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Effect of Tillage and Weed management practices on Weed Control and Yield in Wheat

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A B S T R A C T

A field experiment was conducted during the *rabi* season of 2017-18 at the Agricultural Farm of the Institute of Agriculture (PalliSikshaBhavana), Visva-Bharati, Sriniketan, West Bengal to study the effect of tillage and weed management practices on weed population dynamics and growth in wheat. The experiment was laid out in split-plot design with three replications. Two tillage practices comprising of Zero tillage (ZT) and Conventional tillage (CT) and eight weed management practices *viz.* Straw mulching alone at 4.0 t ha^{-1}, Pendimethalin at 0.75 kg ha^{-1}, Clodinafoppropargyl 15% + Metsulfuron methyl 1% WP at 0.40 kg ha-^{1}, Pendimethalin at 0.75 kg ha^{-1} straw mulching at 4.0 t ha^{-1}, Pendimethalin at 0.75 kg ha^{-1} *fb*clodinafoppropargyl 15% + metsulfuron methyl 1% WP at 0.40 kg at, Straw mulching alone at 4.0 t ha^{-1} *fb*clodinafoppropargyl 15% + metsulfuron methyl 1% WP at 0.40 kg , Weed free and Weedy check were assigned to the sub-plot. It was witnessed that ZT caused a substantial reduction in the population of narrow-leaved and broad-leaved compared to CT. Among the weed management practicespendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1}, pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{-1} and sole application of pendimethalin at 0.75 kg ha^{-1} registered the lowest density as well as biomass of grassy weeds while straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg ha^{-1} and pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{-1} recorded the lowest density as well as biomass broadleaved weeds. Lower values of weed density, total weed biomass and higher yield were registered with combination of zero tillage with integrated use of pre-emergence herbicide pendimethalin at 0.75 kg ha^{-1} with straw mulching at 4.0 t $ha^{-1}$and pendimethalin at 0.75 kg ha^{-1} *fb*clodinafop-propargyl + metsulfuron methyl at 0.4 kg ha^{1}.

Introduction

Wheat (*Triticum aestivum* L.) being the most valuable crop for vast global population is essential for food security of a country. Weeds leads to yield reduction of 15 to 50% or higher depending upon the weed density and dynamics (Sirazuddin *et al*., 2016).Weeds like *Phalaris minor, Avena fatua, Digitaria sanguinalis, Polygonum plebeium, Rumex*

spinosus, Gnaphalium indicum, Spilanthes calva and *Cyperus rotundus* became predominant weed flora in wheat (Mondal and Duary, 2009; Rahaman and Mukherjee, 2009; Pawar *et al*., 2017 and Rana *et al*., 2017).

Conventional tillage through tractor not only results in soil loss but also higher weed seed germination. While, zero tillage mainly needs to build up a defensive cover of residues on soil surface. Zero tillage, largely relying on deposition of crop residues requires appropriate method for placement of seeds on the upper soil layer. As a result of which, relative spread of unwanted weed flora can be minimized to a great extent (Susha *et al*., 2014). Zero tillage is a great option now a days which is enjoying immense response from Indian farmers as it increases both productivity and sustainability. ZT wheat results in higher weed control efficiency over CT by decreasing weed density and dry matter considerably at Varanasi (Prasad *et al*., 2005).

Mulching plays a pivotal role in yield enhancement through increasing water holding capacity of soil and by checking weed population. Application of residue mulch in ZT wheat considerably reduced weed flora over time than CT wheat (Kumar *et al.*, 2015).

In situations of mixed weed flora, pre- mix or consecutive application of herbicides with varied selectivity not only facilitates in efficient weed management but also results in minimizing cost and time, and improving biological activity than their discrete applications (Sharma *et al*., 2015). Tank-mix or pre-mix use of different herbicide chemistries or sequential application of pre- and post-emergence herbicides at different times showed effective weed control (Baghestani *et al.*, 2008). Besides managing mixed weed flora, the integrated use of herbicides may help in managing herbicide resistance problems. So, keeping all these things in mind this experiment was carried out to find out the effect of integrated use of herbicide and straw mulching under different tillage practices to control the weed flora in wheat.

Materials and Methods

The field experiment entitled "Weed management in wheat by integrated use of herbicide and straw mulch under different tillage practices" was conducted in the Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal during*rabi* season of 2017-18. The soil of the experimental field was sandy loam (Ultisol), having pH 5.6, organic carbon 0.38, available N, P and K 138.2 kg, 25.1 kg and 120.41 kg, respectively. The field experiment was conducted in split plot design with three replication. The treatments included two different tillage practices in main plots viz. Zero Tillage; and Conventional Tillage and eight weed management practices in sub-plots. viz. Straw mulching alone at 4.0 t ha^{-1} at 20 DAS, Pendimethalin at 0.75 kg ha^{-1} at 1 DAS, Clodinafoppropargyl 15% + metsulfuron methyl 1% WP at 0.40 kg ha^{-1} at 35 DAS, Pendimethalin at 0.75 kg ha^{-1} at 1DAS *fb* straw mulching at 4.0 t ha^{-1}20 DAS, Pendimethalin at 0.75 kg ha^{-1} at 1 DAS followed by clodinafoppropargyl 15% +metsulfuron methyl 1% WP at 0.40kg at 35 DAS, Straw mulching alone at 4.0 t ha^{-1} at 20 DAS fb clodinafoppropargyl 15% + metsulfuron methyl 1% WP at 0.40kg at 35 DAS, Weed free and Weedy Check.

The conventional tillage plots were ploughed twice by tractor drawn plough and finally planking was done to have a uniform seed bed of fine tilth. No tillage operation was carried out in zero tillage plots. The wheat variety selected for the experiment was HD 2824

(Poorva). In case of conventional tillage line sowing of wheat was followed with a row to row spacing of 20 cm. In case of zero tillage wheat was mechanically sown with national zero till ferti-seed drill machine. Half quantity of nitrogen and full amount of phosphorus and potassium were applied in each plot as basal on the day of sowing. Remaining half quantity of N was applied in two equal splits as top dressing. The first irrigation was given at crown root initiation stage (22 DAS). Afterwards four irrigations were given at tillering, jointing, flowering and at milking stage. The crop was harvested by sickles manually at physiological maturity. The bundles were properly tagged, and sun dried before threshing on the concrete floor and plot-wise weight of grains and straws were recorded separately.

Results and Discussion

The prominent weed species witnessed in the experimental site were *Digitaria sanguinalis*, among the grasses and *Gnaphalium indicum*, *Polygonum plebeium and Spilanthes calva* among broadleaved weeds.

Effect on weeds

At both 45DAS and 75DAS, the density of grassy weeds continues to be more in conventional tillage than zero tillage. At 75DAS, significantly lowest weed density was found in ZT than CT (Table 1). The effect of weed management practices on density of grasses was significant. The treatment pre-emergence application of pendimethalin at 0.75 kg ha^{-1} (W_2), pendimethalin at 0.75 kg ha^{-1} fb straw mulching at 4.0 t ha^{-1} at 20 DAS (W_4) and pendimethalin at 0.75 kg ha^{-1}fb clodinafop-propargyl + metsulfuron methyl (MSM) at 0.4 kg ha^{-1} (W_5) effectively controlled grassy weeds and listed zero count in both 45DAS and 75DAS. These treatments were superior to remaining treatments in controlling grassy weeds and even comparable with weed free check (W_7) also.

The density of broad leaved weeds was found significantly higher in conventional tillage than zero tillage at both 45 and 75 DAS (Table 1).Pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + MSM at 0.4 kg ha^{1} (W_5) was found to be most effective in controlling broadleaved weeds and the treatment was at par with weed free check registering zero count of broadleaved weed at 45DAS. While, clodinafop-propargyl + metsulfuron methyl at 0.4 kg ha^{1} (W_3), integrated use of pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl at 0.4 kg ha^{1} (W_5) and straw mulching *fb c*lodinafop-propargyl + MSM at 0.40 kg ha^{-1}(W_6) listed zero count of broadleaved weeds at 75 DAS and were statistically at par with weed free check (W_7).

The dry weight of grassy weed was higher in conventional tillage. All the weed management practices brought significant reduction in the biomass of grassy weed over weedy check (W_8)(Table 2). The treatment pre-emergence application of pendimethalin at 0.75 kg ha^{1} (W_2), pendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1} at 20 DAS (W_4) and pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl at 0.4 kg ha^{1} (W_5) registered no dry weight at both 45 and 75 DAS. These treatments were even comparable with weed free check (W_7), also reducing the biomass of grasses by 100%.

Biomass of broad leaved weeds was found significantly higher in conventional tillage (T_2) over zero tillage (T_1) at both 45 and 75DAS. Pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5) completely controlled broad leaved weeds and registered no dry weight at 45DAS.While, sole application of *c*lodinafop-propargyl + MSM at 0.40 kg ha^{-1} (W_3),

integrated use of pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl at 0.4 kg ha^{1} (W_5) and straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg ha^{-1} (W_6) registered the lowest biomass and was statistically at par with weed free (W_7) at 75DAS.

Among integrated weed management practices pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5) recorded the highest WCE (100%) which was 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)(Table 3).

The combined use of pendimethalin along with straw mulching or post emergence herbicide displayed better weed control efficiency because of the explanations that component method was used in different time in the growing period thus covering the whole spectrum of weeds and keeping the weed pressure below throughout the period. In addition to herbicide, application of straw mulch suppressed the weeds, which emerged during later stage of crop growth.

Table.1 Effect of tillage and weed management practices on weed density at 45 DAS and 75 DAS in wheat

Treatments	**45 DAS**		**75 DAS**	
Tillage practices	**Grass**	**BLW**	**Grass**	**BLW**
T_1 - Zero tillage	5.86(33.90)	8.22(67.01)	6.28(38.89)	9.20(84.12)
T_2 - Conventional tillage	6.12(36.97)	9.43(88.37)	6.58(42.80)	10.03 (100.15)
S.Em (±)	0.11	0.03	0.04	0.03
LSD (P=0.05)	NS	0.18	0.27	0.16
Weed management practices				
W_1- Straw mulching at 4.0 t ha^{-1} at 20 DAS	10.08(101.06)	13.94 (193.81)	10.12 (101.90)	18.76(351.26)
W_2- Pendimethalin at 0.75 kg ha^{-1}	0.71(0.00)	8.79(76.69)	0.71(0.00)	18.58(344.67)
W_3-Clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	12.22 (148.84)	10.88 (117.85)	14.52 (210.40)	0.71 (0.00)
W_4- W_2 *fb* straw mulching at 4.0 t ha^{-1} at 20 DAS	0.71(0.00)	8.10(65.18)	0.71(0.00)	11.98(142.95)
W_5- W_2 *fb* clodinafop-propargyl + MSM 0.4 kg ha^{-1} 35 DAS	0.71(0.00)	0.71(0.00)	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	8.68 (74.84)	8.40(70.10)	7.76(59.68)	0.71(0.00)
W_7-Weed free	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
W_8-Weedy check	14.14(199.39)	19.05 (362.37)	16.20 (261.90)	24.78 (613.77)
S.Em (±)	0.33	0.35	0.17	0.21
LSD (P=0.05)	0.97	1.02	0.49	0.60

Table.2 Effect of tillage and weed management practices on weed density at 45 DAS and 75 DAS in wheat

Treatments	**45 DAS**		**75 DAS**	
Tillage practices	**Grass**	**BLW**	**Grass**	**BLW**
T_1 - Zero tillage	1.67(2.30)	1.81(2.79)	2.31(4.85)	3.14(9.36)
T_2 - Conventional tillage	1.85(2.93)	2.25(4.56)	2.48(5.67)	3.04(8.770
S.Em (±)	0.03	0.04	0.02	0.01
LSD (P=0.05)	NS	0.22	0.15	0.07
Weed management practices				
W_1- Straw mulching at 4.0 t ha^{-1} at 20 DAS	2.95(8.21)	2.85(7.62)	3.39(10.96)	5.36(28.22)
W_2- Pendimethalin at 0.75 kg ha^{-1}	0.71(0.00)	1.82(2.83)	0.71(0.00)	5.33(27.88)
W_3-Clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	3.01(8.59)	2.32(4.89)	4.73(21.91)	0.71(0.00)
W_4- W_2 *fb* straw mulching at 4.0 t ha^{-1} at 20 DAS	0.71(0.00)	1.95(3.30)	0.71(0.00)	3.41(11.11)
W_5- W_2 *fb* clodinafop-propargyl + MSM 0.4 kg ha^{-1} 35 DAS	0.71(0.00)	0.71(0.00)	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	2.12(4.00)	1.87(2.99)	2.71(6.86)	0.71(0.00)
W_7-Weed free	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
W_8-Weedy check	3.18(9.64)	4.02(15.69)	5.52(30.00)	7.81(60.57)
S.Em (±)	0.12	0.12	0.10	0.09
LSD (P=0.05)	0.35	0.34	0.30	0.26

Table.3 Effect of weed management practices on weed control efficiency in wheat

Treatments	**Weed Control Efficiency (%)**	
	45 DAS	**75 DAS**
Weed management practices		
W_1- Straw mulching at 4.0 t ha^{-1} at 20 DAS	36.89	56.74
W_2- Pendimethalin at 0.75 kg ha^{-1}	88.85	69.23
W_3-Clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	46.68	75.82
W_4- W_2 *fb* straw mulching at 4.0 t ha^{-1} at 20 DAS	86.99	87.74
W_5- W_2 *fb* clodinafop-propargyl + MSM 0.4 kg ha^{-1} 35 DAS	100.00	100.00
W_6-W_1 *fb* clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	72.18	92.43
W_7-Weed free	100.00	100.00
W_8-Weedy check	0.00	0.00

Table.4 Effect of tillage and weed management practices on earsm^{-2}, grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and return rupee^{-1} invested of wheat

Treatment	Ears m^{-2}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Return rupee^{-1} invested
Tillage practices				
T_1 -Zero tillage	258.5	3124	4506	2.06
T_2 -Conventional tillage	251.4	2845	4165	1.45
S.Em (±)	3.36	71.92	90.68	0.04
LSD (P=0.05)	NS	NS	NS	0.26
Weed management practices				
W_1- Straw mulching at 4.0 t ha^{-1} at 20 DAS	252.4	2659	4028	1.51
W_2- Pendimethalin at 0.75 kg ha^{-1}	223.6	3011	4464	2.03
W_3- Clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	232.7	2669	3871	1.77
W_4- W_2 *fb* straw mulching at 4.0 t ha^{-1} at 20 DAS	270.0	3486	4735	1.87
W_5- W_2 *fb* clodinafop-propargyl + MSM 0.4 kg ha^{-1} 35 DAS	265.8	3283	4666	2.07
W_6-W_1 *fb* clodinafop-propargyl + MSM at 0.40 kg ha^{-1} at 35 DAS	289.7	3327	4987	1.81
W_7-Weed free	282.8	3504	4784	1.57
W_8-Weedy check	222.5	1939	3148	1.41
S.Em (±)	9.72	139.62	168.93	0.07
LSD (P=0.05)	28.16	404.41	489.30	0.20

Pendimethalin managed the weeds which appeared in wheat at initial stage of crop growth. The weeds appeared subsequently were again controlled by component method. Number of workers put forwarded opinions regarding beneficial effect of integrated weed management practices over unweeded control (Singh *et al.*, 2005).

Effect on crop

Although zero tillage recorded higher number of ears than conventional tillage but no significant difference was found among the tillage practices. However, significant effect of weed management practices was observed on number of ears. Straw mulching *fb* clodinafop-propargyl + MSM at 0.40 kg ha^{-1}(W_6) reported significantly higher number of ears which was statistically at par with weed free (W_7), pendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1} (W_4) and pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5) (Table 4). Tiwari *et al.*(2016) also reported significantly higher number of shoots (345 m^2) in plots treated with clodinafop-propargyl + metsulfuron methyl at 0.4 kg g ha^{1}.

No significant variation was witnessed among tillage practices regarding grain yield of wheat. While, it varied significantly among the weed management practices (Table 4).

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). Integrated use of pre and post emergence herbicide significantly reduced the density and dry weight of weed and increased grain yield of wheat as also reported by Kumar *et al.* (2017) and Rana *et al.* (2017). Rahaman and Mukherjee (2009) also found maximum grain yield of wheat with pre-emergence application of pendimethalin and hand hoeing.

The highest straw yield was recorded under the treatment straw mulching *fb c*lodinafop-propargyl + MSM at 0.40 kg ha^{-1}(W_6) which was statistically at par with weed free (W_7), pendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1} (W_4) and pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5)(Table 4). Straw yield was increased with the application of rice straw (6 t ha^{-1}), compared to the control (Bharat *et al*., 2012).

Zero tillage fetched significantly the highest return $rupee^{-1}$ invested (2.06) than conventional tillage (1.45) (Table 4). Among the weed management practices, pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5) achieved the highest return $rupee^{-1}$ invested (2.07), followed by pendimethalin at 0.75 kg ha^{-1} (W_2) (2.03) and pendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1} (W_4) (1.87) (Table 4). Integrated use of pendimethalin at 0.75 kg ha^{-1} *fb* straw mulching at 4.0 t ha^{-1} (W_4) and pendimethalin at 0.75 kg ha^{-1} *fb* clodinafop-propargyl + metsulfuron methyl 0.4 kg ha^{1} (W_5) recorded the highest gross return, net return as well as return per rupee invested over remaining treatments in wheat. This was due to higher grain and straw yield of wheat obtained from the above treatments and less cost of cultivation. Similar monetary benefit was also reported by Singh *et al.* (2004) and Singh (2014).

It can be concluded that zero tillage along with integrated use of straw mulching at 4.0 t $ha^{-1}$with pre-emergence herbicide pendimethalin at 0.75 kg ha^{-1} or post emergence application of ready mix herbicide clodinafop-propargyl + metsulfuron-methyl at 0.4 kg^{-1} ha^{-1} or integrated use of pre-emergence herbicide pendimethalin at 0.75 kg ha^{-1} with post emergence application of ready mix herbicide clodinafop-propargyl + metsulfuron-methyl at 0.4 kg^{-1} appeared to be promising for effective and economic weed management in wheat.

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