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# Resource conservation techniques and pendimethalin for control of weeds in *durum* wheat cultivars

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## ABSTRACT

A field experiment was conducted on *durum* wheat during 2005-06 and 2006-07 to study the effect of resource conservation techniques (RCTs), cultivars and pendimethalin herbicide on weeds and yield of *durum* wheat. Zero tillage (ZT) significantly reduced the population of *Phalaris minor* and dry matter of grassy weeds as compared to conventional tillage (CT) and furrow irrigated raised bed system (FIRBS), however, density and dry matter of broad-leaved weeds was higher under ZT that under CT and FIRBS. Grasses were predominant under FIRBS as compared to CT. Cultivar '*PDW 291*' had less density and dry weight of weeds having superior yield attributes and produced significantly higher grain yield over '*WH 896*' and '*WH 912*'. Pre-emergence application of pendimethalin (1.5 kg/ha) reduced the density and dry matter accumulation by grassy as well as broad-leaved weeds effectively and increased the wheat grain yield by 25% over weedy check.

**Key words:** *Durum* wheat, Pendimethalin, Resource conservation techniques, Weeds, Yield

*Durum* wheat (*Triticum durum*) is the second most important species, after *Triticum aestivum*, occupying nearly 10% of the wheat area in India. Earlier its cultivation primarily confined to the rainfed conditions of central and southern India, with very small area in Punjab and West Bengal mainly due to high susceptibility to rusts and foliar diseases. However, with the development of high yielding semi-dwarf type, a large area has come up in Punjab under irrigated conditions, where it was popularized to contain Karnal bunt disease. Now efforts are on to export it to earn foreign exchange (Anonymous 2009). The profitability, productivity and sustainability of rice-wheat cropping systems are at stake. Now, farmers need technologies which are more favorable for lowering their cost and improving their returns. They need environment friendly technologies those have less deleterious effect on natural resources. Under such situations, conservation agriculture based resource conservation techniques (RCTs) *i.e.* zero tillage (ZT) and furrow irrigated raised bed system (FIRBS) could be a valid option to reduce the turn-around time, water, cultivation cost and to ensure establishment of good crop stand of wheat without loss in productivity and sustainability of natural resources.

Since variation in planting system modifies macro- and micro-environment to which plants are exposed, there is a need to identify most appropriate variety best suited for each of the planting system. It has been reported that both *T. aestivum* and *T. durum* wheat varieties differ in physio-morphological traits, thus there is need to identify most appropriate one from the existing recommended varieties of durum wheat species under prevailing conditions in context to changes in planting pattern. Much of the research work was focused on such issues in recent past but mainly in bread wheat (*Triticum aestivum*). Since *durum* wheat may also find ample scope in near future in India due to changing food habits, it was realized to conduct the present investigation to study the effect resource conservation techniques, cultivars and pendimethalin on weeds and performance of durum wheat.

## MATERIALS AND METHODS

A field experiment was conducted on *durum* wheat during *Rabi* of 2005-06 and 2006-07 in a field having soil sandy loam in texture, slightly alkaline in reaction (8.2), low in available N (209.6 kg/ha), medium in available P (15.7 kg/ha) and high in available K (408.0 kg/ha) at Research Farm, Department of Agronomy, CCS Haryana Agricultural University, Hisar, India. The experiment including three resource conservation techniques, *viz.* ZT, CT and FIRBS in main plot and three cultivars (*WH 896*, *WH 912* and *PDW 291*) and two weed control treatments (pendimethalin 1.5 kg/ha and weedy check) in sub-plots was laid out in split-plot design in four replications. ZT plots were kept undisturbed after harvesting of mungbean

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crop. CT plots were prepared by harrowing thrice followed by cultivator and planking. The plots marked for FIRBS were harrowed thrice followed by cultivator twice and a planking to prepare a finer seed bed. Beds were made using a bed planter, having bed dimension of 37.5 on top with 30 cm wide furrows (between two beds). Under ZT plots, glyphosate (1.5 kg/ha) was sprayed 7 days before sowing to control the pre-emerged perennial weeds. The experimental crop was raised using recommended dose of N (150 kg/ha) and $P_2O_5$ (60 kg/ha) through DAP and urea. As per treatments, sowing under ZT, CT and FIRBS was done using ZT drill, CT drill and bed planter each at a seed rate of 100 kg/ha on 12$^{th}$ November 2005 and 14$^{th}$ November 2006 during first and second year of experimentation, respectively.

Pendimethalin (1.5 kg/ha) was applied as pre-emergence using knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 l/ha. Weeds from two randomly selected places of 1 $m^2$ were counted species wise, removed and dried at 70$^0$C for recording the dry matter at 30 and 60 days after sowing (DAS). All other agronomic practices were adopted as per recommended package of practices. The crop was harvested on 7$^{th}$ April 2006 during the first year and 13$^{th}$ April 2007, during the second year. Harvesting was done manually by cutting the plants from the ground level with the help of sickles. The crop was left in the field for one week for sun drying. The crop was threshed plot wise with the help of mini-thresher and the grain yield was recorded. Data was analyzed by the method of analysis of variance (ANOVA) as described by Panse and Sukhatme(1985).

## RESULTS AND DISCUSSION

### Effect on weeds

During both the years, ZT, CT and FIRBS were dominated by similar weed species, *viz. Phalaris minor, Avena ludoviciana, Chenopodium album, Anagallis arvensis* and *Melilotus indica*. Weeds like *Coronopus didymus, Convolvulus arvensis* and *Rumex dentatus* were present in lesser number and were therefore grouped as miscellaneous weeds (Table 1).

Among the complex weed flora at 30 DAS, the grassy weeds accounted for 30.2, 41.1 and 39.4% during 2005-06 and 32.1, 40.6 and 42.2% during 2006-07 under ZT, CT and FIRBS, respectively. The corresponding values for broad-leaved weeds were 69.8, 58.9 and 60.6%, during 2005-06 and 67.9, 59.4 and 57.8% during 2006-07. ZT significantly lowered the population of *P. minor* (14.1 plants/$m^2$) as compared to FIRBS (27.3 plants/$m^2$) and CT (24.0 plants /$m^2$) at 60 DAS (Table 2). This could be due to undisturbed inter-row space in ZT, where seeds of *P. minor* lying at lower depths did not germinate. Malik *et al.* (2000a) have already reported less germination of *P. minor* under ZT. In FIRBS and CT, repeated ploughing brought the weed seeds on upper soil surface and create favorable conditions for weed seed emergence. Tillage practices did not influence the population of *A. ludoviciana*, while the population of *C. album, A. arvensis* and miscellaneous broad-leaved weeds were significantly lower under CT than recorded under ZT. Singh *et al.* (2002b) and Yadav *et al.* (2002) also reported similar results. ZT significantly reduced the dry matter accumulation by grassy weeds to the tune of 27.9 and 32.3% over CT and FIRBS,

**Table 1. Per cent composition of weed flora in weedy check at 30 DAS**

| Weed species | 2005-06 | | | 2006-07 | | |
|---|---|---|---|---|---|---|
| | ZT | CT | FIRBS | ZT | CT | FIRBS |
| *Grassy* | | | | | | |
| *Phalaris minor* | 16.5 | 27.2 | 26.5 | 17.1 | 27.2 | 29.0 |
| *Avena ludoviciana* | 13.7 | 13.9 | 12.9 | 14.9 | 13.4 | 13.2 |
| Total | 30.2 | 41.1 | 39.4 | 32.1 | 40.6 | 42.2 |
| *Broad-leaved* | | | | | | |
| *Chenopodium album* | 19.5 | 16.3 | 17.9 | 21.3 | 16.0 | 16.5 |
| *Melilotus indica* | 16.2 | 15.5 | 14.1 | 16.5 | 15.9 | 14.0 |
| *Anagallis arvensis* | 17.3 | 14.4 | 13.4 | 13.4 | 13.2 | 13.2 |
| *Rumex dentatus* | 16.7 | 12.7 | 15.3 | 16.8 | 14.3 | 14.1 |
| Total | 69.8 | 58.9 | 60.6 | 67.9 | 59.4 | 57.8 |

ZT-Zero tillage, CT- Conventional tillage, FIRBS- Furrow irrigated raised bed system respectively (Table 3). Better tilth and exposure of weed seeds to upper soil in CT and FIRBS might have increased the population and thereby dry weight of weeds in these systems. Malik *et al*. (2000b) also reported similar results. The dry matter accumulation by broad-leaved weeds was significantly higher under ZT in comparison to CT. This might be due to more congenial environment in ZT for broad-leaved weeds. These results are in conformity with the earlier findings (Singh *et al*. 2002a, Yaduraju and Mishra 2002).

On an average, cultivar *'PDW 291'* significantly reduced the population of *P. minor* (20.0 /$m^2$) as compared to cultivar *'WH 896'* (23.5/$m^2$). Population of *A. ludoviciana, C. album, M. indica* and miscellaneous broad-leaved weeds as well as dry matter accumulation of both grassy and broad-leaved weeds was not much influenced by different cultivars. Similar results were reported earlier by Bhat (2005).

Pre-emergence application of pendimethalin significantly lowered the density of all the weed species in comparison to weedy check plots during both the years (Table 2). Pendimethalin on an average reduced the dry matter accumulation by grassy and broad-leaved weeds to the extent of 71.6 and 59.2%, respectively at 60 DAS (Table 3). Similarly, 62% control of both grassy and broad-leaved weeds by pendimethalin was observed by Singh and Khole (1998), and Shukla and Mishra (2006).

**Effect on crop**

In general, yield attributes, grain, straw and biological yields were comparatively higher in second year. This might be due to combined effect of rainfall and comparatively low temperature in the month of February and March, which favored spike and grain development during the month of March, leading to increase in growing period of the crop.

The yield components of wheat crop, *viz*. number of spikes/mrl, spike length, grains per spike and 1000-grain weight were not influenced significantly by various resource conservation techniques (Table 3).

**Table 2. Effect of resource conservation techniques, cultivars and weed control treatments on density (no./$m^2$) of different weeds**

| Treatment | *P. minor* | | *A. ludoviciana* | | *C. album* | | *A. arvensis* | | *M. indica* | | Othor | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 |
| *RCTs* | | | | | | | | | | | | |
| ZT | 3.6 (14.5) | 3.6 (13.7) | 3.8 (14.1) | 3.7 (13.9) | 3.9 (16.6) | 3.8 (15.8) | 3.9 (16.3) | 3.7 (13.8) | 3.6 (13.7) | 3.6 (13.5) | 3.9 (15.5) | 3.6 (13.3) |
| CT | 4.7 (23.6) | 4.8 (24.5) | 3.7 (13.9) | 3.8 (14.0) | 3.7 (14.1) | 3.6 (13.1) | 3.8 (15.2) | 3.5 (12.8) | 3.6 (12.8) | 3.6 (12.8) | 3.5 (12.3) | 3.5 (12.1) |
| FIRBS | 5.1 (27.4) | 5.1 (27.2) | 3.7 (13.6) | 3.6 (12.9) | 3.9 (15.9) | 3.7 (14.2) | 3.8 (14.6) | 3.8 (12.7) | 3.6 (13.0) | 3.6 (12.8) | 3.8 (14.6) | 3.6 (13.3) |
| LSD (P=0.05) | 0.2 | 0.2 | NS | NS | 0.1 | 0.1 | 0.1 | 0.1 | NS | NS | 0.1 | 0.1 |
| *Cultivars* | | | | | | | | | | | | |
| *'WH 896'* | 4.6 (23.3) | 4.7 (23.7) | 3.9 (14.6) | 3.7 (13.8) | 3.8 (15.7) | 3.8 (14.8) | 3.9 (16.1) | 3.8 (14.9) | 3.6 (13.2) | 3.6 (13.2) | 3.8 (14.8) | 3.6 (13.3) |
| *'WH 912'* | 4.5 (22.1) | 4.5 (21.6) | 3.7 (13.1) | 3.7 (13.6) | 3.8 (15.1) | 3.7 (14.5) | 3.9 (15.6) | 3.6 (12.7) | 3.6 (13.2) | 3.6 (13.3) | 3. 8 (14.0) | 3.6 (13.1) |
| *'PDW 291''* | 4.3 (20.0) | 4.4 (20.0) | 3.7 (13.8) | 3.7 (13.3) | 3.9 (15.8) | 3.6 (13.9) | 3.7 (14.4) | 3.4 (11.6) | 3.6 (13.2) | 3.5 (12.6) | 3.6 (13.6) | 3.5 (12.3) |
| LSD (P=0.05) | 0.2 | 0.2 | NS | NS | NS | NS | 0.2 | 0.2 | NS | NS | NS | NS |
| *Herbicide* | | | | | | | | | | | | |
| Pendimethalin (1.5 kg/ha) | 3.0 (8.6) | 3.2 (9.3) | 3.1 (8.6) | 2.9 (7.9) | 2.7 (6.6) | 2.5 (5.3) | 2.7 (6.7) | 2.6 (5.6) | 2.5 (5.6) | 2.5 (5.4) | 2.8 (7.1) | 2.7 (6.4) |
| Weedy check | 5.9 (35.0) | 5.8 (34.3) | 4.5 (19.1) | 4.5 (19.3) | 5.0 (24.4) | 4.9 (23.5) | 4.9 (24.0) | 4.6 (20.5) | 4.6 (20.8) | 4.6 (20.7) | 4.7 (21.2) | 4.5 (19.4) |
| LSD (P=0.05) | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.14 |

Original data given in parentheses were subjected to square root ($\sqrt{x+1}$) transformation before analysis; ZT - Zero tillage; CT - Conventional tillage; FIRBS- Furrow-irrigated raised-bed system

The two years average grain yield of *durum* wheat under ZT, CT and FIRBS was 5.46, 5.33 and 5.31 t/ha, respectively. Similar or higher yield attributes in ZT than CT were reported earlier by many researchers (Malik *et al.* 2000b, Yadav *et al.* 2005, Kakkar *et al.* 2005).

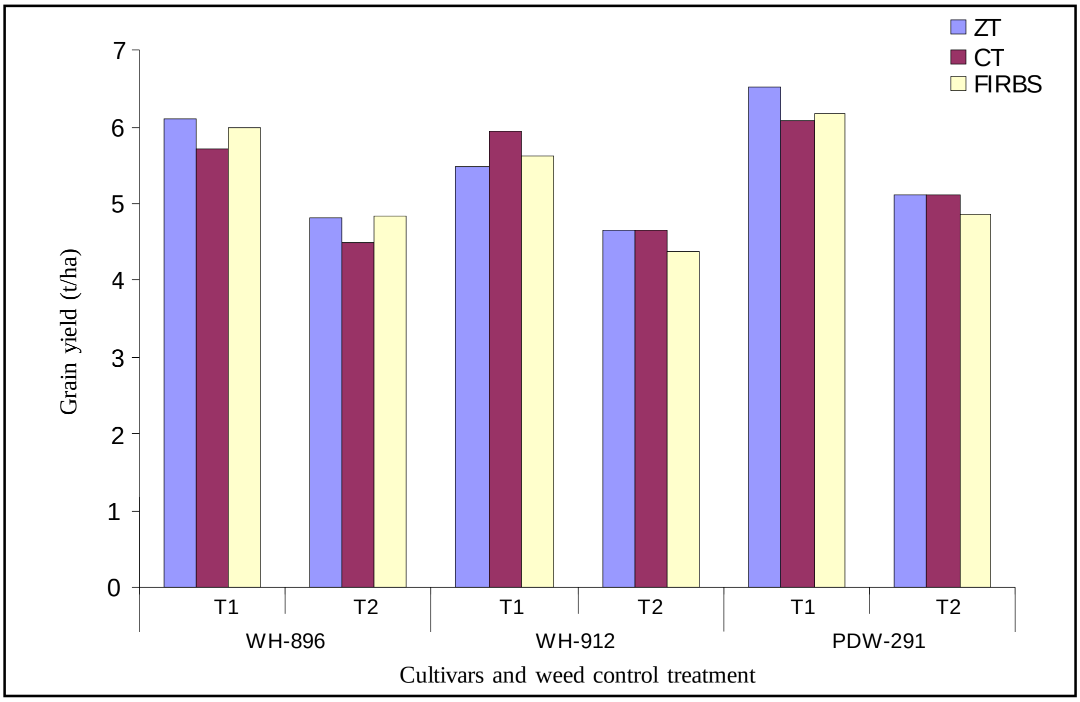
Among three cultivars, '*PDW 291'* produced highest number of spikes, longer spike, more grain per spike and improved 1000-grain weight. Cultivar *'PDW 291'* on an average produced 6.5 and 9.7% higher number of spikes than that produced by '*WH 896'* and *'WH 912'*, respectively. Average spike length of cultivars, *'PDW 291'*, *'WH 912'* and '*WH 896'* was 9.8, 9.2 and 9.5 cm, respectively. Cultivar, '*PDW 291'* produced 7.1 and 11.6 % more grains per spike than that produced by cultivars '*WH 912'* and '*WH 896'*, respectively. During each year of study, cultivar, '*PDW 291'* recorded significantly highest 1000-grain weight and it was lowest in '*WH 912*'. Cultivar '*PDW 291'* produced significantly higher grain yield by 6.0 and 10.2% over the cultivars '*WH 896' and 'WH 912'*, respectively. Mahajan *et al.* (2004), Kumar *et al.* (2005) and Bhat (2005) also reported similar results. The marked increase in number of spikes of '*PDW 291*' might be due to improved growth of plants at successive stages as reflected by higher dry matter accumulation. This subscribes to view that there was adequate supply of metabolites in cultivar '*PDW 291'* compared to other cultivars for growth and development of effective tillers. Besides number of spikes, higher grains per spike, spike length and 1000-grain weight under '*PDW 29'* also seems to be on account of higher dry matter accumulation and its inherent characters. It is well documented that in wheat crop, the potential number of various yield components are decided during vegetative phase while reproductive stage determines their realizable number and size. Meisner *et al.* (1992) also opined that efficient partitioning of dry matter to harvestable part (grains) from rest of the plant parts is most important for realization of higher wheat yield.

Application of pendimethalin as pre-emergence significantly increased the yield attributing parameters *i.e.* the number of spikes, spike length and grains per spike over weedy check (Table 3). The average increment in number of spikes, spike length and grains per spike was 26.5, 7.2 and 16.7%, respectively over weedy plots. The average 1000-grain weight under pendimethalin treated plots (41.6 g) and weedy check (40.6 g) was similar. The increase in grain and straw yields due to pendimethalin application was 25.0 and 19.7% over weedy check, respectively. Higher yield attributes and yield with pendimethalin over weedy check have also been reported by Singh and Singh (1996) and Shukla and Mishra (2006). Pendimethalin reduced the density and dry matter accumulation by grassy as well as broadleaf weeds very effectively and on an average, it increased the grain yield of wheat by 25% over weedy check.

The concomitant effect of resource conservation techniques, cultivars and weed control significantly influenced

**Table 3. Effect of resource conservation techniques, cultivars and weed control treatments on weed dry matter (60 DAS), yield attributes and yield of *durum* wheat**

| Treatment | Dry matter ($g/m^2$) | | | | Spike length (cm) | | Grains/ spike | | 1000-grain weight (g) | | Grain yield (t/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grassy weeds | | Broad-leaved weeds | | | | | | | | | |
| | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 | 2005-06 | 2006-07 |
| *RCTs* | | | | | | | | | | | | |
| ZT | 13.3 | 12.8 | 14.2 | 12.8 | 9.4 | 9.7 | 47.3 | 49.5 | 41.2 | 42.2 | 5.28 | 5.64 |
| CT | 17.8 | 18.4 | 12.5 | 11.7 | 9.3 | 9.5 | 45.7 | 48.3 | 39.9 | 40.5 | 5.12 | 5.54 |
| FIRBS | 19.5 | 19.1 | 13.6 | 12.5 | 9.5 | 9.8 | 46.2 | 47.8 | 40.9 | 41.9 | 5.14 | 5.49 |
| LSD (P=0.05) | 1.1 | 1.2 | 1.0 | 0.7 | NS | NS | NS | NS | NS | NS | NS | NS |
| *Cultivars* | | | | | | | | | | | | |
| *'WH 896'* | 18 | 17.8 | 13.7 | 12.7 | 9.4 | 9.7 | 46 | 48 | 40.3 | 41.3 | 5.13 | 5.53 |
| *'WH 912'* | 16.7 | 16.7 | 13.7 | 12.5 | 9.1 | 9.4 | 44.1 | 46.1 | 39.2 | 40.1 | 4.96 | 5.31 |
| *'PDW 291'* | 16 | 15.8 | 13 | 11.8 | 9.7 | 9.9 | 49.2 | 51.5 | 42.4 | 43.3 | 5.46 | 5.84 |
| LSD (P=0.05) | 2.4 | 2.3 | NS | NS | 0.5 | 0.5 | 2.4 | 2.5 | 2.1 | 2.1 | 0.27 | 0.29 |
| *Herbicide* | | | | | | | | | | | | |
| Pendimethalin (1.5 kg /ha) | 7 | 8.1 | 6.8 | 8.1 | 9.7 | 10 | 50.3 | 51.8 | 41.1 | 42 | 5.76 | 6.17 |
| Weedy check | 26.8 | 26.5 | 20 | 16.6 | 9.1 | 9.3 | 42.5 | 45.2 | 40.1 | 41 | 4.60 | 4.94 |
| LSD (P=0.05) | 0.2 | 0.4 | 0.3 | 0.2 | 0.1 | 0.2 | 0.4 | 0.4 | NS | NS | 0.04 | 0.04 |




T1 - Pendimethalin (1.5 kg/ha); T2 - Weedy check; ZT - Zero tillage; CT - Conventional tillage; FIRBS- Furrow-irrigated raised-bed system

**Fig. 1. Interactive effect of resource conservation techniques, cultivars and weed control treatments on grain yield of *durum* wheat.**

the grain yield of durum wheat during both the years (Fig.1). During 2005-06 cultivar, '*WH 896*' under ZT and FIRBS, when treated with pendimethalin gave statistically same yield of 5.92 and 5.74 t/ha, however, the grain yield significantly decreased when cultivar '*WH 896*' (5.51 t/ha) sown under CT and treated with pendimethalin. Similarly, cultivar, '*WH 912*' under CT and cultivar '*PDW 291*' under ZT gave significantly higher grain yield of 5.73 and 6.33 t/ha compared to the situation when these cultivars were sown under ZT and CT, respectively at same weed control treatment (pendimethalin). Highest grain yield of 6.33 t/ha was produced by cultivar '*PDW 291*' under ZT when treated with pendimethalin. This treatment combination produced 46.2% higher grain yield than that produced under cultivar '*WH 912*' under CT without weed control (4.33 t/ha). Similar interaction effects among resource conservation techniques, cultivars and weed control were observed in 2006-07.

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