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STUDY EFFECT OF TILLAGE, HERBICIDE AND FERTILIZER RATES ON WHEAT (*TRITICUM AESTIVUM*) AND WEED POPULATIONS IN IRAN

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Abstract

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Wheat grain production will not be sufficient for the increasing world population demands in next decades. The aim of integrated weed management (IWM) is to use of a combination of different practices to maintain weed densities at manageable levels. Field experiments were carried out in 2005 and 2006 to investigate the effects of conventional (CT) and no-tillage (NT) systems, interacting with three herbicide dose levels and three nitrogen (N) levels on weed growth and wheat production of two varieties Zarrin and Pishtaz in Agronomy College, University of Tehran. There was a higher grain yield for NT system compared with CT in one year. CT weed biomass was lower than from NT weed biomass, in both varieties. No differences on wheat biomass and grain yield were observed between full and reduced herbicide rates. N fertilizer increased wheat biomass and grain yield significantly. Only N medium level had an effect upon weed biomass with respect to non-fertilized plots, while the highest fertilization rate lowered weed biomass. Conventional tillage, reduced herbicide rates and nitrogen fertilization were effective ways of limiting weed production in wheat.

Key words: Integrated weed management, tillage, herbicide, fertilizer, wheat

Introduction

The potential for increased crop yields, soil and water conservation, reduced input costs, and better economic returns has resulted in the increased adoption of conservation tillage (Buhler et al., 1996). Nevertheless, as tillage is decreased, weed control can become a limiting factor in crop production (Buhler, 1992). Froud-Williams et al. (1983) found weed control problems associated with herbicide selectivity and changes occurring in weed communities.

Changes in tillage practices can affect weed population dynamics, rendering them dependent upon heavy use of herbicide (Buhler, 1995). Different studies have shown the impact of reducing tillage on the population dynamics of weed species. These include increased populations of perennials, summer annual grasses, biennials, and winter annual species (Buhler

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1995). It is important to note that the responses of population dynamics are site specific (Arshad et al., 1995) and depend upon species, location and environment (Thomas and Frick, 1993). Conservation tillage is an integral component of integrated weed management (IWM) (Swanton and Weise, 1991). Despite the increasing interest in IWM as a method of reducing herbicide use, contrasting results have been reported. Kim et al. (1997) found that the use of subnormal herbicide doses (50%) reduced the grain yield of two wheat varieties by approximately 7%, while the weed biomass increased nearly by 6 %. Walker et al. (1998) stated that the seed production of *Avena fatua* and *Phalaris paradoxa* was either minimal or prevented with the application of the 25 % herbicide rate when competing with 150 pl m^{-2} of a barley variety. Moreover, in a two-year study, an average of 85% wild oat control using half herbicide dose has been reported by Wille et al. (1998). Fertilizer application is an important management factor in conservation tillage systems.

Nevertheless, the effect of fertility on weed communities and weed-crop interactions has been investigated to a lesser extent (O'Donovan et al. 1997). Conflicting results have been reported on the effect of nitrogen (N) fertilizer on crop-weed interaction. Valenti and Wicks (1992) found that increasing N rates applied to winter wheat decreased annual grass weed populations and yields. Conversely, in other studies, applications of N favored *Setaria viridis* (Peterson and Nalewaja, 1992) and *Avena fatua* (Carlson and Hill, 1986) over wheat. Jornsgard et al. (1996) found differences in the biomass of individual weed species in both wheat and barley crops with N fertilizer applications. Soil tillage, herbicide, fertility and weeds are thus expected to interact strongly in order to have definitive effects on crop growth and yields. Information on the impact of several management techniques, i.e., herbicide rates, fertilizer application and different types of tillage, is needed for developing a reliable IWM. This study is concerned with effects of two tillage systems and different management inputs of nitrogen (N) fertilizer and herbicide rates on the biomass and yield of wheat varieties and weed biomass.

Materials and Methods

Field experiments were established during 2005 and 2006 at the Experimental Station of Agronomy college, Agriculture Paradise, University of Tehran (35º 34´N, 55º 57´E, Karaj city, Iran). Rainfall during the study period (July-December) was 536.9 mm in 2005 and 708.1 mm in 2006 (July-December average: 528.5 mm). The experiments were arranged in a randomized complete block design with four replications, with the treatments arranged as split-split plots. The

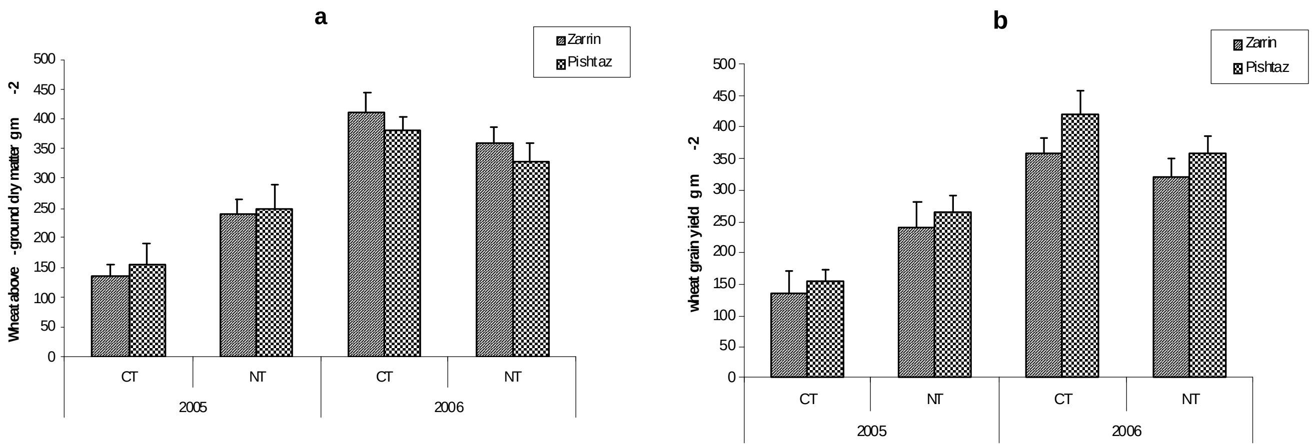

Fig. 1. (a) Wheat above-ground dry matter (ADM, g m^{-2}) and (b) wheat grain yield (GY, g m^{-2}) under two tillage system (CT: conventional tillage, NT: No- tillage). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$) test

whole plot factor consisted of two tillage systems (A). This includes A1: conventional tillage (CT, ploughing-20 cm, disk-harrowing, standard sowing) and A2: no-tillage (NT, herbicides used to control weeds and straw spread with harrows).

The same tillage treatments were applied to the same whole plot each year. The subplot factor consisted of three levels of herbicide rates (B). Three doses of metsulfuron-methyl+dicamba (0/0 (0x), 3.0/50 (0.5x) and 6.0/100 (1x) g a.i. cm^{-3} ha^{-1}, respectively) were applied at the fourth leaf-unfolded stage (Z14, Zadoks et al., 1974). The sub-subplot factor consisted of three N levels (C). No N was applied in the low-N treatment areas. Urea fertilizer (46% N, w/w) was broadcasted and incorporated at Z14 stage at rates of 50 kg and 100 kg N ha^{-1} $year^{-1}$ as the medium-N and highN treatment area, respectively. Two wheat cvs (Pishtaz and Zarrin) were sown at a density of 300 pl m^{-2}. The major weed species were *Chenopodium album*, *Viola arvensis*, *Stellaria media*, *Lamiun amplexicaule*, *Polygonum convolvulus* and *Lolium multiflorum*. Minor weed species were *Anagallis arvensis*, *Capsella bursa-pastoris* and *Spergula arvensis*. Weed population was harvested from a 0.5 m² area in each plot (ten samples per each sub-subplot) at Z31 stage and their above-ground dry matter (ADM, g m^{-2}) determined. Crop ADM (g m^{-2}), at Z31 stage was determined by hand harvesting samples on triplicate 0.5 by 0.5 m quadrats randomly located in each sub-subplot. Grain yield (g m^{-2}) was measured on five 1m² quadrats on each sub-subplot. ANOVA and LSD mean separation was performed for $p \leq 0.05$. The analyses were repeated over years and tested for homogeneity of variance and normality of distribution.

Results and Discussion

Soil Tillage

Tillage effects were significant ($p<0.05$) for wheat ADM. CT produced significantly ($p<0.01$) higher wheat ADM than NT in 2006 but not in 2005 (Figure 1a). The relatively drier spring of the first year could have mainly conditioned the ADM production of crop and weed at CT treatment.

There were opposite trends for grain yield between the two evaluated years. The tillage effects at 2005 resulted in lower crop grain yield under CT plots than NT plots, with lower production in Pishtaz than in Zarrin (Figure 1b). Conversely, there was a higher grain yield ($p<0.05$) for CT than NT plots for the varieties tested in the second year (Figure 1b). Despite the higher weed ADM registered in Pishtaz, a greater grain yield was obtained, compared with Pishtaz (Figure 1b). These results showed a varietal difference for the effect of both tillage and weed competition. Zarrin appears as a higher competitive variety than B.Pronto. However, due to the larger weed growth registered at Zarrin plots, the long-term impact of weed seed return on seed bank dynamics must be examined.

These results are in agreement with Arshad et al. (1995) who found that differences in weed infestation do not always result in significant yield differences. This lack of relation between weed biomass and crop yield could be explained by the occurrence of resources complementarities (no crop-weed competition). Weed ADM varied across years. Conversely to crop biomass, the main tillage effects in both years

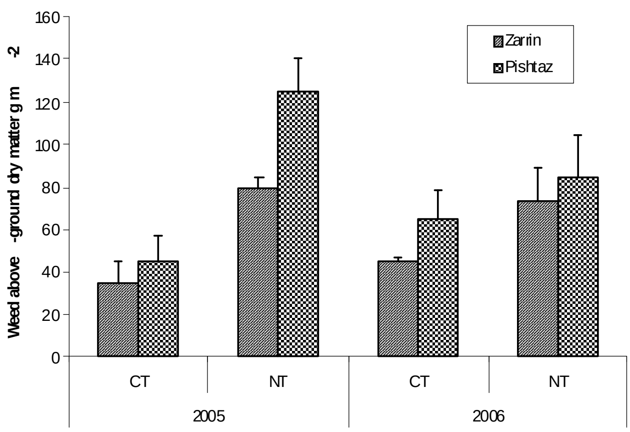

Fig. 2. Weed above-ground dry matter (ADM, g m^{-2}) under two tillage system (CT: conventional tillage, NT: No- tillage). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$) test

were lower weed biomass production under CT in both varieties, and a lower production in 1999 than in 2000 (Figure 2). These results are in agreement with Arshad et al. (1995) who found a higher weed mass in NT than in CT. In no-tillage systems, the weed seeds remain in the upper layer and immediately contribute to infestation. This could explain the greater biomass registered in NT than in CT plots, despite the relatively drier 2005 spring. However, Buhler (1995) determined that the effect of surface residue on weed dynamics appears to be complex and controlled by interacting factors (soil type, weed species, quality and type of residue, allelopathy, and environmental conditions).

Herbicide

No differences were observed between the effects caused by the 1x and 0.5x dose in the crop ADM and grain yield. Conversely, significant differences ($p \leq 0.05$) amongst these herbicide rates and 0x were observed for crop variables (Figure 3a, Figure 3b). Zarrin had higher ($p<0.05$) tolerance to weed competition than Pishtaz for the herbicide rates evaluated. This effect was visualized in the 0x plots, where Pishtaz, despite the higher weed ADM obtained (Figure 4), showed a higher grain yield than Pishtaz during both years.

Similarly to crop variables, weed biomass was mostly reduced (55% in both years) by reduced herbicide rates (0.5 x) with no significant differences with 1.0x herbicide rate. Nevertheless, when no herbicide was applied, there were significant differences ($p<0.05$) between wheat varieties. For both years, a higher weed ADM in Zarrin plots was obtained (Figure 4). On the other hand, no tillage-herbicide interactions were found. According to these results, herbicides influenced grain yield and weed ADM similarly, irrespective of tillage treatments.

Teasdale et al. (1991) revealed the risk of confounding the effect of tillage with herbicide effects and stated the need to evaluate the direct effects of tillage systems on weed population dynamics over several years of rotation. No significant tillage-herbicide interactions were found here. These results indicate that there is no influence of tillage system on weeds despite herbicide application at reduced doses. Such data tend to indicate that reduced herbicide rates have an adequate fit to the weed flora present in the study, agreeing with the results obtained by Walker et al. (1998).

Fertilization

For the two years evaluated, N fertilizer significantly increased wheat ADM and grain yield with dif-

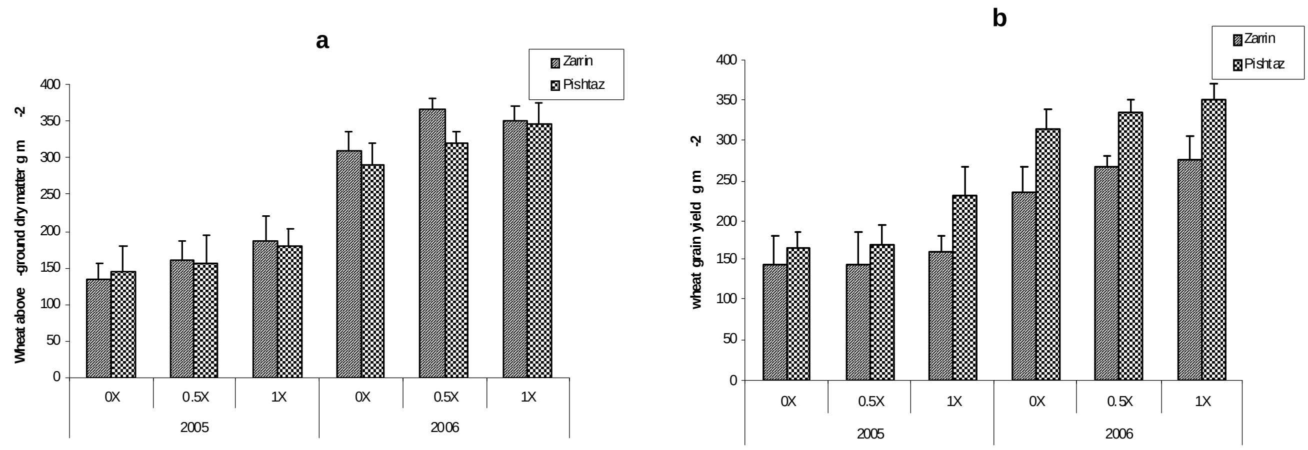

Fig. 3.(a) Wheat above-ground dry matter (ADM, g m^{-2}) and (b) wheat grain yield (GY, g m^{-2}) of wheat varieties as affected by herbicide rate (0X: No Herbicide, 0.5 X: Half rate and 1.0 X: Normal rate). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$) test

ferences ($p<0.05$) between medium and high level for grain yield. In 2005, a year with a relatively dry spring, a minor effect was obtained (Figure 5a, Figure 5b). No significant tillage-fertilization interaction was obtained at each year for grain yield. A higher yield increase of wheat under no-tillage treatment (NT) in each year (100 N: 120 % in 2005, 110 % in 2006) was registered, compared to conventional tillage (CT, 100 N: ~70 % both years) (Figure 5a, Figure 5b). Only at Pishtaz plots a weed ADM increase was obtained when applying moderate N rates (50 N) (Figure 6). However, the two fertilization levels significantly lowered weed biomass when competing with Zarrin (Figure 6). As in the tillage treatment, when nitrogen was added full rate (100 N) the cvs presented differences in tolerance to competition against weeds.

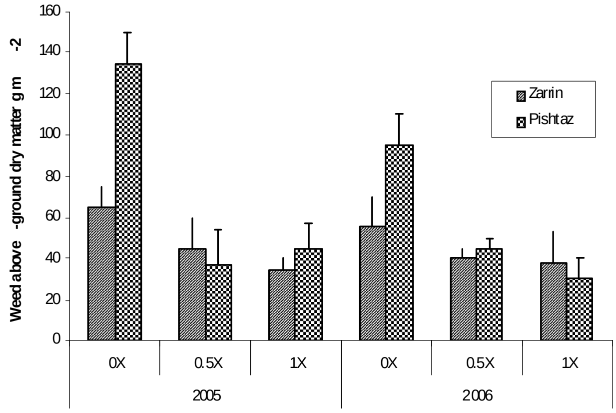

Fig. 4. Weed above-ground dry matter (ADM, g m^{-2}) as affected by herbicide rate (0X: No Herbicide, 0.5 X: Half rate and 1.0 X: Normal rate). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$) test

Highest grain yield was obtained by Zarrin (Figure 5b), despite the higher weed ADM observed in the full rate plots (Figure 6). The results indicate that N optimum rate does not concur for wheat and weed natural populations. These results are in agreement with Valenti & Wicks (1992), who found that applying N to winter wheat decreased annual grass weed populations and weed yields, as well as with those obtained by Jornsgard et al. (1996). These authors

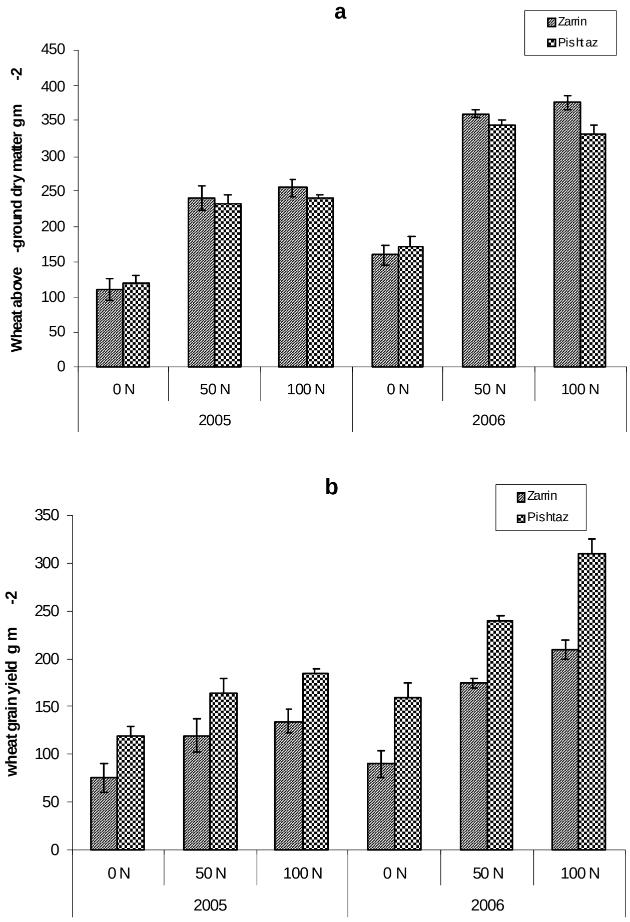

Fig. 5. (a) Wheat above-ground dry matter (ADM, g m^{-2}) and (b) wheat grain yield (GY, g m^{-2}) of wheat varieties as affected by fertilizer rate (0N: No fertilizer applied, 50 N: 50 kg N ha^{-1} and 100 N: 100 kg N ha^{-1} fertilizer applied). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$)

found that above dry matter of *Chenopodium album*, *Lamiun amplexicaule*, *Stellaria media* and *Veronica* spp. cannot be improved with N application in competition with wheat and barley. Consequently, they concluded that in a low input agriculture, a lower application of N could favour the increase of such species and a different proportion of them in weed natural populations. Our results contrast with those reached by Acciaresi et al. (2001), who reported a progressively higher *Lolium multiflorum* aggressively with

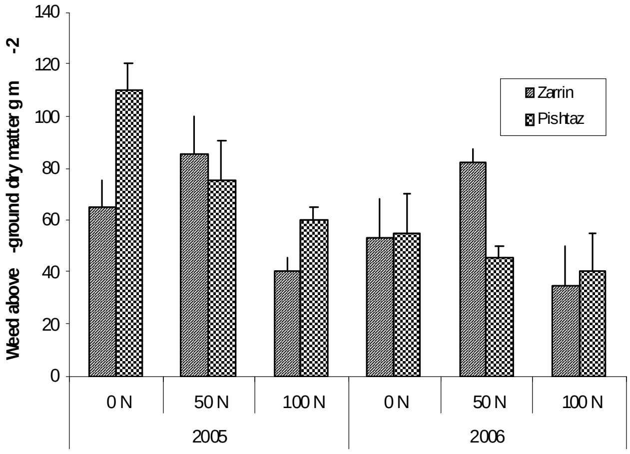

Fig. 6. Weed above-ground dry matter (ADM, g m^{-2}) as affected by fertilizer rate (0N: No fertilizer applied, 50 N: 50 kg N ha^{-1} and 100 N: 100 kg N ha^{-1} fertilizer applied). Means in a given variety followed by different letters indicate significant differences on based on LSD ($p \leq 0.05$) test

increasing N rates in competition wheat varieties and with those obtained by Cook and Clarke (1997). These authors stated that weed number increased with successive use of low herbicides and that weed control was rendered more difficult with the continued use of low N rates.

These results suggest that variety selection may be an important component to tillage, herbicide and fertilization. Within the conditions tested here, the use of subnormal herbicide doses (50%) and N fertilization may be useful in wheat production systems (conventional and no tillage systems) as a strategy to manage natural weed populations. Further information is needed on management practices to minimize long-term effects on weed dynamics.

Acknowledgments

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References

Acciaresi, H. A., H. O. Chidichimo and S. J. Sarandon, 2001. Wheat-*Lolium multiflorum* competition: effect of nitrogen application onto Argentinean varieties aggressivity. *Cereal Res. Comm.*, **29**: 451-458.

Arshad, M. A., K. S. Gill and G. R. Coy, 1995. Barley, canola and weed growth with decreasing tillage in a cold, semiarid climate. *Agron. J.*, **87**: 49-55.

Buhler, D. D., 1992. Population dynamics and control of annual weeds in corn (*Zea mays*) as influenced by tillage systems. *Weed Sci*., **40**: 241-248.

Buhler, D. D., 1995. Influence of tillage systems on weed populations dynamics and management in corn and soybean in the central USA. *Crop Sci*., **35**: 1247-1258.

Buhler, D. D., **T. C. Mester and K. A. Kohler,** 1996.The effect of maize residues and tillage on emergence of *Setaria faberi*, *Abutilon theophrasti*, *Amaranthus retroflexus* and *Chenopodium album*. *Weed Res*., **36**: 153-165.

Carlson, H. L. and J. E. Hill, 1986. Wild oat (*Avena fatua*) competition with spring wheat: effects of nitrogen fertilization. *Weed Sci*., **34**: 29-33.

Cook, S. K. and J. H. Clarke, 1997. The effects of six-years of reduced-rate herbicide use and rotation on weed levels, yields and profitability-TALISMAN results. In: Brighton Crop Protection Conference,1-3, 1997, Brighton. Proceedings of Brighton Crop Protection Council. 705-710.

Foud-Williams, R. J., D. S. H. Drennan and R. J. Chancellor, 1983. Influence of cultivation regime on weed floras of arable cropping systems. *J. Appl. Ecol*., **20**: 187-197.

Jornsgard, B., K. Rasmussen, J. Hill and J. L. Christiasen, 1996. Influence of nitrogen on competition between cereals and their natural weed populations. *Weed Res*., **36**: 461-470.

Kim, D. S., B. L. Flank and R. J. **Chancellor,** 1997. Effects of sub-lethal doses of metsulfuron-methyl on crop-weed competition in two varieties of winter wheat. In: Brighton Crop Protection Conference, 1-3, 1997, Brighton. Proceedings of Brighton Crop Protection Council, pp. 669-670.

Odonovan, J. T., D. W. McAndrew and G. Thomas, 1997. Tillage and nitrogen influence weed population dynamics in Barley (*Hordeum vulgare*).

Weed Technol., **11**: 502-509.

Peterson, D. A. and J. D. Nalewaja, 1992. Environment influences green foxtail competition with wheat. *Weed Technol.*, **6**: 607-610.

Swanton, C. J. and S. F. Weise, 1991. Integrated weed management in Ontario: the rationale and approach. *Weed Technol.*, **5**: 657-663.

Teasdale, J. R., C. E. Beste and W. E. Potts, 1991. Response of weeds to tillage and cover crops residue. *Weed Sci.*, **39**: 195-199.

Thomas, A. G. and B. L. Frick, 1993. Influence of tillage systems on weed abundance in southwestern Ontario. *Weed Technol.*, **7**: 699-705.

Valenti, S. A. and G. A. Wicks, 1992. Influence of nitrogen rates and wheat (*Triticum aestivum*) cultivars on weed control. *Weed Sci.*, **40**: 115-121.

Walker, S. R., G. R. Robison and R. W. Medd, 1998. Management of wild oats and paradoxa grass with reduced dependence on herbicides. Proceedings, In: Australian Agronomy Conference, 9.Wagga-Wagga. Australian Society of Agronomy, p. 572.

Wille, M. J., D. C. Thill and W. J. Price, 1998. Wild oat (*Avena fatua*) seed production in spring barley (*Hordeum vulgare*) is affected by the interaction of wild oat density and herbicide rate. *Weed Sci.*, **46**: 336-343.

Zadoks, J. C., T. T. Chang, C. F. Konzak, 1974. A decimal code for the growth stages of cereals. *Weed Res.*, **14**: 415-421.

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