage practices** | |
| $T_1$ - Zero tillage | 12.31(150.94) |
| $T_2$ - Conventional tillage | 13.17(173.04) |
| S.Em (±) | 0.16 |
| LSD (P=0.05) | NS |
| CV (%) | 6.30 |
| **Weed management practices** | |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 21.58(465.16) |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 16.40(268.45) |
| $W_3$-Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 14.30(203.93) |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 11.05(121.69) |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 0.71(0.00) |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 7.43(54.75) |
| $W_7$-Weed free | 0.71(0.00) |
| $W_8$-Weedy check | 29.74(883.96) |
| S.Em (±) | 0.21 |
| LSD (P=0.05) | 0.61 |
| CV (%) | 4.03 |
| Interaction | S |

Tillage had no significant influence on total weed density when observation was recorded at 90 DAS (Table 1). However, total weed density was lower in zero tillage compared to conventional tillage. Sole application of straw mulch at 4.0 t $ha^{-1}$ ($W_1$), pendimethalin at 0.75 kg $ha^{-1}$ ($W_2$) and clodinafop-propargyl + metsulfuron methyl at 0.4 kg $ha^{1}$ ($W_3$) reduced the total weed density by 47.38, 69.63 and 76.93%, respectively. Whereas, integrated application of pendimethalin at 0.75 kg $ha^{-1}$ *fb* straw mulching at 4.0 t $ha^{-1}$ ($W_4$) and straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$($W_6$) resulted in greater level of weed control with the reduction in the total weed density by 86.23 and 93.81%, respectively (Table 1).

**Table 2:** Interaction effect of tillage and weed management practices on density of total weed density at 90 DAS

| Treatments | Total weed density (No. $m^{-2}$) at 90 DAS | |
|---|---|---|
| **Weed management practices** | **Zero tillage** | **Conventional tillage** |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 20.43(416.74)* | 22.73(516.24) |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 14.55(211.08) | 18.25(332.69) |
| $W_3$-Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 14.77(217.71) | 13.82(190.59) |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 10.27(105.01) | 11.84(139.59) |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 0.71(0.00) | 0.71(0.00) |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 8.10(65.11) | 6.77(45.28) |
| $W_7$-Weed free | 0.71(0.00) | 0.71(0.00) |
| $W_8$-Weedy check | 28.92(835.70) | 30.56(933.57) |
| | T×W | W×T |
| S.Em (±) | 0.30 | 0.43 |
| LSD (P=0.05) | 0.86 | 1.20 |
| CV (%) | 4.03 | |

*Figures within parenthesis indicate original values and the data were transformed to √(X + 0.5) before analysis ; MSM = Metsulfuron methyl

Pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg $ha^{1}$ registered zero count on weed density both under zero ($T_1W_5$) and conventional tillage ($T_2W_5$), while straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ resulted in comparatively lower total weed densityboth in zero and conventional tillage ($T_1W_6$ and $T_2W_6$). Interaction effect between weed management with different tillage practices exhibited that total weed density was significantly lower in weedy check under zero tillage ($T_1W_8$) over conventional tillage ($T_2W_8$) (Table 2).

### Total weed biomass at 90 DAS

Tillage as well as weed management practices had significant influence on total weed biomass when observation was recorded at 90 DAS (Table 3). The biomass of all categories of weed was found significantly lower in zero tillage compared to conventional tillage.

**Table 3:** Effect of tillage and weed management practices on weed biomass at 90 DAS

| Treatments | Weed biomass (g $m^{-2}$) at 90 DAS |
|---|---|
| | Total weeds |
| **Tillage practices** | |
| $T_1$ - Zero tillage | 4.79(22.16) |
| $T_2$ - Conventional tillage | 5.16(26.14) |
| S.Em (±) | 0.03 |
| LSD (P=0.05) | 0.19 |
| CV (%) | 3.13 |
| **Weed management practices** | |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 8.47(71.27) |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 5.24(26.98) |
| $W_3$-Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 6.85(46.45) |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 3.05(8.83) |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 0.71(0.00) |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 3.33(10.60) |
| $W_7$-Weed free | 0.71(0.00) |
| $W_8$-Weedy check | 11.45(130.57) |
| S.Em (±) | 0.09 |
| LSD (P=0.05) | 0.27 |
| CV (%) | 4.59 |
| Interaction | S |

Among weed management practices integrated use of pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl at 0.4 kg $ha^{1}$ ($W_5$) registered significantly the lowest density of total weed with a reduction of 100.0% over weedy check followed by pendimethalin at 0.75 kg $ha^{1}$ *fb* straw mulching at 4.0 t $ha^{-1}$($W_4$) and straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$($W_6$) (93.24 and 91.88%, respectively). Whereas, straw mulch alone at 4.0 t $ha^{1}$ ($W_1$) was able to reduce the total weed biomass by 45.42% only.

**Table 4:** Interaction effect of tillage and weed management practices on total weed biomass at 90 DAS

| Treatments | Total weed biomass (g $m^{-2}$) at 90 DAS | |
|---|---|---|
| **Weed management practices** | **Zero tillage** | **Conventional tillage** |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 8.14(65.81)* | 8.80(76.94) |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 4.73(21.87) | 5.75(32.61) |
| $W_3$-Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 6.86(46.55) | 6.85(46.36) |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 2.76(7.12) | 3.35(10.71) |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 0.71(0.00) | 0.71(0.00) |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 3.61(12.55) | 3.05(8.81) |
| $W_7$-Weed free | 0.71(0.00) | 0.71(0.00) |
| $W_8$-Weedy check | 10.82(116.49) | 12.08(145.45) |
| | T×W | W×T |
| S.Em (±) | 0.13 | 0.10 |
| LSD (P=0.05) | 0.38 | 0.39 |
| CV (%) | 4.59 | |
| *Figures within parenthesis indicate original values and the data were transformed to √(X + 0.5) before analysis ; MSM =Metsulfuron methyl | | |

Interaction effect among tillage and different levels of weed management showed that biomass of total weed was lowest in pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl at 0.4 kg $ha^{1}$ ($W_5$) which registered zero count both in zero and conventional tillage and was significantly superior to all other treatments (Table 4).

Interaction effect among same level of weed management with different levels of tillage revealed that pendimethalin alone at 0.75 kg $ha^{-1}$ registered significantly the lower total weed biomass under zero tillage ($T_1W_2$), compared to conventional tillage ($T_2W_2$). Straw mulching at 4.0 t $ha^{-1}$ ($W_1$) and pendimethalin at 0.75 kg $ha^{1}$ *fb* straw mulching at 4.0 t $ha^{-1}$($W_4$) was also significantly more effective under zero tillage in reducing the total biomass of weed when compared with conventional tillage.

**Wheat growth**

No significant difference was found with respect to plant height of wheat among the different tillage practices. Whereas, plant height varied significantly among the weed management practices at 90 DAS and at harvest. Significantly the highest plant height was recorded with pendimethalin at 0.75 kg $ha^{-1}$ *fb* straw mulching at 4.0 t $ha^{-1}$ ($W_4$) which was statistically at par with straw mulch alone at 4.0 t $ha^{-1}$ ($W_1$), pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg $ha^{1}$ ($W_5$), straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ ($W_6$) and with weed free ($W_7$) at 90 DAS and (Table 5). Interaction effect between tillage and weed management practices on plant height was found non-significant.

**Table 5:** Plant height of wheat as influenced by tillage and weed management practices at 90DAS and at harvest

| Treatments | Plant height | |
|---|---|---|
| | 90 DAS | Harvest |
| **Tillage practices** | | |
| $T_1$ -Zero tillage | 91 | 96 |
| $T_2$ -Conventional tillage | 91 | 94 |
| S.Em (±) | 0.62 | 0.70 |
| LSD (P=0.05) | NS | NS |
| CV (%) | 3.34 | 3.61 |
| **Weed management practices** | | |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 91 | 95 |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 89 | 93 |
| $W_3$-Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 90 | 93 |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 93 | 98 |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 90 | 94 |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 93 | 97 |
| $W_7$-Weed free | 96 | 98 |
| $W_8$-Weedy check | 88 | 91 |
| S.Em (±) | 1.61 | 1.43 |
| LSD (P=0.05) | 4.68 | 4.14 |
| CV (%) | 4.33 | 3.68 |
| Interaction | NS | NS |

Rana *et al.* (2017) [8] reported that combined application of herbicide reduced weed count and dry weight and increased plant height over weedy check. Organic mulches added nutrients to soil when decomposed by microbes and might have helped in root proliferations (Osuji, 1990) [6], increased water availability (Rahman *et al*., 2005) [7] which ultimately may increases plant height in plot treated with straw mulch.

**Effect of treatments on dry matter accumulation of wheat at different growth stages**

No significant difference in dry matter accumulation (DMA) due to tillage practices was observed at 90 DAS (Table 6). However, zero tillage registered more dry matter accumulation than conventional tillage at 90 DAS.

Among different weed management practices pendimethalin at 0.75 kg $ha^{-1}$ *fb* straw mulching at 4.0 t $ha^{-1}$ ($W_4$) registered significantly higher DMA at 30 and 90 DAS over other treatments and was statically at par with pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg $ha^{1}$ ($W_5$), straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$($W_6$) and weed free ($W_7$) (Table 6).

**Table 6:** Effect of tillage and weed management practices on dry matter accumulation in wheat at 90DAS

| Treatments | Dry matter accumulation (g $m^{-2}$) |
|---|---|
| | 90 DAS |
| **Tillage practices** | |
| $T_1$ -Zero tillage | 479 |
| $T_2$ -Conventional tillage | 459 |
| S.Em (±) | 6.54 |
| LSD (P=0.05) | NS |
| CV (%) | 6.84 |
| **Weed management practices** | |
| $W_1$- Straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 407 |
| $W_2$- Pendimethalin at 0.75 kg $ha^{-1}$ | 487 |
| $W_3$- Clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 407 |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t $ha^{-1}$ at 20 DAS | 546 |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg $ha^{-1}$ 35 DAS | 508 |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ at 35 DAS | 531 |
| $W_7$-Weed free | 541 |
| $W_8$-Weedy check | 324 |
| S.Em (±) | 16.43 |
| LSD (P=0.05) | 47.59 |
| CV (%) | 8.58 |
| Interaction | NS |

**Grain yield (kg $ha^{-1}$)**

Statistical analysis of the data revealed that grain yield was significantly affected herbicides, (Table 7). Weed free ($W_7$) treatment registered the highest grain yield which was statistically at par with pendimethalin at 0.75 kg $ha^{-1}$ *fb* straw mulching at 4.0 t $ha^{-1}$ ($W_4$), pendimethalin at 0.75 kg $ha^{-1}$ *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg $ha^{1}$ ($W_5$) and straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg $ha^{-1}$ ($W_6$).Similar results were reported by Baghestani *et al.* (2008) [2]; and Chhokar *et al.* (2008) [3]. They reported that herbicides significantly increased grain yield in wheat corresponding to their weed control spectrum.

**Table 7:** Yield of wheat affected by different weed management practices

| Treatment | Grain yield (kg ha$^{-1}$) |
|---|---|
| **Tillage practices** | |
| $T_1$ -Zero tillage | 3124 |
| $T_2$ -Conventional tillage | 2845 |
| S.Em (±) | 71.92 |
| LSD (P=0.05) | NS |
| CV (%) | 11.80 |
| **Weed management practices** | |
| $W_1$- Straw mulching at 4.0 t ha$^{-1}$ at 20 DAS | 2659 |
| $W_2$- Pendimethalin at 0.75 kg ha$^{-1}$ | 3011 |
| $W_3$- Clodinafop-propargyl + MSM at 0.40 kg ha$^{-1}$ at 35 DAS | 2669 |
| $W_4$- $W_2$ *fb* straw mulching at 4.0 t ha$^{-1}$ at 20 DAS | 3486 |
| $W_5$- $W_2$ *fb* clodinafop-propargyl + MSM 0.4 kg ha$^{-1}$ 35 DAS | 3283 |
| $W_6$-$W_1$ *fb* clodinafop-propargyl + MSM at 0.40 kg ha$^{-1}$ at 35 DAS | 3327 |
| $W_7$-Weed free | 3504 |
| $W_8$-Weedy check | 1939 |
| S.Em (±) | 139.62 |
| LSD (P=0.05) | 404.41 |
| CV (%) | 11.46 |
| Interaction | NS |

## Conclusion

The herbicides controlled weeds to a varying level and significantly affected all parameters such as weed density m$^{-2}$, dry weed biomass, and grain yield. Among the herbicidal treatments, Affinity was the most effective broad-spectrum herbicide which controlled both grassy and broad-leaved weeds and gave the highest grain yield.

## References


1. Ali QM, Tunio S. Effect of various planting patterns on weed population and yield of wheat. Asian J Plant Sci 2002;1(93):216-217.
2. Baghestani MA, Zand E, Soufizadeh S, Beheshtian M, Haghighi A, Barjasteh A *et al*. Study on the efficacy of weed control in wheat (*Triticum aestivum* L.) with tank mixtures of grass herbicides with broadleaved herbicides. Crop Prot 2008;27:104-111.
3. Chhokar RS, Singh S, Sharma RK. Herbicides for control of isoproturon-resistant littleseed canarygrass (*Phalaris minor*) in wheat. Crop Prot 2008;27:719-726.
4. Mann RA, Ashraf M, Gill MA. Sustainable wheat production system through conservation tillage technology. In: Proc. Intern. Conf. Environmentally Sustainable Agriculture for Dry Areas, Shijiazhuang, China, 2002.
5. Mehla RS, Verma JK, Gupta RK, Hobbs PR. Stagnation in the productivity of wheat in the Indo-Gangetic plains: zerotill-seed-cum-fertilizer drill as an integrated solution: Ricewheat consortium paper series 8. New Delhi, India: Rice-wheat consortium for the Indo-Gangetic Plains, 2000, 12.
6. Osuji GE. Tillage and mulching effects on seed-zone soil environment and cowpea seedling growth in the humid tropics. Soil Use Manage 1990;6(3):152-156.
7. Rahman MA, Chikushi J, Safizzaman M, Lauren JG. Rice straw mulching and nitrogen response of no-till wheat following rice in Bangladesh. Field Crops Research 2005;91:71-81.
8. Rana SS, Badiyala D, Brari P. Evaluation of herbicide combinations for controlling complex weed flora in wheat. Indian Journal of Weed Science 2017;49(4):335-340.