International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2014/7-14/1452-1456
ISSN 2227-670X ©2014 IJACS Journal

Effect of mung bean living mulch, plastic mulch and herbicides on for age maize yield and weed control

Hamid Khodam Kahangi, Hamid Reza Rajablarijani*, Mohamad Nasri

Department of Agronomy, College of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

Corresponding author email: larijani2004@gmail.com

ABSTRACT: Plastic mulches have been used commercially for the production of vegetables since the early 1960's, and their usage is still increasing throughout the world. However, plastic mulches should be removed from the field and disposed. Living mulches can be excellent alternatives to plastic mulches. Living mulch provides food and habitat for beneficial insects, retains moisture, regulates soil temperature, weed suppression improves soil structure and adds nutrients such as nitrogen. The experiment was conducted in Varamin Branch, Islamic Azad University in 2012. nine treatments were investigated: black plastic mulch (T1), silver on black plastic mulch (T2), mung bean living mulch (Vigna radiata) in 100000 and 200000 plants ha^{-1} (T3 and T4, respectively), nicosulfuronherbicide(2 lit. ha^{-1}, T5),nicosulfuron+rimsulfuron herbicide (175 g ha^{-1}, T6), Integrated Control (silver on black plastic mulch + nicosulfuronherbicide with 1 lit. ha^{-1}, T7), control by hand weeding (T8) and weedy check (T9). The effect ofexperimental treatmentsonplant height, earsize, ear andforageyieldandweedbiomasswas significant ($p < 0.01$). Thelowestweed biomasswas recordedin plasticmulch treatments although, living mulch also controlled weedby 54to 66%. Highestforageyield(116 tha^{-1}) was recorded inintegrated controltreatment andfollowedbyplasticmulchtreatments. In contrast, livingmulchwas harvested with cornat the endof the season.While, yieldinlivingmulchwasonly 8% less than Integrated controltreatment. Although primary concern of living mulch systems is the extent of competition between the major crop and the mulch, that can be reducedbychoosethe appropriatedensity of living mulch. In addition to, thesafety productscan beproducedwithout theuse ofherbicidesand away from theproblemsof plasticmulch.

Keywords: living mulch, competition, ear yield, integrated control

INTRODUCTION

Weeds are biggest problems of sustainable agricultural systems. While in many parts of the world, their control is intensively dependent on herbicides (Mohammadi, 2012), because of environmental necessities, weeds becoming resistant to herbicides and food health, it is important to find suitable non-chemical solutions. In the other hand mulching using PE plastics has a lot of advantages such as weeds effective controlling, but the problem with this kind of mulching is its collection and recycling and in the case of not being collected, it will pollute and destroy farms. Planting crops as mulches between main crop is called living mulch. Living mulch decreases erosion (Malik et al., 2000), decreases soil temperature, prevents evaporation of soil moisture, increases soil organic carbon and microbial activity and optimizes soil structure (Steenwerth and Belina 2008). They are also suitable choices to non-chemically control weeds via competition and allelopathy (Brady and Weil, 2002). Living mulches from leguminous such as mungbean increase soil fertility (Brown et al., 1993). The different plants such as millet (Pennisetum glaucum), rye (Secale cereale), clover (Trifolium Sp), mung bean (Vignaradiate), bean (Phaseolusvulgaris L.) and soybean (Glycinemax L.) are studied and planted in farms as living mulch (Masiunas et al., 1997; Weston, 1996). The study of Hall et al. (1984) showed that using living mulch between corn rows suppressed weed and decreased grain yield by 6%. In another study, the use of velvet bean (as living cover crop) reduced weed biomass by 68%(Caamal-Maldonado et al., 2001)**.** The lowest weeds biomass and the highest maize grain yield were obtained from 30 and 22 plants m^{-2} of cowpea living mulch density, respectively (Moradi Talebbeigi and Ghadiri, 2012). According to Jedrszczyk et al. (2005) in cultivation of cabbage with white clover, weed fresh weight and their number reduced by 96% and 89%, respectively. Barberi et al. (2008) found the proportional decrease in total biomass of weeds in spinach cultivation in relation to the amount of biomass of living mulch from sub clover (Trifolium subterraneum). Beneficial effect of living mulches, consisting in weeds suppression, was also observed by Walters and Young (2008) in zucchini intercropping with winter species. The most important attributes required for species used as living mulches are quick emergence and soil covering, short height, low water and nutrients demands (Kołota and Adamczewska-Sowińska, 2013).

Therefore, the objective of the present study was to find a non-chemical weed control strategyby comparison of mulches, herbicides and hand weeding on forage corn.

MATERIALS AND METHODS

Field experiment was conducted in a randomized complete block design with four replicates in 2012 at the research farm of the Faculty of Agriculture on the Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran (lat. 35˚17´ N, long. 51˚40´ E).nine treatments were investigated: black plastic mulch (T1), silver on black plastic mulch (T2), mung bean living mulch (*Vigna radiata*) in 100000 and 200000 plants ha^{-1} (T3 and T4, respectively), nicosulfuronherbicide (2 lit. ha^{-1}, T5), nicosulfuron+rimsulfuron herbicide (175 g ha^{-1}, T6), Integrated control (silver on black plastic mulch + nicosulfuron with 1 lit. ha^{-1}, T7), control by hand weeding (T8) and weedy check (T9). The plastic mulch was 120 cm wide and 30 μ thick. Plot size was 6 m × 6 m. Each plot consisted of four beds 75 cm apart with two rows of corn (*Zea mays* L. var. indentata) cultivar S.C 704 was planted in each bed in mid-July.Two rows of mung bean (cultivare parto) were planted as living mulch. The hand weeding in control treatment was done twice (30 and 45 days after crop emergence). We also watered the plants throughout surface drip irrigation system. Diameter of tape was 16 mm, emitter spacing 20 cm, and flow rate 2 lit. h^{-1}. The irrigation frequency varied 3 to 5 day according to plant growth stage, temperature, and the presence or absence of mulch. At silk emergence stage, stem height and diameter were measured and at kernel milk stage, ear and forage yield, yield components and mung bean dry weight were measured. At harvest, natural weed population and biomass were also assessed by throwing two 50 × 50-cm quadrates two times over the unmulched plots. However, in plastic mulch treatments, weed was assessed from a 3-m length of a row.

Table 1.Analysis ofvariance foreffect oftreatmentson some morphological traits, yields and weedbiomass in 2013, Varamin, Iran.

S.O.V	MS df	Plant height	Stem diameter	Length of Ear	Ear diameter	Ear yield	Total fresh yield	Weed biomass
Replicate	3	28.842	0.405	0.588	2.611	272379	66268989	0.057
Treatment	8	887.078**	13.635**	2.676**	18.4**	1453594**	91610866**	1.543**
Error	24	12.594	0.511	0.484	3.564	4956301	6225052	0.026
C.V (%)	-	3.71	3.68	3.25	4.28	6.34	2.45	10.5

**, indicates significance at 0.01.

Ear size

Table 2.Effect of differenttreatmentson some morphological traits and yieldsin 2013, Varamin, Iran.

Treatment	Plant height (cm)	Stem diameter (mm)	Length of Ear(cm)	Ear diameter(mm)	Ear yield (t ha^{-1})	Total fresh yield(t ha^{-1})
T1	227 cd	19.7 bc	22.6 a	47.2 a	39.5 a	111.9 b
T2	247 a	21.9 a	22.1 ab	45 abc	41.3 a	110 bc
T3	233bcd	18.2 d	21 bcd	44 bc	34 b	106.8 cd
T4	191 e	16.2 e	20.6 cd	40.3 d	32.3 bc	105.9 d
T5	224 d	18.4 d	21.6 bc	43.9 bc	39.4 a	109.8 bc
T6	221 d	19 bc	21 bcd	42.4 cd	32.8 bc	97.7 e
T7	238 ab	22.1 a	22.9 a	46.1 a	42.6 a	116.2 a
T8	235 bc	20 b	20.2 d	42.1 cd	29.7 c	90.2f
T9	200 e	18.9 cd	21.5 bc	45.2 abc	24.4 d	67.2 g

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. T1,black plastic mulch; T2, silver on black plastic mulch; T3 and T4, mung bean living mulch in 100000 and 200000 plants ha^{-1} respectively; T5, nicosulfuronherbicide(2 lit. ha^{-1}); T6, nicosulfuron+rimsulfuron herbicide (175 g ha^{-1}); T7, Integrated Control (silver on black plastic mulch + nicosulfuron herbicide with 1 lit. ha^{-1}); T8,control by hand weeding and T9,weedy check .

Effect of different treatments on length and diameter of ear was significant at 1% level (Table 1). Corn plants were planted in integrated control plots produced biggest corns compared to other treatments (22.9 cm height and 46.1 mm diameter). However the use of plastic mulch (T1 and T2) and nicosulfuronherbicide (T5) had also same results and the difference between those were not statistically significant (Table 2). Taber and Heard (2008) reported that ear height and diameter of sweet corn increased in some colored plastic mulch. The comparison of living mulch treatments indicated ear size reductioninlow-density (100 plant m^{-2})wasmuch lowerthan high density(200 plant m^{-2}). It seems the competitionbetweencorn andlivingmulch wasmoresevere in high density than the low-density and ledtoa substantial reductionin earsize. According to Kolota and Adamczewska-Sowinska (2013) Managing competition between living mulch and the cash crop is a major concern for the farmers. So,reducing interferencebetweenlivingmulch andcropis important objective that will be possible via changing density of living mulch or removing mulch in a special level of growth.

RESULTS AND DISCUSSION

Plant height and stem diameter

Effect of different treatments on plant height and stem diameter was significant on 1% level (Table 1). The silver on black plastic mulch (T2) with 247cm and (T7) integrated control and with 22.9 mm had the highest height and diameter, respectively, although there was no statistically significant difference between these treatments (Table 2). In fact the treatments with highest effect on weeds control had the highest height and diameter. According to Khurshid et al. (2006), the use of plastic mulch significantly increased the height of corn plant compared to bare soil. The lowest height and diameter of corn was recorded in living mulch treatment (T4) which could be the result of competition between corn, mung bean and weeds. According to the results of Jedrszczyk and Poniedzialek (2007) living mulch treatments reduced the height of sweet corn by 31cm. The reduction of stem diameter can be the result of competition between crop and weed on environmental parameters such as light, water and space which reduces photosynthesis and production (Moosavi et al., 2012).

Ear and forage yield

The measurement of ear yield could be good criteria to identify the quality of fodder. According to results of table 1, ear yield was significantly influenced by different treatments. The highest ear yield was related to integrated control treatment. However there was no statistically significant difference between this treatment and plastic mulch treatment, control treatment and nicosulfuronherbicide (Table 2). Although ear yield in living mulch treatments was significantly lower than plastic mulch treatment but it was 32 to 40 percent higher than weedy treatment. This can be due to the effect of living mulch on weeds.

Analysis of variance also showed that effect of experimental treatments was significant on forage yield at 1% level (Table 1). The highest forage yield was obtained from integrated control treatment and followed by black plastic, silver/ black, nicosulfuronherbicide, living mulch with density of 100 m^{-2} and living mulch (116.2, 111.9, 110, 109.8, 106.8 and 105.9 t ha^{-1}, respectively) (Table 2). In the other hand, the results of means comparison suggested that fresh forage yield decreased by 42% in weedy treatment compared to integrated control. It is obvious that the existence of weeds resulted in intense competition for light, nutrition and thereby reduction ofyield. But the forage yield in living mulch markedly only was 8% lower than in integrated control treatment. In fact, adding weight of mung bean to total yield compensated corn yield loss due to weed. In a research, a subterranean clover (Trifolium subterraneum L.) living mulch reduced weed biomass and increased soybean yield by 91 % relative to weedy control plots (Ilnicki and Enache 1992). Increased forage yield is often a result of applying nitrogen fertilizer to grasses or of growing grasses in mixture with legumes without addition of fertilizer N (Albrecht, 2002).

Weed biomass

The dominant weed species in the field included redroot pigweed (Amaranthus retroflexus L.), jungle rice (Echinochloa colona L.), common purslane (Portulaca oleracea L.), green foxtail (Setaria viridis L.), and Johnson grass (Sorghumhalepense L.), all of which have a C4 photosynthetic pathway and high competition ability against summer crops. The total dry weights of weeds were significantly influenced by experimental treatments ($P < 0.01$) (Table 1). At silking, lowest weed biomass was recorded in integrated control treatment although there was no statistically significant difference between this treatment and T1, T2 T3 and T4 (Figure 1). Based on the weed control efficiency, after integrated control treatment (98%), the most successful were silver/ black plastic mulch (97.5%), black plastic mulch (96%), nicosulfuron (96%) and nicosulfuron+rimsulfuron (95%), respectively. The findings of Rajablarijani et al. (2014) showed that black plastic mulch controlled weeds in sweet corn by 94.7%. Mung bean living mulch treatments (T3 and T4) decreased the weed dry weight by 54%and 66% compared to weedy plots. According to the results of Moradi Talebbeigi and Ghadiri (2012), planting cowpea between corn rows significantly reduced weed.

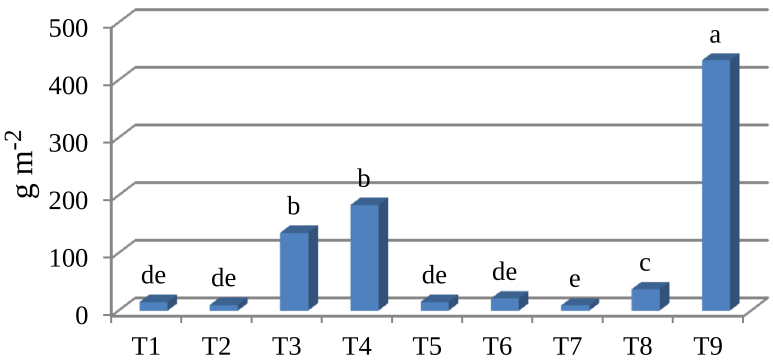

Figure1.Effect of differenttreatmentson weed biomass in 2013, Varamin, Iran.

* Figure bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. T1,blackplastic mulch; T2, silver on black plastic mulch; T3 and T4, mung bean living mulch in 100000 and 200000 plants ha^{-1} respectively; T5, nicosulfuron herbicide(2 lit. ha^{-1}); T6, nicosulfuron+rimsulfuron herbicide (175 g ha^{-1}); T7, Integrated Control (silver on black plastic mulch + nicosulfuron herbicide with 1 lit. ha^{-1}); T8,control by hand weeding and T9,weedy check.

CONCLUSION

Using herbicidehas beenalwaysincreasingindeveloping countriesto producemore food. In other words,herbicides are considered as the most important method to weed control. According to the fact that the highest yield and weed control was achieved with integrated plastic mulch treatment and nicosulfuronherbicide with lowered dose, this treatment was important due to the decrease in herbicide usage, saving in the costs of weed control and helping the creation of sustainable agriculture. In the other hand, mung bean living mulch treatment decreased the weeds biomass by 66% and forage yield in this treatment was only 8% lower than integrated control treatment. Of course, it seems that the yield decrease due to the competition between weeds and mulch compensated via extra production of living mulch. In this regard, although the purpose of using living mulch is not production, it can be harvested as Fodder simultaneously with or after the main plant harvest. In addition to, no herbicide is used in this system. Therefore we cangetcloserto thetargets ofsustainable agriculturethrough mechanizing the operations of planting to harvest and choose of appropriate plant and density for living mulch.

REFRENCES

Albrecht KA. 2002. Experiences with kura clover in agricultural systems in Wisconsin. p. 83- 88. *In* Proc. Great Lakes International Grazing Conference. 11-12 Feb. Battle Creek, MI.

Barberi P, Bigongiali F, Antichi D, Carlesi S, Fontanelli M, Fiasconi C, Lulli L. 2008. Cultivating the future based on science. Vol. 1: Organic crop production. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR). Modena, Italy, 18–20 June, 252–255

Brady NC, Weil RR. 2002. The nature and properties of soils. Upper Saddle River, N.J., Prentice Hall, 13th edition. 960 pp.

Brown RW, Varvel GE, Shapiro CA. 1993. Residual effects of interseeded hairy vetch on soil nitrate–nitrogen levels. Soil Sci. Soc. Am. J. 57:121–124

Caamal-Maldonado JA, Jimenez-Osornio JJ, Torres-Barragan A, Anaya AL. 2001. The use of allelopathic legume cover and mulch species for weed control in cropping systems. J. Agron. 93:27-36

Hall J, Hartwing L, Hoffman L. 1984. Cyanazine losses in runoff from no-tillage corn in living mulch and dead mulches vs. unmulched conventional tillage. J. Environ. Qual. 13:105-110

Ilnicki RD, Enache AJ. 1992. Subterranean clover living mulch, an alternative method of weed control. Agric. Ecosys. Environ. 40:249–264

Jedrszczyk E, Poniedzialek M, Sekara A. 2005. Effect of living mulches on white head cabbage (*Brassica oleracea* var. *capitata subvar. alba* L.) yielding. Flora Horticulturae. 17(2):29-36

Jedrszczyk E, Poniedzialek M. 2007. The impact of the living mulch on plant growth and selected features of sweet corn yield. Folia Horticulturae. 19(1):3-13

Khurshid K, Iqbal M, Arif MS, Nawaz A. 2006. Effect of tillage and mulch on soil physical properties and growth of maize. Int. J. Agri. Biol. 8(5):593–596

Kołota E, Adamczewska-Sowinska K. 2013. Living mulches in vegetable crops production: perspectives and limitations (a review). Acta Sci. Pol. 12(6):127-142.

Malik RK, Green TH, Brown GF, Mays D. 2000. Use of cover crops in short rotation hardwood plantations to control erosion. Biomass and Bioenergy 18:479-487

Masiunas JB, Eastburn DM, Waja VN, Eastman CE. 1997. The impact of living and cover crop mulch systems on pests and yields of snap beans and cabbage. J. Sustain. Agric. 9(2/3):61-89

Mohammadi GR. 2012. Living mulch as a tool to control weeds in agroecosystems: A Review. In: Price, A. J. (Ed.), Weed Control. InTech Press, Croatia. pp. 75-100

Moosavi SG, Seghatoleslami MJ, Moazeni A. 2012. Effect of planting date and plant density on morphological traits, LAI and forage corn (Sc. 370) yield in second cultivation. Int. Res. J. App. Basic Sci. 3(1):57-63

Moradi Talebbeigi R, Ghadiri H. 2012. Effects of cowpea living mulch on weed control and maize yield. J. Biol. Environ. Sci. 6(17):189-193

Rajablarijani HR, Mirshekari B, AghaAlikhani M, Rashidi V, Farahvash F. 2014. Sweet corn weed control and yields in response to sowing date and cropping systems. Hortscience. 49(3):289–293

Steenwerth K, Belina KM. 2008. Cover crops enhance soil organic matter, carbon dynamics and microbiological function in a vineyard agro ecosystem. Appl. Soil Ecol., 40:359-369

Taber HG, Heard M. 2008. Sweet corn plastic mulch comparison. Iowa State University, Horticulture Research Station. http://www.ag.iastate.edu/farms/ 08reports/Horticulture/SweetCorn Plastic.pdf.

Walters SA, Young BG. 2008. Utility of winter rye living mulch for weed management in zucchini squash production. Weed Technol. 22(4):724–728

Weston LA. 1996. Utilization of allelopathy for weed management in agroecosystems. Agron. J. 88:860-866