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# Effects of some cover crops on weeds population and biomass in Sunflower (*Helianthus annuus* L.) field

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**Abstract**

In order to evaluate the effects of some cover crops on weed populations and biomass during sunflower growth, an experiment was done in 2012 at the research field of Tabriz University, Iran. The experimental design was a randomized complete block with nine treatments in three replications. Treatments included triticale, hairy vetch, rapeseed, triticale + hairy vetch, triticale + rapeseed, hairy vetch + rapeseed, application of trifluralin herbicide, and controls (weed infested and weed free without planting cover crop). Results indicated that total weed density was reduced 44.92% in triticale + rapeseed treatment, but application of trifluralin caused 64.24% reduction in total weed density in comparison with weed infested. However, in triticale + rapeseed treatment, total weed dry biomass was reduced 72.12% compared with weed infested, so that this treatment was better than application of trifluralin. The use of cover crops as a strategy to reduce the damage of weeds and application of herbicide can be helpful.

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## Introduction

In many agricultural systems around the world, weed competition is one of the major factors reducing crop yield and farmer's income. Weeds, simply defined as plants growing in an undesired location, compete with crops for resources, lower crop yields, and can contaminate the crop with their seeds thereby perpetuating the problem into subsequent growing seasons (Vyvyan, 2002). In conventional farming systems, weeds are routinely controlled by herbicides, but this practice has negative impacts on human, wildlife and environmental health are additional concerns related to the heavy use of synthetic herbicides (Bertholdsson, 2005). The widespread use of herbicides has also created new weed problems, in terms of a shift in the weed populations and herbicide resistant weeds (Lemerle *et al.*, 2001). A growing list of herbicide-resistant weeds (Heap, 2005) reinforces the concept that repeated use of a single tactic for pest control may not only facilitate infestations of the most problematic species, but may fundamentally change population genetics.

Integrated weed management (IWM) aims, in part, to prevent infestations of species that are most difficult to control by stressing the use of multiple tactics that collectively address the causes of weed problems, rather than simply reacting to infestations (Buhler, 2002).Organic management systems attempt to increase soil organic matter through additions of plant biomass generated by cover cropping practices, additions of manure, compost, and other organic amendments, and conservation of crop residue. Soil organic matter enhances the formation of aggregates, which stabilizes soil and reduces runoff and erosion (Sainju *et al.*, 1997).

Allelopathy is defined as the effect of one plant on another through the release of a chemical compound into the environment (Bhowmik and Inderjit, 2003). Investigations showed that some plants such as alfalfa (*Medicago sativa* L.), buckwheat (*Eriogonum douglasii*), hairy vetch (*Vicia villosa*) and velvet bean (*Mucuna prurients* L.) have allelopathic potential (Kohli, 1998; Galiba *et al.*, 1998; Hong *et al.*, 2001; Xuan *et al.*, 2002). To date, the use of allelopathic cover crops, such as rye and oat, has resulted in the greatest application of this concept in agriculture (Colquhoun, 2006). The allelopathy of these plants can be used in a number of ways. The allelopathic crops, in rotation, may help in weed suppression in subsequent crops. As with all other techniques, caution needs to be employed. Allelopathic crops may suppress subsequent crop growth. Allelopathic crops can also be used as cover crops or green manures. The weed suppressive activity of several cover crops has been attributed to the release of allelochemicals (Putnam and DeFrank 1979, 1983; White *et al.*, 1989). Cover crop mulch systems can reduce weed emergence and growth. They alter the light stimulus needed for emergence of certain weeds (More *et al.*, 1994), and can release allelochemicals that inhibit weed growth (Barnes and Putnam, 1983; Mwaja *et al.*, 1995). Summer annual cover crops can be included in cropping systems for their potential role in improving soil health and providing weed management benefits by suppressing weeds at different life cycle stages. In many cropping systems there is a gap between early-harvested summer crops (e.g., peas or snap beans) and winter wheat. Land is often left bare during this period, allowing weeds to grow and reproduce. Inclusion of a summer annual cover crop with strong weed-suppressive ability is useful for suppressing weed growth and improving soil in this late-summer niche (Bjorkman *et al.*, 2008; Creamer and Baldwin, 2000).

Taylor *et al.* (2001) noted among the cereals, the most competitive are probably oat and winter rye, followed by triticale and wheat. Barley competed with weeds mostly for below ground resources through root competition, whereas in oats and wheat competition for light appears more important. Trials at Elm farm research center in organic cereal also show that oat and triticale are more weed suppressive than wheat (Davies and Welsh, 2002). Rye (*Secale cereal* L.) is a cereal cover crop known to be allelopathic to many weed species (Putnam and Defrank, 1983). There is evidence that the weed suppressive ability of rye is comparable to standard herbicide treatments

(Shilling *et al*., 1986). Both the living cover crop and mulch of rye have been shown to suppress many broadleaf and grass weeds in crops such as maize, tobacco, snap beans cabbage and other vegetable species (Shilling *et al*., 1986; Dhima *et al*., 2006; Masiunas *et al*., 1997; Creamer *et al*., 1996). Ateh and Doll (1996) investigated the control of weeds by a living cover crop of rye in soybean (*Glycine max* (L.) Merr.) and observed 90, 82 and 60% reduction in weed shoot biomass by rye in 1992, 1993, and 1994, respectively.

Annual legume species such as crimson clover, hairy vetch, and subterranean clover have been investigated for potential weed control benefits (Reddy, 2001, 2003; Teasdale and Daughtry, 1993; Teasdale *et al*., 1991; Yenish *et al*., 1996). In addition to the benefits provided by cereal cover crops, the legume cover crops biologically fix atmospheric N, which subsequently becomes available to a crop during residue decomposition (Sainju and Singh, 1997; Varco *et al*., 1999). Teasdale (1988) reported that hairy vetch residue suppressed pigweed (*Amaranthus* spp.), foxtail (*Setaria* spp.), and velvetleaf (*Abutilon theophrasti* Medikus), and he also suggested that maximum weed suppression by hairy vetch residue occurs shortly after cover crop death. The idea of using a living mulch as a “designated weed” and learning to live with it is very appealing when compared with the constant battle of learning to fight an ever-changing weed spectrum (Hartwig and Ammon, 2002).

This study was conducted in order to evaluate the effect of some cover crops on weed population and biomass in sunflower filed.

## Materials and methods

This study was conducted in 2012 at the research field of Tabriz University, Iran ($38^{\circ}01'$ North latitude, $46^{\circ}25'$ East longitude and an altitude of 1676 meters). The soil type was loam, 42.4% sand, 38% silt, 19.6% clay, 0.17% organic matter, PH 7.4, and Ec 0.93 ds/m. The experimental design was a randomized complete block with nine treatments and three replications. Treatments included planting triticale, hairy vetch, rapeseed, triticale + hairy vetch, triticale + rapeseed, hairy vetch + rapeseed cover crops two weeks before sunflower (*Helianthus annuus* L) planting, application of trifluralin herbicide (2,6-Dinitro-*N,N*-dipropyl-4-(trifluoromethyl) aniline) two weeks before sunflower planting, and controls (weed infested and weed free without planting cover crops before sunflower planting). Conventional tillage consisted of spring mouldboard ploughing to a depth of 30 cm, followed by secondary tillage with a tandem disk harrow and furrower before planting. Each treatment plot was in 3.5 m wide and 5 m long. Triticale, hairy vetch, and rapeseed were down furrow drilled at 180, 45, and 9 $kgha^{-1}$, respectively. Cover crop treatments were grown during sunflower growing seasons. Oil hybrid sunflower cv. Urofoure was direct top of the furrow drilled (seven rows per plot; 50 cm row spacing; 86,000 seeds $ha^{-1}$) two weeks after cover crop planting. To evaluate the effects of cover crops on weed populations and biomass during sunflower growth was sampled six times. In each plot, kinds of weeds, their density, cover percentage, and dry weight were measured. Data were analyzed using SAS and mean comparison was conducted according to the Duncan's t-test.

## Results and discussion

### *Weed density*

Analysis of variances indicated that weed density was significantly affected by treatments, times and their interaction (Table 1). Mean comparison indicated that weed infested treatment had highest weed density at the end of season, but application of trifluralin at first sampling time had lowest weed density (Table 2).

**Table 1.** Analysis of variances of the measured traits.

| S.O.V | df | Weed density | Weed biomass |
|---|---|---|---|
| Replication | 2 | 1072.89 $^{ns}$ | 1244.45 $^{ns}$ |
| Treatments | 7 | 49298.37 $^{**}$ | 10046.10$^{**}$ |
| Error(a) | 14 | 1654.46 | 450.46 |
| Times | 5 | 17829.52 $^{**}$ | 24856.01 $^{**}$ |
| Treatments× Times | 35 | 6757.27 $^{**}$ | 1623.13 $^{**}$ |
| Replication× Times | 10 | 719.73 $^{ns}$ | 192.21$^{*}$ |
| Error(a) | 70 | 396.01 | 95.80 |
| CV (%) | 143 | 13.49 | 19.72 |

*=Significant at 5% level, **= Significant at 1% level, ns=Non-significance

Dominant weed species included common lambsquarters (*Chenopodium album* L.), bindweed (*Convolvulus arvensis* L.), green bristlegrass (*Setaria viridis* L.), pigweed (*Amaranthus sp),* and birdsfoot trefoil *(Lotus corniculatus* L.) (Figure 1). In all cover crop treatments except Hairy vetch, weed density reduction was observed. This may have been due to increased nitrogen availability to weeds resulting from secretion of Hairy vetch root as treatment Highest reduction in total weed density was observed in application of trifluralin treatment (64.24%), also 44.92% and 44.13% reduction was observed in triticale + rapeseed, and rapeseed treatments, respectively (Table 3). common lambsquarters density was reduced 39.65% 36.78% in hairy vetch + rapeseed and hairy vetch cover crop, respectively. Bindweed density was reduced 72.97% in rapeseed and 68.11% by triticale + hairy vetch cover crops treatments. Rapeseed and triticale + rapeseed, caused 62.06% and 63.98% reduction in birdsfoot trefoil density, respectively (Table 3).

**Table 2.** Effect of interactions Treatments and times on the weed density.

| Treatments | Time1 | Time2 | Time3 | Time4 | Time5 | Time6 |
|---|---|---|---|---|---|---|
| Triticale | 66 TU | 172.67 HIJK | 157.33 JKLM | 222.33 DEFG | 258.00 BC | 133.67 MNOPQ |
| Hairy vetch | 150.67 KLMNO | 197.33 FGHI | 161 IJKLM | 235 CDE | 227.67 B | 251.33 BCD |
| Rapeseed | 35 U | 117.33 NOPQR | 131.67 LMNOPQ | 166 IJKL | 164.67 IJKL | 49.67 TU |
| Triticale + Hairy vetch | 127 LMNOPQ | 197.67 FGHJ | 239.67 CDE | 220 DEFG | 221.33 CDEFG | 153.67 JKLMN |
| Triticale + Rapeseed | 83 RST | 158 JKLM | 129.00 MNOPQ | 113.00 OPQR | 101.67 QRS | 68.67 STU |
| Hairy vetch + Rapeseed | 111.33 PQR | 190.67 GHIJ | 109.33 PQR | 123.33 NOPQ | 115.00 OPQR | 49.67 TU |
| Application of trifluralin | 45 TU | 159.67 JKLM | 50 TU | 65 TU | 49.67 TU | 52 TU |
| Weed infect | 206.33 EFGH | 231.00 CDEF | 147 KLMNOP | 161 IJKLM | 137.33 LMNOPQ | 313.67 A |

*Weed biomass*

Results showed that all treatments significantly reduced the total weed biomass (Table 1). Mean comparisons indicated that between all treatments at the end of season, weed biomass was lower in rapeseed cover crop, but was highest in weed infested treatment (Table 4). In all cover crops treatments the effect of cover crops in reducing all weed dry biomass was observed (Fig. 2).

In triticale + rapeseed treatment, total weed biomass was 72.12% (compared to weed infested) and was better than trifluralin with 54.85% reduction. Triticale + rapeseed caused 71.58%, 76.19% ,78.66% and 80.62% reduction in *Chenopodium album* L., *Convolvulus arvensis* L., *Setaria viridis* L. and *Amaranthus* sp, respectively compared to weed infested. These weed species had similar dry biomass in rapeseed ,hairy vetch + rapeseed cover crops (Table 5).

Integrated crop management (ICM) can be an economically viable management strategy designed to synergistically control weeds and other pests, manage soil fertility, and promote soil and water conservation (Elmore 1996; Swanton and Murphy 1996). The cover crops can improve crop productivity and reduced rates of environmentally benign herbicides can minimize the herbicide requirements. Although cereals and legumes are the most commonly used cover crops, glucosinolate-producing cover crops may offer broader pest control through production of natural pest suppressants (Fahey *et al.*, 2001; Boydston and Al-Khatib, 2006). Glucosinolate-producing cover crops may suppress weed germination and growth (Haramoto and Gallandt, 2004; Norsworthy *et al.*, 2005).

**Table 3.** Percent inhibition of treatments on weed species density (Che.alb = (*Chenopodium album* L.), Con.arv= (*Convolvulus arvensis* L.), Set.vir.= (*Setaria viridis* L.), Ama.spp.= (*Amaranthus sp*), Lot.cor.=(*Lotus corniculatus* L.))

| Treatments | Che.alb. | Con.arv. | Set.vir. | Ama.spp. | Lot.cor. | All weeds |
|---|---|---|---|---|---|---|
| Triticale | -19.35 | +3.96 | -11.27 | -2.73 | -56.89 | -14.42 |
| Hairy vetch | -36.78 | -12.97 | +112.24 | +6.72 | -78.45 | +7.06 |
| Rapeseed | -28.42 | -72.97 | -62.06 | -68.92 | -90.46 | -44.13 |
| Triticale + Hairy vetch | -8.62 | -68.11 | -21.26 | +99.78 | -35.34 | -0.81 |
| Triticale + Rapeseed | -38.22 | -32.07 | -63.98 | -42.05 | -15.9 | -44.92 |
| Hairy vetch + Rapeseed | -39.65 | -59.1 | -41.65 | -34.08 | -72.79 | -41.04 |
| Application of trifluralin | -53.17 | -20 | -93.30 | -60.23 | -80.57 | -64.24 |

+ have additive effects and - is a inhibition effect.

**Table 4.** Effect of interactions treatments and times on the weed biomass.

| Treatments | Time1 | Time2 | Time3 | Time4 | Time5 | Time6 |
|---|---|---|---|---|---|---|
| Triticale | 8.08 TUV | 11.96 STUV | 30.24 NOPQRS | 65.22 HIJK | 95.39 DE | 69.85 FGHIJ |
| Hairy vetch | 13.41 STUV | 35.11 MNOPQ | 38.04 LMNOP | 87.63 EF | 111.79 D | 158.72 B |
| Rapeseed | 4.06 UV | 9.64 TUV | 13.06 STUV | 80.87 EFGH | 56.14 IJKL | 25.25 OPQRST |
| Triticale + Hairy vetch | 10.32 TUV | 35.82 MNOPQ | 45.23 LMN | 78.05 EFGH | 95.87 DE | 83.85 EFG |
| Triticale + Rapeseed | 5.21 UV | 15.47 RSTUV | 17.21 QRSTUV | 35.06 MNOPQ | 37.91 LMNOP | 42.6 LMNO |
| Hairy vetch + Rapeseed | 14.88 RSTUV | 17.9 QRSTUV | 22.29 PQRSTU | 33.34 NOPQR | 47.99 KLMN | 30.05 NOPQRS |
| Application of trifluralin | 1.55 V | 18.91 QRSTUV | 34.69 MNOPQ | 66.03 GHIJ | 73.86 FGHI | 53.44 JKLM |
| Weed infect | 8.92 TUV | 40.51 LMNOP | 63.3 HIJK | 105.11 D | 139.68 C | 192.82 A |

**Table 5.** Percent inhibition of treatments on weed species biomass (Che.alb = (*Chenopodium album* L.), Con.arv= (*Convolvulus arvensis* L.), Set.vir.= (*Setaria viridis L.*), Ama.spp.= (*Amaranthus sp*), Lot.cor.=(*Lotus corniculatus* L.)).

| Treatments | Che.alb. | Con.arv. | Set.vir. | Ama.spp. | Lot.cor. | All weeds |
|---|---|---|---|---|---|---|
| Triticale | -56.91 | -29.57 | -57.54 | -53.69 | +20.61 | -48.99 |
| Hairy vetch | -48.90 | -38.60 | +27.57 | -59.41 | -38.79 | -19.20 |
| Rapeseed | -45.43 | -74.73 | -84.57 | -90.64 | -59.40 | -65.65 |
| Triticale + Hairy vetch | -15.01 | -79.04 | -51.32 | +49.45 | +54.85 | -36.56 |
| Triticale + Rapeseed | -71.58 | -76.19 | -78.66 | -80.62 | +4.52 | -72.12 |
| Hairy vetch + Rapeseed | -62.37 | -62.13 | -76.26 | -76.38 | -35.92 | -69.76 |
| Application of trifluralin | -17.19 | -50.08 | -93.47 | -18.35 | -3.17 | -54.85 |

+ have additive effects and - is a inhibition effect.

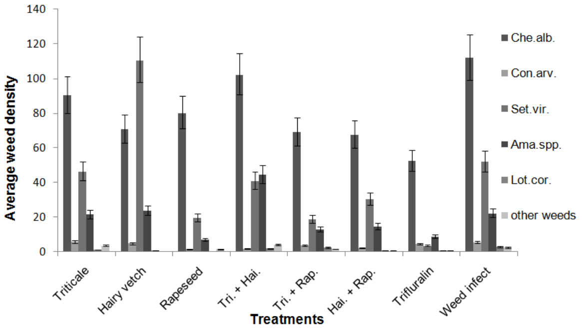


**Fig. 1.** Effects of treatments on weed density (Tri.+ Hai.= Triticale + Hairy vetch, Tri.+ Rap.= Triticale + Rapeseed, Hai.+ Rap.= Hairy vetch + Rapeseed)

We set out to evaluate the effect of cover crops on weed control in sunflower field was selected. Haramoto and Gallandt (2005) and Al Khatib (1997) found reductions in the emergence of bioassay species following Brassica cover crop residue incorporation in the field of 23–34% which were very similar to Kruidhof *et al* ( 2008) results. Boydston and Hang (1995) found higher reductions of weed density (73–85%) following rapeseed incorporation. Norsworthy *et al.* (2007), who compared the weed-suppressive effects of seven glucosinolate producing cover crops, found control levels along this whole spectrum, ranging from 38% to 79% control of *Digitaria sanguinalis* (L.) Scop. and 23% to 48% control of *Amaranthus palmeri* S. Watson. According to the results of numerous experiments and Peterson *et al* (2001) observations to weed suppression by release of Isothiocyanates from Turnip-Rape mulch, like our survey results determined that cover crops, especially rapeseed, can be used in integrated weed management (IWM) into sunflower production with associated weed suppression and reduce application of herbicides.

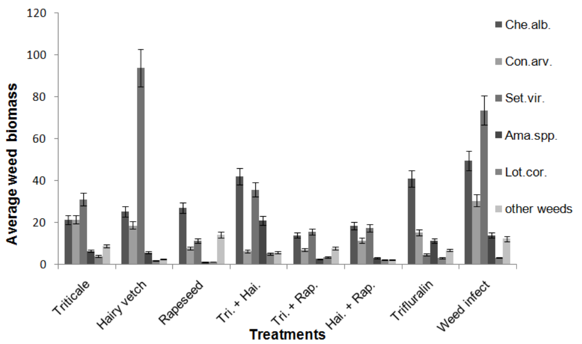


**Fig. 2.** Effect of treatments on weed biomass (Tri.+ Hai.= Triticale + Hairy vetch, Tri.+ Rap.= Triticale + Rapeseed, Hai.+ Rap.= Hairy vetch + Rapeseed)

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