Uluslararası Tarım Araştırmalarında Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Agricultural Research 2019, Vol. 3 (4), 680-689
https://doi.org/10.29329/ijiaar.2019.217.14

Original article

Effectiveness of *Arachis pintoi* Karp. & Greg. as Biomulch to Control Weeds on Maize Cultivation

Ade Sumiahadi [a, *], M.A. Chozin [b] & Dwi Guntoro [b]

[a] Department of Agrotechnology, Faculty of Agriculture, Muhammadiyah University of Jakarta, Indonesia
[b] Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Indonesia

Abstract

Weeds constitute one of the limiting factors in crop production that has significant effects, both economically and ecologically. The continuous use of herbicides increased the resistance of weeds to herbicides and causes chemical and biological soil degradation. The use of cover crops can be an alternative environmentally friendly weed management. The objective of this research was to study the effectiveness of *Arachis pintoi* as biomulch in suppressing the growth and development of weeds. This experiment used nested-randomized block design with the first factor was the slope of the land with 2 levels (flat and sloping lands) and the second factor was the types of mulch with 5 levels (without mulch without weeding, without mulch with weeding, plastic mulch, straw mulch, and *A. pintoi* biomulch). The types of mulch factor nested on the slope of the land factor. The results showed that the use of *A. pintoi* biomulch suppressed the growth of weed more than 58% compared to the without mulch without weeding treatment. The study also showed that *A. pintoi* was effective in suppressing broadleaf and sedge weeds but not effective to suppress grass weeds. The use of *A. pintoi* biomulch by allowing the coverage of the entire soil surface suppressed the growth and yield of maize compared to the without mulch with weeding and straw mulch treatments.

Keywords: Cover crops, Mulch, Ornamental peanut, Summed dominance ratio, Weed management.

Received: 27 October 2018 * **Accepted:** 08 September 2019 * **DOI:** https://doi.org/10.29329/ijiaar.2019.217.14

[*] **Corresponding author:**

Ade Sumiahadi, a lecturer in Dept. of Agrotechnology, Faculty of Agriculture, Muhammadiyah University of Jakarta, Indonesia and now doing PhD programme in Dept. of Field Crops, Selcuk University, Konya, Turkey. Works on Plant Production and Sustainable Agriculture.
Email: ade.sumiahadi@gmail.com

INTRODUCTION

The existence of weeds on agricultural land causes some losses, especially for crops and farmers, such as leading to competition with agricultural crops that can decrease the quality and quantity of production and increase the cost of weed control and pests and diseases control because some weeds also host several pests and plant diseases (Zhimdahl, 2007). In maize production, weeds exert significant effects, both economically and ecologically, with competition reducing grain yields up to 70% (Teasdale, 1995).

The use of agrochemicals including herbicides for weed management became one of the most important practices of modern agriculture which has positively influenced agricultural production (Ruegg et al., 2007; Yavuz et al., 2017). On the other hand, intensified agricultural production with agrochemical uses increased pollution in the water and soil, and may have harmful effects on the environment (Rice et al., 2001). Continuous use of herbicides increased the resistance of weeds to herbicides (Purba et al., 2011) and the herbicide residues in the soil also caused chemical and biological soil degradation (Devi et al., 2013). As a result, the use of herbicides no longer has a significant effect on weed control.

In sustainable agriculture practices, like organic farming systems, the use of herbicides for weed control cannot be accepted (Atalay et al., 2016), with mechanical weed control becoming the most used alternative practice. However, this practice leaves the soil in bare condition and increases the risk of erosion, run-off, and leaching of fertilizers and pesticides into surface and groundwater (Hiltbrunner et al., 2007). Therefore, the use of cover crops can be an alternative environmentally friendly weed management.

Soil cover crops can suppress weeds with several mechanisms, either by reducing the availability of resources (Ngouajio and Mennan, 2005) or by inhibiting weed growth through allelopathy (Reberg-Horton et al., 2005). Access to light, nutrients, water, and soil influenced by cover crops may affect the presence of weeds (Ngouajio and Mennan, 2005) and composition of the weeds (Fitriana et al., 2013). Cover crops can also increase the levels of C and N, the two main components that regulate soil biological activities (Wagger, 1989), thereby increasing the presence of beneficial organisms that can suppress biological competitors such as weeds (Kremer and Li, 2003), parasitic nematodes and soil pathogens through allelochemicals (Bailey and Lazarovits, 2003). The residue of cover crops can also increase the diversity of microfauna, thus increasing the loss of weed seeds by predatory microfauna (Pullaro et al., 2006) and can affect the dynamics of weed population (den Hollande et al., 2007).

The success of weed suppression by using cover crops has been reported for annual crops such as maize using *Calopogonium caeruleum* Hemsl. (Tampubolon, 2004), wheat using *Trifolium repens* L., *Trifolium subterraneum* L. and *Lotus corniculatus* L. (Hiltbrunner *et al.*, 2007) and tomato plant using

Vicia villosa Roth., *Trifolium terraneum* L. and *Avena sativa* L. (Campaglia et al., 2010). In perennial plants, the use of cover crops can suppress weeds in citrus crops (Linares et al., 2008). The use of *Mucuna bracteata* is also significantly effective in suppressing weeds in oil palm (Harahap et al., 2011) and rubber plantations (Nusyirwan, 2012).

Arachis pintoi is a species of the Leguminosae family which has suitable properties for use as a soil cover crops (Sumiahadi et al., 2016). Maswar (2004) stated that the use of *A. pintoi* in coffee plantations in Sumberjaya, West Lampung, is as effective as *Desmodium ovalifolium* in suppressing weeds, and more effective than herbicide. Perez-Nieto et al. (2005) reported that the use of *A. pintoi* can suppress the growth of weeds in coffee plantations. The objective of this research was to study the effectiveness of *A. pintoi* as biomulch (cover crop) in suppressing the growth and development of weeds and its effects on the growth and production of maize crops.

Material and Methods

The study was conducted at Experimental Field of Bogor Agricultural University, Indonesia from August 2013 until March 2014. The experiment used nested-block randomized design. The first factor was the slope of the land consisted of sloping and flat land, while the second factor was the type of mulch that was nested in slop of the land factor, consisted of 5 levels i.e. without mulch and without weeding, without mulch with weeding, plastic mulch, straw mulch and *A. pintoi* biomulch, so there are 10 combinations of treatments with 3 replications.

A. pintoi cuttings used are taken from the Experimental Field of Bogor Agricultural University. The cuttings with 4 segments are planted directly on the experimental field of *A. pintoi* biomulch treatments with the spacing of 15 cm x 15 cm. The maize planting was done when *A. pintoi* plants reached 70% of land cover. Straw and plastic mulches were installed a week before maize planting. Weed observation was done 3 times, before land preparation, at the age of maize crops 6 and 10 weeks after planting (WAP) using a 50 cm x 50 cm quadrant.

Result and Discussion

Weed growth

The observation of the effectiveness of *A. pintoi* biomulch in suppressing weed growth was done on variables of dry weight and summed dominance ratio (SDR) of weeds. The result of variance analysis showed that the slope of the land had the significant effect on dry weight of weeds at 6 WAP, but did not affect at 10 WAP, whereas the type of mulch treatments had a significant effect on the dry weight of weed at 6 and 10 WAP. There was no interaction between the slope of the land and the type of mulch on the dry weight of weeds at both 6 and 10 WAP (Table 1).

Table 1. Average of the dry weight of weeds on the slope of the land and type of mulch treatments (Chozin et al., 2018)

Treatments		**Dry weight of weeds (g/0.25 m^2)**	
		6 WAP	**10 WAP**
Slope of the land	Flat land	16.03a	9.36
	Sloping land	10.38b	9.12
Type of mulch	Without mulch and without weeding	34.33a	57.15a
	Without mulch with weeding	2.81c	9.68c
	Plastic mulch	2.91c	10.78c
	Straw mulch	11.75b	32.00b
	A. pintoi biomulch	14.22b	27.09b

The number folowed by the same letter in the same column shows no significance in the DMRT (Duncan Multiple Range Test) at the 5% significance level.

Table 1 shows that *A. pintoi* biomulch was effective in suppressing weed growth. The weight of weeds of *A. pintoi* biomulch treatment at 6 and 10 WAP (27.09 g and 14.22 g respectively) was significantly lower than without mulch without weeding treatment at 6 and 10 WAP (34.33 g and 57.15 g respectively). These results indicate that *A. pintoi* can suppress weed growth of 58.58% at 6 WAP and 52.60% at 10 WAP. Previous studies have reported that the use of *A. pintoi* was effective in suppressing the growth of weeds in coffee (Perez-Nieto et al., 2005; Santos et al., 2013), potato (Samad et al., 2009), and tomato cultivations (Chozin et al., 2014)

Compared with weed species composition before treatment, there is an indication that the type of mulch treatments caused the shifting of weed species. The composition of weed species differed among the type of mulch treatments on both flat and sloping land. The result of vegetation analysis in Table 2 shows that the flat land before treatments was dominated by broadleaf weed Borreria alata with SDR of 24.40%. During the study, vegetation analysis was performed at 6 and 10 WAP that indicated the type of mulch treatments affected the composition of weed species and their dominance. In A. pintoi biomulch treatment, weed dominance shifted from Borreria alata (before treatment) to Digitaria adscendens which is a group of grass weeds with SDR of 35.29 and 28.74% at 6 and 10 WAP respectively.

Table 2. Weed species and their dominance on type of mulch treatments in flat land.

Mulch treatments	**Time (WAP)**	**Summed Dominance Ratio (%)**						
		Borreria alata	*Axonopus compressus*	*Pennisetum polystachion*	*Digitaria adscendens*	*Mimosa pudica*	*Cyperus rotundus*	*Cleome rutidosperma*
Before treatment	0	24.40	13.86	10.65	10.49	6.96	6.56	0.00
Without mulch without weeding	6	16.15	11.42	0.00	43.54	2.86	16.64	1.52
	10	14.41	6.77	5.27	45.79	3.59	6.78	0.00
Without mulch with weeding	6	36.77	0.00	0.00	22.92	3.22	37.09	0.00
	10	27.81	11.64	9.36	10.51	14.59	17.42	0.00
Plastic mulch	6	22.83	5.40	0.00	33.37	0.00	31.48	0.00
	10	28.21	18.57	0.00	33.32	0.00	6.80	0.00
Straw mulch	6	23.00	7.57	0.00	14.78	1.86	40.20	2.43
	10	20.07	6.24	1.74	13.50	3.73	23.84	9.69
Arachis pintoi biomulch	6	23.15	6.32	0.00	35.29	5.93	9.31	4.54
	10	19.19	9.69	6.03	28.74	6.50	2.97	3.13

The shifting of weed species also occurred on sloping land. Table 3 shows that before treatment, the land was dominated by a grass weed species *Pennisetum polystachion* with SDR value of 26.30%. Then the results of vegetation analysis at 6 and 10 WAP showed that in the treatment of *A. pintoi* biomulch, the dominant weed was *Borreria alata* (25.70%) at 6 WAP then shifted again to *Axonopus compressus* (22.80%) at 10 WAP.

Table 3. Weed species and their dominance on type of mulch treatments in sloping land.

Mulch treatments	**Time (WAP)**	**Summed Dominance Ratio (%)**						
		Pennisetum polystachion	*Melochia corchorifolia*	*Borreria alata*	*Axonopus compressus*	*Rottboelia exaltata*	*Imperata cylindrica*	*Cleome rutidosperma*
Before treatment	0	26.30	13.58	10.92	10.68	7.00	4.58	1.68
Without mulch without weeding	6	4.39	15.38	27.59	6.64	17.80	6.41	8.30
	10	2.56	12.94	27.70	7.61	14.48	8.13	2.36
Without mulch with weeding	6	0.00	15.41	37.40	10.37	5.49	13.32	0.00
	10	0.00	5.45	25.92	16.07	17.31	18.34	0.00
Plastic mulch	6	0.00	7.88	27.28	0.00	6.50	30.38	8.32
	10	0.00	20.89	24.40	0.00	21.15	10.46	5.27
Straw mulch	6	0.00	16.49	13.48	0.00	42.32	2.96	4.27
	10	0.00	16.27	12.46	0.00	34.27	5.67	2.75
Arachis pintoi biomulch	6	5.82	2.00	25.70	10.65	16.42	14.04	5.06
	10	11.74	10.76	9.17	22.80	21.36	10.84	8.04

The result of vegetation analysis on both flat and sloping lands shows that A. pintoi biomulch was able to suppress broadleaf and sedge weeds but not effective to suppress grass weeds. This is consistent with the resulting study by Febrianto and Chozin (2014) indicated that *A. pintoi* biomulch effectively suppress broadleaf and sedge weeds, but less effectively suppress grass weeds.

Growth and Production of Maize

Analysis of variance showed that the slope of the land affected the variable of 100 grains weight but not significantly affected other growth and yield variables of maize. This result indicates that the production of maize in general is not affected by the slope of the land to the slope limit used in this study. The type of mulch treatments significantly affected plant height, plant dry weight, and production component variables of maize (Table 4). There was no interaction between the slope of the land and the type of mulch treatments in all observed variables.

Table 4. Average of growth and production variables of maize in the slope of the land and the type of mulch treatments

Treatments	**Plant height (cm)**	**Number of leaves**	**Time of flowering (DAP)**	**Dry weight of plant (g/plant)**	**Maize yield (g/plant)**	**100 grains weight (g)**
Slope of the land						
Flat land	170.63	15.01	58.58	61.33	93.57	32.08b
Sloping land	168.69	14.84	58.38	61.68	90.56	33.15a
Type of mulch						
Without mulch without weeding	164.01bc	14.98	58.67	58.88cd	87.23b	31.97bc
Without mulch with weeding	177.82ab	15.22	57.50	69.54a	110.44a	34.66a
Plastic mulch	166.05bc	14.64	59.17	61.38bc	86.64b	32.28bc
Straw mulch	184.22a	15.35	57.33	66.81ab	102.81a	33.68ab
Arachis pintoi biomulch	158.95c	14.74	59.33	53.59d	79.36b	31.04c

The number folowed by the same letter in the same column shows no significance in the DMRT (Duncan Multiple Range Test) at the 5% significance level.

The type of mulch had no significant effect on the number of leaves and flowering time of maize plants (Table 4). This shows that the environmental modification given in this study did not give enough effects on the number of leaves and the time of flowering of maize plants. According to Gardner et al. (2008), the number of leaves, the size of leaves and the position of leaves as well as the flowering time are mainly controlled by genotypes.

The results show that in general, the highest growth and production variables of maize were obtained in conventional weeding treatments (without mulch with weeding) which were used as a control and were not significantly different from straw mulch treatment. Maize plants had a highest plant height with straw mulch treatment (184.22 cm) which was not significantly different from conventional weeing treatment (177.82 cm), while the lowest plant height was maize plants with *A. pintoi* biomulch treatment (158.95 cm) which was not significantly different with plastic mulch (166.05 cm) and natural vegetation (without mulch without weeding) (164.01 cm) treatments.

The yield of maize in the without mulch with weeding treatment was 110.44 g/plant and significantly higher than that in all treatments, except straw mulch (102.81 g/plant). *A. pintoi* biomulch, although effective in suppressing the growth of weed, was not able to increase the production of maize. The yield of maize plants with *A. pintoi* biomulch treatment was 79.36 g/plant, significantly lower than control (110.44 g/plant). These results indicate that the competition in resources use between *A. pintoi* as biomulch and maize plants as main crops occurred in the first cultivation year.

Several previous studies showed that the use of cover crops including *A. pintoi* has an inconsistent effect on plant growth and production. Samad et al. (2009) reported that the use of *A. pintoi* increased the height of potato plants. The study by Sumarni et al. (2009) using peanut (*Arachis hypogea*) and kidney beans (*Vigna angularis*) as cover crops on cucumber cultivation showed that peanut cover crop did not have a different effect from the treatment without cover crop (control), while cucumber plants with kidney bean cover crop had lower leaf area, plant dry weight and production compared to control. Taufik et al. (2011), reported that the use of *A. pintoi* was able to increase the growth of pepper plants compared to control. Santos *et al.* (2013) reported that the use of legume cover crops (*A. pintoi*, *Macrotyloma axillare*, *Neonotonia wightii* and *Calopogonium mucunoides*) did not have a significant effect on growth and yield of coffee plants compared to manual or chemical controls. The study of Febrianto and Chozin (2014) showed that the use of *A. pintoi* biomulch did not give significant effects on growth and production of tomato plants. Chozin et al. (2014) also reported that the use of *A. pintoi* as biomulch increased the growth and production of tomato plants that are not significantly different with plastic mulch treatment.

The inconsistency of these results is thought to be caused by the differences in the growth management of cover crop used around the main crops. In this study, to see the competition effect of *A. pintoi* on the growth and production of maize plants, *A. pintoi* was allowed to grow to cover the entire land surface including around maize plants. Considering the great benefits of *A. pintoi*, especially in weed control, the growth management of *A. pintoi* is needed to reduce its negative impact on the main crops.

Conclusions

The use of *A. pintoi* biomulch suppressed the growth of weed more than 58% compared to the natural vegetation (without mulch without weeding) treatment. The study also showed that *A. pintoi* was effective in suppressing broadleaf and sedge weeds but not effective to suppress grass weeds. The use of *A. pintoi* biomulch by allowing the coverage of the entire soil surface suppressed the growth and yield of maize compared to the without mulch with weeding and straw mulch treatments. However, with its potentials, especially in supressing the growth of weeds and also in nitrogen fixation, *A. pintoi* has the potentials to increase the growth and yield of maize with proper growth management.

REFERENCES

Atalay, E., M. Yorgancilar and M.T. Erenkoyuncu (2016). Organik bitkisel üretimi. Yorgancilar, M. [Ed]. Organik Tarım. Atlas Akademi. Konya, Turkey, 11-37.

Bailey, K.L. and G. Lazarovits (2003). Suppressing soil-borne diseases with residue management and organic amendments. Soil Tillage Res., 72, 169-180.

Campaglia, E., R. Manchinelli, E. Radicetti and F. Caporali (2010). Effect of cover crops and mulches on weed control and nitrogen fertilization in tomato (*Lycopersicon esculentum* Mill.). Crop Protect., 29, 354-363.

Chozin, M.A., J.G. Kartika and R. Baharudin (2014). The Use of *Arachis pintoi* as biomulch in tomato cultivation. J. Hort. Indonesia, 4(3), 168-174.

Chozin, M.A., F.I. Nuryana, D. Guntoro, A. Sumiahadi, R.N. Badriyah and A.P. Wibowo (2018). Potency of *Arachis pintoi* Krap. & Greg. as biomulch in the tropical upland agriculture. IOP Conf. Ser.: Earth Environ. Sci., 196, 012011.

den Hollande, N.G., L. Bastiaans and M.J. Kropff (2007). Clover as a cover crop for weed suppression in an intercropping design II. Competitive ability of several clover species. Europ. J. Agronomy, 26, 104-112.

Devi, K.M.D., C.T. Abraham and S. Krishnan (2013). Changes in chemical and biological characteristics of soil under long term application of herbicides in rice – rice system. Bakar B. H., D. Kurniadie and S. Tjitrosoedirdjo [Eds.]. Proc. 24th Asian-Pasific Weed Science Society Conference, 22-25 October, Bandung, Indonesia, 331-337.

Febrianto, Y. and M.A. Chozin (2014). Pengaruh jarak tanam dan jenis stek terhadap kecepatan penutupan *Arachis pintoi* Karp. & Greg. sebagai biomulsa pada tertanaman tomat (*Licopersicon esculentum* M.). Bul. Agrohorti, 2(1), 37-41.

Fitriana, M., Y. Parto, Munandar and D. Budianta (2013). Pergeseran jenis gulma akibat perlakuan bahan organik pada lahan kering bekas tanaman jagung (*Zea mays* L.). J. Agron. Indonesia, 41(2), 118-125.

Gardner, F.P., R.B. Pearce and R.L. Mitchell (2008). Fisiologi Tanaman Budidaya. UI Press, Jakarta, Indonesia.

Harahap, I.Y., T.C. Hidyat, Y. Pangaribuan and E. Listia (2011). *Mucuna bracteata* as a cultural weed control in oil palm plantation. J. Gulm. Tumb. Invasif Trop., 2(1), 35-38.

Hiltbrunner, J., M. Leidgens, L. Bloch, P. Stamp and B. Streit (2007). Legume cover crops as living mulches for winter wheat: components of biomass and the control of weed. Europ. J. Agronomy, 26, 21-29.

Kremer, R. and J. Li, (2003). Developing weedsuppressive soils through improved soil quality management. Soil Tillage Res., 72, 193–202.

Linares, J., J Scholberg1, K. Boot, C.A. Chase, J.J. Ferguson and R. McSorley (2008). Use of the cover crop weed index to evaluate weed suppression by cover crops in organic citrus orchards. Hortscience, 43(1), 27-34.

Maswar (2004). Kacang hias (*Arachis pintoi*) pada usahatani lahan kering. Balai Benelitian Tanah, Jakarta, Indonesia, http://balittanah.litbang.deptan.go.id. Date accessed: 10 March 2013.

Ngouajio, M. and H. Mennan (2005). Weed populations and pickling cucumber (*Cucumis sativus*) yield under summer and winter cover crop systems. Crop. Prot., 24, 521-526.

Nusyirwan (2012). Potensi penutup tanah *Mucuna bracteata* di bawah tanaman karet. J. Gulm. Tumb. Invasif Trop., 3(1), 39-42.

Perez-Nieto, J., E. Valdes-Velarde, M.E. Hernandez-San Roman and V. Ordaz-Chaparro (2005). Rain, runoff, and soil erosion in shaded coffee agroforestry systems. Agrociencia, 39, 409–418.

Pullaro, T.C., P.C. Marino, D.M. Jackson, H.F. Harrison and A.P. Keinath (2006). Effect of killed cover crop mulch on weeds, weed seeds and herbivores. Agric. Ecosys. Environ., 115, 97-114.

Purba, E.R. Nababan and T. Simanungkalit (2011). Three populations of barnyard grass in North Sumatera resistant to metsulfuron methyl. J. Gulm. Tumb. Invasif. Top., 2(1), 28-30.

Reberg-Horton, S.C., J.D. Burton, D.A. Danehower, G. Ma, D.W. Monks, J.P. Murphy, N.N. Ranells, J.D. Williamson and N.G. Creamer (2005). Changes over time in the allelochemical content of ten cultivars of rye (*Secale cereale* L.). J. Chem. Ecol., 31, 179–193.

Rice, P.J., L.L. McConnell, L.P. Heighton, A.M. Sadeghi, A.R. Isensee, J.R. Teasdale, A.A. Abdul-Baki, J.A. Harman-Fetcho and C. Hapeman (2001). Runoff loss of pesticides and soil: a comparison between vegetative mulch and plastic mulch in vegetable production systems. J. Environ. Qual., 30, 1808–1821.

Ruegg, W.T., M. Quadranti and A. Zoschke (2007). Herbicide research and development: challenges and opportunities. Weed Res., 47, 271–275.

Samad, S., M. Mustafa, Baharuddin and A. Rampisela (2009). Optimalisasi produksi kentang ramah lingkungan di Parigi Kecamatan Tinggi Moncong Kabupaten Gowa. J. Sains dan Teknol., 9(1), 36-43.

Santos, J.C.F., A.J. da Cunha, F.A. Fereerira, R.H.S. Santos, N.S. Sakiyama and P.C. de Lima (2013). Cultivation of perennial herbaceous legumes in weed management in coffee plantation on the Cerrado. J. Agric. Scie. Technol., 3, 420-428.

Sumarni, N., E. Sumiati and R. Rosliani (2009). Respon tanaman mentimun terhadap penggunaan tanaman penutup tanah kacang-kacangan dan mulsa jerami. J. Hort., 19(3), 294-300.

Sumiahadi, A., M.A. Chozin and D. Guntoro (2016). Evaluasi pertumbuhan dan perkembangan *Arachis pintoi* sebagai biomulsa pada budidaya tanaman di lahan kering tropis. J. Agron. Indonesia, 44(1), 98-103.

Tampubolon, B.H. (2004). Pertumbuhan dan hasil tanaman jagung yang ditumpangsarikan dengan *Calopogonium caeruleum* Hemsl. disertai pemupukan nitrogen. Bul. Agron., 32(1), 13-19.

Taufik, M., A. Khaeruni, A. Wahab and Amiruddin (2011). Agens hayati dan *Arachis pintoi* memacu pertumbuhan tanaman lada (*Piper nigrum*) dan mengurangi kejadian penyakit kuning. Menara Perkebunan, 79(2), 42-48.

Teasdale, J.R (1995). Influence of narrow row/high population corn (*Zea mays*) on weed control and light transmittance. Weed Technol., 9, 113–118.

Wagger, M.G. (1989). Cover crop management and nitrogen rate in relation to growth and yield of no-till corn. Agron. J., 81, 533-538.

Yavuz, R., M. Esmeray and V. Urin (2017). The effect of some herbicides on maize and weed biomass. Journal of Bahri Dagdas Crop Research, 6(2), 1-6.

Zhilmdahl, R.L. (2007). Fundamentals of Weed Science 3rd Edition. Elsevier, London, UK.