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Rapeseed residue management for weed control and corn production

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Abstract

To study the effects of rapeseed residues on weeds growth and the following corn yield, this experiment was conducted in 2009 at Hamedan Agriculture Research Center, Iran. The experiment design was split plot in the form of a randomized complete block design with three replications. Treatments of the experiment were hand weeding (with and without) and rapeseed residues (0, 15 and 30 kg/plot). Results indicated that hand weeding significantly affected all the measured traits of corn, but residue had only significant effect on plant height, ear diameter and 1000 kernels weight. Residue had also significant effect on weeds growth; the highest residue rate (30 kg/plot) was more effective and gave the highest weed control.

Keywords: Allelopathy, Brassica napus, Residue, Weed, Zea mays.

Introduction

During the past decades, increased application of chemical herbicides has caused concerns about the effect of these materials on environment and products health. Moreover, the reliance of weed management on herbicides has increased the number and distribution of herbicide resistant weeds (Shanahan *et al*., 2003; Anonymous, 2010; Monaco *et al*., 2002). To overcome these problems, researchers are working to develop non-chemical weed management techniques and the integrated weed management.

One of the non-chemical methods is the application of allelopathic compounds instead of the chemically synthetic ones. These compounds are plant derived materials which suppers other plants. A more natural way to take advantages of allelopathy in weed control, in addition to the costly extraction from plant materials, is to put the allelopathic crop plants in rotation and incorporate their residues into soil or leave them on soil surface (Kohli *et al*., 2001; Kato-Noguchi, 2003; Putnam, 1988; Putnam & Defrank, 1983). So many different plant species contain allelopathic compounds and their residues may have inhibitory effect on weeds. Rye (*Secale cereale* L.), sorghum (*Sorghum bicolor* L.), barley (*Hordeum vulgare* L.), cowpea (*Vigna unguiculata* L.) and different clovers (*Trifolium* spp.) are examples of these plants (Einhellig & Souza, 1992; Hartwig & Ammon, 2002; Teasdale *et al*., 2007; Malik *et al*., 2008) studied the effects of wild radish and rye cover crops and residues on weds and concluded that the two cover crops reduced the total weeds density by 35% and 50, respectively. Mafakheri *et al*. (2010) also reported that rye cover crop residues controlled the total weeds density by about 28%, at 4th week after corn planting.

Rapeseed, in addition to being an important oil crop, is an allelopathic compounds containing plant. This crop has a valuable defense system called Myrosinase-Glucosinolate, which is an active allelopathic system (Bones & Rossiter, 1996). Studies indicate that incorporating rapeseed residues to soil (as cover crop or mulch) suppresses weed germination (Fenwick *et al*., 1983). These allelopathic materials may also affect germination of crops, especially those with small seeds. Moyer & Huang (1997) reported that rapeseed aqueous extract reduced wheat germination compared with the control (distilled water). Regarding the importance of mulches and residues in non-chemical and integrated weed management, this study was conducted to evaluate the effects of rapeseed residues on weeds, and on yield of the following corn cultivation.

Materials and methods

This experiment was conducted in 2009 at Hamedan Agriculture Research Center, Iran (51°48' E, 31°48 N, 1671m above the sea level). The area is a mountainous, cold and semi arid region with average annual precipitation of about 309mm. The mean temperature of the warmest and the coldest month of the year are 23.66 and 2.3°C, respectively. The soil type at the test site was loam with pH of 7.4.

This study was conducted in a split plot experiment in the form of a randomized complete block design with three replications and two factors; 1).The main plots: with (H_1) and without (H_0) hand weeding, 2).The sub plots: three rapeseed residues rates as 0 (R_0), 15 (R_{15}) and 30 (R_{30}) kg/plot. Plots size was 13m^2.

After the field was prepared, rapeseed residues were left on soil and then corn seeds were planted. At the end of the growing season, corn yield and yield components were measured according to the standard method. Plant height was measured from the soil surface to the first branch of tassel. To measure the biologic yield (biomass), harvested plants were dried at 72°C in an oven for 48h. Then, weeds density was counted using a 1.5m × 1.5m quadrate, weeds were harvested, oven dried and their dry weight was measured. The natural weed infestation at the time of sampling included Johnson grass (*Sorghum*

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Table 1. Analysis of the variances for corn yield and yield components

SOV	df	Mean Squares (MS)					
		Plant height	Ear diameter	Kernels / row	1000 kernels weight	Grain yield	Biologic yield
Replication	2	ns	*	ns	ns	ns	ns
Hand weeding (A)	1	**	**	**	**	**	**
Residue (B)	2	**	**	ns	**	ns	ns
A×B	2	**	**	ns	**	ns	ns
CV (%)	-	3.04	1.94	3.16	1.33	3.03	15.89

ns, nonsignificant; **, significant at P≤0.01; *, significant at P≤0.05.

Table 2. Effect of hand weeding, residues and their interaction on corn yield and yield components

Treatments	Plant height (cm)	Ear diameter (cm)	Kernels / row	1000 kernels weight (g)	Grain yield (ton/ha)	Biologic yield (ton/ha)
H_1	192.27a	17.10a	44.71a	282.98a	14.71a	51.99a
H_0	143.22b	16.01b	36.73b	240.90b	10.52b	38.64b
R_0	160.58b	15.53b	39.66a	251.40b	12.36a	43.86a
R_{15}	173.95a	16.37a	40.66a	268.85a	12.70a	45.61a
R_{30}	170.20a	16.26a	40.33a	265.57a	12.78a	46.46a
H_1R_0	194.16a	17.01a	44.20a	281.56a	14.33a	51.50a
H_1R_{15}	191.33a	17.24a	44.66a	285.78a	14.83a	51.50a
H_1R_{30}	194.33a	17.07a	43.26a	281.60a	14.96a	52.96a
H_0R_0	127.00d	14.05c	35.13c	221.25c	10.40b	36.23c
H_0R_{15}	156.38b	15.51b	37.66b	251.91b	10.56b	39.73b
H_0R_{30}	144.08c	15.46b	37.40b	249.55b	10.60b	39.96b

R_0, 0; R_{15},15; R_{30}, 30 kg residues/plot. H_0, without; H_1, with hand weeding.
Means in a column followed by the same letter are not significantly different at P≤0.01.

Table 3. Analysis of the variances for weeds density and biomass

SOV	df	Mean Squares (MS)			
		Total biomass	*S. halepense*	*A. retroflexus*	*Rumex* spp
Replication	2	ns	ns	ns	ns
Residue (B)	2	*	ns	**	**
CV (%)	-	13.48	17.93	7.61	9.70

ns, nonsignificant; **, significant at P≤0.01; *, significant at P≤0.05.

halepense L.), Redroot pigweed (*Amaranthus retroflexus* L.) and Sorrel (*Rumex* spp). Finally, data were analyzed using MSTAT-C and SPSS, and means were compared according to Duncan's multiple range test.

Results and discussion

Corn yield and yield components

Analysis of the variances indicated that hand weeding significantly affected all the measured traits (P≤0.01; Table 1). Hand weeding increased corn height by 34.25%, 1000 kernels weight by 17.47% and grain yield by 39.83% and biologic yield by 34.55%, compared with the control (Table 2). Hand weeding made the field free of weeds and removed the competition effect. This helped plants to grow well during the vegetative growth phase. Moreover, absence of weeds allowed plants to take advantages of light, water and nutrients; resulting in an improved photosynthesis; the improved photosynthesis is responsible for increased corn yield and yield components.

Rapeseed residue had also a significant effect on plant height, ear diameter and 1000 kernels weight (Table 1). The effect of 15 and 30 kg residues/plot were the same on most of the measured traits (Table 2). Allelopathic residues have improved corn growth and yield through suppressing weeds; lower weed competition means higher crops growth and yield. Mafakheri *et al*. (2010) conducted an experiment to evaluate the effect of winter rye cover crop and mulch residues on the following corn cultivation and weeds infestation. They concluded that rye cover crop residues increased corn grain yield by 7.89% and plant height by 10.24%. Vasilakoglou *et al*. (2006) also studied the effect of different cover crop residues on weeds and reported that at the third week after cotton cultivation, mulched treatments reduced germination of *Setaria verticillata* by 33-57% and *Digitaria sanguinalis* by 35-83%, compared with the unmulched controls.

Weeds biomass and density

Results showed that rapeseed residues significantly affected the total weeds biomass and the density of *Amaranthus retroflexus* and *Rumex* spp (Table 3). Mean comparison indicated that 30 kg residues/ha reduced the total weeds biomass from 7.33 to 4.03 kg/plot. The difference of 15 and 30 kg residues/ha was no significant on the total weeds biomass, but was significant on the density of *A. retroflexus* and *Rumex* spp., (Table 4). These results indicate that higher residues rate is more effective on weeds control. The effect of residue rate on weed control is reported by other author. Teasdale & Mohler (2000) reported that weed emergence declined when mulch rate increased. They also found that *A. retroflexus* emergence was even stimulated when mulch mass was lower than 2000 kg/ha. Treadwell *et al*. (2007) represented that weed density reduction is significantly correlated to cover crop residue dry weight.

Table 4. Effect of residues on weeds density and biomass

Treatments	Biomass (kg/plot)	Density		
	Whole weed species	*S. halepense*	*A. retroflexus*	*Rumex* spp
R_0	7.33a	5.00a	10.07a	4.83a
R_{15}	4.80b	5.33a	2.67b	3.70b
R_{30}	4.03b	4.57a	1.00c	1.57c

R_0, 0; R_{15}, 15; R_{30}, 30 kg residues/plot.
Means in a column followed by the same letter are not significantly different at P≤0.01.

Mafakheri *et al*. (2010) also reported that 3100-3350 kg rye residues/ha stimulated *A. retroflexus* biomass and increased it by 4.97%, but 9700-10150 kg residues/ha controlled and reduced the weed biomass by 19.30%, compared with the control.

Mulches and residues control weeds through different mechanisms. The first mechanism is that mulches cover the soil surface and prevent light to reach the soil surface; lowering soil temperature. Presence of red light and warm environment is vital for weeds seeds germination, so mulches reduce weeds germination. Another mechanism is the exudation of allelopathic compounds (allelochemicals). Allelochemicals are plant defense system against other plants; they can be used as natural herbicides (Weston, 1996; Putnam, 1988; Xuan *et al*., 2005). Randhawa *et al*. (2002) studied the effect of sorghum water extract on germination and growth of a weed species (*Trianthema portulacastrum*) and observed that the 100% concentration of the extract reduced the weed germination by 15-20%. Finally, mulches and residues control weeds by affecting soil conditions and improvement of soil biological activity which results in the reduction of soil seed bank; the process is called seed predation. Shearin *et al*. (2008) reported that presence of cover crops and residues on soil surface promoted the activity of *Harpalus rufipes* beetles. This seed predator feeds on weed seeds in soil and results in the depletion of soil seed bank and lower seeds germination.

Conclusion

Results of this experiment indicated that rapeseed residues significantly affected weeds germination and growth; reducing the total weeds biomass to 4.03 kg/plot from 7.33 kg/plot. Moreover, residues significantly increased corn height by 6%, grain yield by 3.4% and biomass by 5.92% compared with the no residue control.

References

1. Anonymous (2010) International survey of herbicide resistant weeds, from http://www.weedscience.org. Accessed: Apr. 18, 2010.
2. Bones AM and Rossiter JT (1996) The Myrosinase-Glucosinolate system - an innate defense system in plants. *Physiol Plantarum*. 97(1), 194-208.
3. Einhellig FA and Souza IF (1992) Phytotoxicity of sorgoleone found in grain Sorghum root exudates. *J. Chem. Ecol.* 18(1), 1-11.
4. Fenwick GR, Heaney RK and Mullin WJ (1983) Glucosinolates and their breakdown products in food and food plants. *Crit. Rev.Food Sci. & Nutr.*18 (2), 123-201.
5. Hartwig NL and Ammon HU (2002) Cover crops and living mulches. *Weed Sci*. 50, 688-699.
6. Kohli RK, Singh HP and Batish DR (2001) *Allelopathy in Agroecosystems*. Food Products Press, USA.
7. Mafakheri S, Ardakani MR, Meighani F, Mirhadi MJ and Vazan S (2010) Rye cover crop management affects weeds and yield of corn (*Zea mays* L.). *Not. Bot. Hort. Agrobot. Cluj*. 38(3), 117-123.
8. Malik MS, Norsworthy JK, Culpepper AS, Riley MB and Bridges Jr W (2008) Use of wild radish (*Raphanus raphanistrum*) and rye cover crops for weed suppression in sweet corn. *Weed Sci.* 56, 588-595.
9. Monaco TJ, Weller SC and FM Ashton (2002) *Weed Science*, 4th ed: Principles and Practices. John Wiley & Sons, USA.
10. Moyer JR and Huang HC (1997) Effect of aqueous extracts of crop residues on germination and seedling growth of ten weed species. *Bot. Bull. Academia Sinica*. 38, 131-139.
11. Putnam AR (1988) Allelochemicals from plants as herbicides. *Weed Technol.* 2(4), 510-518.
12. Putnam AR and DeFrank J (1983) Use of phytotoxic plant residues for selective weed control. *Crop Protection*. 2, 173-181.
13. Randhawa MA, Cheema ZA and Ali MA (2002) Allelopathic effect of sorghum water extract on the germination and seedling growth of *Trianthema portulacastrum*. *Int. J. Agri & Biol*. 4(3), 383-384.
14. Shanahan M, Jordan C, Trent S and Williams J (2003) What's your poison? From Environmental justice Foundation: http://www.ejfoundation.org. Accessed: Jan. 7, 2008.
15. Shearin AF, Reberg-Horton SC and Gallandt ER (2008) Cover crop effects on the activity-density of the weed seed predator *Harpalus rufipes* (Coleoptera: Carabidae). *Weed Sci*. 56, 442-450.
16. Teasdale JR and Mohler CL (2000) The quantitative relationship between weed emergence and the physical properties of mulches. *Weed Sci*. 48, 385-392.
17. Teasdale JR, Brandsaeter LO, Calegari A and Skora Neto F (2007) Cover crops and weed management. In: *Non-Chemical Weed Management: Principles, Concepts and Technology* (eds. Upadhyaya MK & Blackshaw RE), pp. 49-64. CABI Publ., UK.
18. Treadwell DD, Creamer NG, Schultheis JR and Hoyt GD (2007) Cover crop management affects weeds and yield in organically managed sweetpotato systems. *Weed Technol*. 21, 1039-1048.
19. Vasilakoglou I, Dhima K, Eleftherohorinos I and Lithourgidis A (2006) Winter cereal cover crop mulches and inter-row cultivation effects on cotton development and grass weed suppression. *Agronomy J.* 98, 1290-1297.
20. Weston LA (1996) Utilization of allelopathy for weed management in agroecosystems. *Agronomy J.* 88, 860-866.
21. Xuan TD, Shinkichi T, Khanh TD and Chung IM (2005) Biological control of weeds and plant pathogens in paddy rice by exploiting plant allelopathy. *Crop Protect*. 24(3), 197-206.