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Effect of tillage and weed management practices on growth and grain yield of wheat (*Triticum aestivum* L.) in Chhattisgarh plain ecosystem

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Abstract
Poor weed management practices is one of the severe barrier to enhance productivity of wheat. Today high yield agriculture relies on herbicides, as integral part of weed control practices The experiment treatments were divided into horizontal and vertical plots in strip plot design with three replications. The horizontal plots were divided into six weed management practices and vertical plots were divided into three tillage practices. The treatments comprised of unweeded control (W_1) , pendimethalin @ 1.0 kg ha^{-1} as pre-emergence (PE)(W_2), sulfosulfuron@25gha^{-1} as post-emergence(PoE) (W_3), pendimethalin@1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4), hand weeding at 30 DAS (W_5) and black polythene mulch (W_6) in horizontal plot under weed management practices and conventional tillage (T_1), minimum tillage (T_2) and zero tillage (T_3) in vertical plots under tillage management practices. The application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (PoE) was found to be statistically superior over all the treatment except hand weding at 30 DAS at the same level of convetional tillage during both the years. The convetional tillage was found to be statistically superior over minmum and zero tillage at the same level of the application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (PoE) during both the years.

Keywords: Tillage management, weed management, growth, grain yield, wheat

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important winter cereal crop of India. Higher yield of the wheat can play a vital role in stabilizing the food prices in increasing population. Poor weed management practices is one of the severe barrier to enhance productivity of wheat. Today high yield agriculture relies on herbicides, as integral part of weed control practices. In recent years, herbicide have been developed and found promising tool in weed management. Tillage or soil surface manipulation is desired to obtain good seedbed which is major input in agricultural production and helps in controlling weeds by different ways. It is also an important component of weed management which influencing the vertical distribution of weed seeds in soil layer and weed diversity. Tillage has been considered as an inevitable operation for successful crop production. It not only provides a good seed bed for initial establishment of crops but also control weeds effectively.

Material and methods
Wheat sowing after rice is generally delayed till mid December which affects the production as well as quality adversely. Keeping the above consideration in view, the present investigation was planned and conducted during two consecutive years of 2009-2010 & 2010-2011. The field experiment was conducted during *rabi* seasons of 2009-10 and 2010-11 at the research cum instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The experiment on wheat crop were undertaken during two consecutive *rabi season* of 2009-2010 & 2010-2011. The experiment treatments were divided into horizontal and vertical plots in strip plot design with three replications. The horizontal plots were divided into six weed management practices and vertical plots were divided into three tillage practices. The treatments comprised of unweeded control (W_1), pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE) (W_2), sulfosulfuron@ 25gha^{-1} as post-emergence (PoE) (W_3), pendimethalin@1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4), hand weeding at 30 DAS (W_5) and black polythene mulch (W_6) in horizontal plot under weed management practices and conventional tillage (T_1), minimum tillage (T_2) and zero tillage (T_3)

in vertical plots under tillage management practices. The wheat crop variety cv. *Kanchan* was sown on 24th November 2009 and 28th November 2010 and harvested on 24th March 2010 and 29th March 2011, respectively.

Results

Data on plant height at various growth stages are presented in Table 1. Plant height was increased with the advancement of crop age. The plant height was influenced significantly due to weed and tillage management at all the stages of observation i.e.30, 60, 90 DAS and at harvest, during both the years. Among the different weed management practices, the application of pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (W_4) produced the highest plant height, which was at par with hand weeding at 30 DAS during both the years and harvest stage during 2009-10, while during 2010-11, pendimethalin @ 1.0 kg ha^{-1} as pre emergence (W_2), sulfosulfuron @ 25 g ha^{-1} as post emergence (W_3), hand weeding at 30 DAS (W_5) and pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (W_4) were comparable to each other in producing plant height. At 60 and 90 DAS, during both the years, application of pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (W_4) exhibited significantly superior plant height over rest of the treatments.

Among the different tillage management practices, highest plant height was found under conventional tillage followed by minimum and zero tillage, respectively, during both the years. The weed management and tillage management practices were significantly influenced the length of spike in both the years. Among the weed management practices, maximum length of spike was noted with application of pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) which was significantly superior to rest of the treatments and it was followed by hand weeding at 30 days after sowing (W_5), sulfosulfuron @ 25 g ha^{-1} as post emergence (PoE) (W_3), pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE) (W_2) and black polythene mulch (W_6) in descending order. Among tillage management practices, conventional tillage (T_1) proved to be the best for producing length of spike and it was followed by minimum tillage (T_2) and zero tillage (T_3), in descending order in both the years. (Table3). The effectiveness of these herbicides has also been reported by *Yadav et al.* (2004) [7] and *Khandwe & Sharma* (1999) [3].

The weed management and tillage management practices were influenced significantly the number of spikelet in both the years. Among the weed management practices, maximum number of spikelet was obtained with application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE), and it was significantly superior to rest of the treatments during 2009-10. However, during 2010-11, application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) and hand weeding at 30 DAS (W5) were equally effective in enhancing number of spikelet, further it was noted that rice straw. covering(@ 5 t ha^{-1} (W_2), black polythene mulch (W_3) and sulfosulfuron @ 25 g ha^{-1} as post emergence (W_5) were comparable to each other in producing number of spikelet. Among different tillage management practices, conventional tillage proved its superiority in number of spikelet over followed by minimum tillage and zero tillage, during both the years (Table 2).

The weed management and tillage management practices were influenced significantly the test weight in both the years. Among the weed management practices, application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1}(PoE) (W_4) though produced highest test weight,but application of pendimethalin@ 1.0 kg ha^{-1} (W_2), application of sulfosulfuron @ 25g ha^{-1}(W_3) and hand weeding at 30 DAS(W_5) were at par each other in enhancing test weight and they were significantly superior over unweeded control. Among tillage management a practice, maximum test weight was obtained with conventional tillage (T_1) and it was significantly higher than that of obtained under minimum tillage (T_2) and zero tillage (T_3) in both the years (Table 2).

This might be due to better control of weeds and thus resulted in lower accumulation of dry matter of weeds, lower crop weed competition associated with better availability of moisture and nutrients to wheat crop. Photosynthetic food material synthesized in the plant gets deposited in the different plant part leading to enlargement and development of plant tissues. This cause gradual increment in dry matter. The higher growth parameters under conventional tillage was due to the lower weed competition, better aeration which help in deeper penetration and profilezation of roots and thereby more absorption of nutrients. Thus, cumulatively helped in better growth under conventional tillage than minimum and zero tillage. Sharma and Singh (2010) also reported the similar results. Nayak *et al*. (2006) reported that plant height was influenced significantly due to tillage system and weed control methods in wheat and found the maximum plant height under conventional tillage.

The weed management and tillage management practices were influenced significantly the grain yield during both the years. Among the weed management practices, maximum grain yield (17.67 and 15.93 q ha^{-1}) was obtained with application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) which was significantly higher than rest of the weed management treatments. Hand weeding at 30 DAS (W_5) was next best treatment. Grain yield was incresed to the tune of 34.9 per cent with pre emergence application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) over control (W_1). Among tillage management practices, maximum grain yield was obtained with conventional tillage (T_1) followed by minimum tillage (T_2) and zero tillage (T_3) respectively in both the years. There was 71.79 per cent increse in grain yield with conventional tillage than zero tillage (Table 3).

Different weed management and tillage management practices showed their interaction effect on grain yield of wheat during both the years (Table 3.1). The application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (PoE) was found to be statistically superior over all the treatment except hand weding at 30 DAS at the same level of convetional tillage during both the years. The convetional tillage was found to be statistically superior over minmum and zero tillage at the same level of the application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25 g ha^{-1} (PoE) during both the years.

The weed management and tillage management practices influenced significantly the straw yield during both the years. Among the weed management practices, maximum straw yield was (27.98 and 25.67 q ha^{-1}) obtained with application of pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) and it was significantly superior to rest of the treatments during both the years except in 2009-10, where hand weeding at 30 DAS (W_5) was found equally effective to that of application of pendimethalin@ 1.0 kg ha^{-1} (PE) followed by sulfosulfuron @ 25g ha^{-1} (PoE) (W_4). Among tillage management practices, straw yield followed

the similar trends to that of grain yield (Table 4). The weed management and tillage management practices influenced significantly the harvest index (%) during both the years. During 2009-10, among the weed management practices, maximum harvest index was obtained with hand weeding at 30 DAS (W_5), which was at par with pre em application of pendimethalin @ 1.0 kg ha^{-1} (PE) followed by post em application of sulfosulfuron @ 25g ha^{-1} (PoE) (W_4) and application of sulfosulfuron @ 25g ha^{-1} (PoE) (W_3) However, during 2010-11, black polythene mulch (W_6) exhibited maximum harvest index but hand weeding at 30 DAS (W_5) was found comparable to black polythene mulch (W_6) in respect to harvest index. Among tillage management a practice, conventional tillage (T_1) proved to be the best and it was followed by minimum tillage (T_2) and zero tillage (T_3), in descending order in both the years (Table 4). This might be due to more availability of nutrients, moisture, light and space to wheat plants due to suppression of weeds. The better growth and development of wheat crop was due to availability of nutrients in balanced form in sufficient quantity. The allocation of proper space to individual plants provide congenial environment for proper utilization of nutrient, moisture and solar radiation resulted better photosynthesis which in turn produced higher value of yield attributes and grain yield throughout the growing period. Bajpai and Tripathi (2000) [1], Chitale *et al*. (2007) [2], Pandey and Kumar (2007) [4] and Verma *et al*. (2008) [6] also reported the similar results. Sannigrahi and Borah (2002) [5] reported that **t**he maximum okra yield was recorded with black polythene mulch (121.2 q ha^{-1}) followed by water hyacinth (107.1 q ha^{-1}) and poultry waste (101.3 q ha^{-1}). Black polythene increased okra yield by 88 per cent over control. Also black polythene mulch was the most effective treatment for weed control (83.5 per cent). Sharma and Singh (2010) reported that highest grain yield of wheat was found with the mechanical weeding at 15, 35 DAS followed by sulfosulfuron (25 g ha^{-1}), rice straw mulch (2 t ha^{-1}), neem oil spray (3%).

Table 1: Plant height (cm) of wheat crop at different growth stages as influenced by different weed and tillage management practices

Treatment	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			Harvest		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Weed management												
W_1:Unweeded control	20.04	18.42	19.23	43.89	42.15	43.02	78.33	76.47	77.40	78.28	78.24	78.26
W_2:Pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE)	22.15	20.61	21.38	51.47	49.95	50.71	81.87	80.37	81.12	83.13	81.64	82.39
W_3: Sulfosulfuron @ 25 g ha^{-1} as post emergence (PoE)	22.56	21.02	21.79	51.99	50.48	51.24	82.79	81.29	82.04	83.88	82.40	83.14
W_4: Pendimethalin@ 1.0 kg ha^{-1} (PE) followed by Sulfosulfuron @ 25 g ha^{-1} (PoE)	24.08	22.54	23.31	55.45	53.93	54.69	85.51	84.01	84.76	85.52	84.10	84.81
W_5 : Hand weeding at 30 DAS	23.38	21.84	22.61	54.46	52.95	53.71	84.11	82.13	83.12	84.80	83.31	84.06
W_6 : Black polythene mulch	21.64	20.10	20.87	49.31	47.75	48.53	81.52	80.03	80.78	81.62	80.73	81.17
SEm±	0.46	0.48	-	0.12	0.14	-	0.41	0.37	-	0.46	0.92	-
CD (P=0.05)	1.45	1.51	-	0.38	0.44	-	1.28	1.18	-	1.45	2.90	-
Tillage management												
T_1: Conventional tillage	24.23	22.69	23.46	53.90	52.39	53.15	85.23	83.73	84.48	85.96	84.46	85.21
T_2: Minimum tillage	21.89	20.35	21.12	50.93	49.41	50.17	82.36	80.86	81.61	82.92	81.86	82.39
T_3: Zero tillage	20.81	19.23	20.02	48.45	46.83	47.64	79.48	77.80	78.64	80.79	78.30	79.55
SEm±	0.64	0.42	-	0.11	0.16	-	0.53	0.60	-	1.12	1.13	-
CD (P=0.05)	2.53	1.65	-	0.44	0.63	-	2.10	2.35	-	4.42	4.44	-

Table 2: Yield attributing characters of wheat crop as influenced by weed and tillage management treatments

Treatment	Yield attributing characters								
	Length of spike (cm)			Number of spikelet			Test weight (g)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Weed management									
W_1 : Unweeded control	8.13	7.99	8.06	38.56	37.14	37.85	41.11	40.80	40.96
W_2 : Pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE)	8.33	8.21	8.27	41.02	39.59	40.31	41.98	41.61	41.80
W_3 : Sulfosulfuron @ 25 g ha^{-1} as post emergence (PoE)	8.46	8.34	8.40	41.33	39.90	40.62	42.07	41.70	41.89
W_4: Pendimethalin@ 1.0 kg ha^{-1} (PE) followed by Sulfosulfuron @ 25 g ha^{-1} (PoE)	8.73	8.61	8.67	42.44	41.02	41.73	42.28	41.91	42.10
W_5 : Hand weeding at 30 DAS	8.63	8.51	8.57	41.52	40.09	40.80	42.22	41.85	42.04
W_6 : Black polythene mulch	8.29	8.17	8.23	40.62	39.20	39.91	41.73	41.36	41.55
SEm±	0.02	0.02	-	0.28	0.31	-	0.11	0.10	-
CD (P=0.05)	0.07	0.06	-	0.88	0.99	-	0.36	0.31	
Tillage management									
T_1: Conventional tillage	8.55	8.43	8.49	42.37	40.95	41.66	42.26	41.89	42.08
T_2: Minimum tillage	8.43	8.31	8.37	40.48	39.05	39.77	41.93	41.56	41.75
T_3: Zero tillage	8.30	8.17	8.24	39.90	38.48	39.19	41.50	41.16	41.33
SEm±	0.03	0.03	-	0.14	0.15	-	0.05	0.04	-
CD (P=0.05)	0.10	0.12	-	0.54	0.57	-	0.20	0.16	-

Table 3: Yields and harvest index (%) attributes of wheat crop as influenced by weed and tillage management treatments

Treatment	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Weed management									
W_1 : Unweeded control	13.53	11.38	12.45	21.64	18.41	20.02	38.40	38.12	38.26
W_2 : Pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE)	16.62	14.47	15.54	26.47	23.23	24.85	38.45	38.22	38.33
W_3 : Sulfosulfuron @ 25 g ha^{-1} as post emergence (PoE)	16.87	14.72	15.79	26.81	23.57	25.19	38.51	38.28	38.39
W_4: Pendimethalin@ 1.0 kg ha^{-1} (PE) followed by Sulfosulfuron @ 25 g ha^{-1} (PoE)	17.67	15.93	16.80	27.98	25.67	26.82	38.56	38.09	38.32
W_5 : Hand weeding at 30 DAS	17.24	15.37	16.30	27.33	23.86	25.59	38.53	39.01	38.76
W_6 : Black polythene mulch	16.25	15.60	15.92	25.95	23.48	24.71	38.40	39.91	39.15
SEm±	0.13	0.11	-	0.22	0.46	-	0.02	0.43	-
CD (P=0.05)	0.42	0.34	-	0.70	1.46	-	0.07	1.36	-
Tillage management									
T_1: Conventional tillage	20.46	18.64	19.55	31.41	28.47	29.94	39.43	39.55	39.49
T_2: Minimum tillage	16.3	14.66	15.48	26.43	23.30	24.86	38.15	38.57	38.36
T_3: Zero tillage	12.33	10.43	11.38	20.25	17.34	18.79	37.85	37.69	37.77
SEm±	0.05	0.04	-	0.08	.19	-	0.01	0.23	-
CD (P=0.05)	0.19	0.17	-	0.32	.76	-	0.03	0.89	-

Table 3.1: Interaction effect of weed and tillage management treatments on grain yield of wheat

Weed management / Tillage management	Conventional tillage			Minimum tillage			Zero tillage		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
W_1 : Unweeded control	15.99	13.84	14.91	12.68	10.53	11.60	11.94	9.79	10.86
W_2 : Pendimethalin @ 1.0 kg ha^{-1} as pre emergence (PE)	20.82	18.67	19.74	16.86	14.71	15.78	12.19	10.04	11.11
W_3 : Sulfosulfuron @ 25 g ha^{-1} as post emergence (PoE)	20.95	18.80	19.87	17.22	15.07	16.14	12.46	10.31	11.38
W_4: Pendimethalin@ 1.0 kg ha^{-1} (PE) followed by Sulfosulfuron @ 25 g ha^{-1} (PoE)	22.30	20.48	21.39	17.39	16.15	16.77	13.32	11.17	12.24
W_5 : Hand weeding at 30 DAS	22.19	20.20	21.19	17.20	15.67	16.43	12.34	10.24	11.29
W_6 : Black polythene mulch	20.54	19.89	20.21	16.49	15.84	16.16	11.75	11.10	11.42
	SEm±						CD (P= 0.05)		
For comparing means of weed management practices at the same level of tillage management	0.19			0.18			0.58	0.56	
For comparing means of tillage management practices at the same level of weed management	0.16			0.17			0.48	0.52	

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