IJABBR- 2014- eISSN: 2322-4827

International Journal of Advanced Biological and Biomedical Research

Journal homepage: www.ijabbr.com

Original Article

Weed Management in Citrus Orchards in Khuzestan Using Summer Cover Crop Mulch

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ARTICLE INFO

Article history:
Received: 04 August, 2014
Revised: 27 August, 2014
Accepted:19 September, 2014
ePublished: 30 October, 2014

Key words:
Weed
Glyphosate
Covering Crops
Citrus orchards
Weedmaster

ABSTRACT

Objective: Importance of management of gardens weeds is an issue that unfortunately has less been investigated by weeds researchers of country. One of the most important restrictive agents of cultivated surface and producing crops of Citrus orchards are weeds. **Methods:** To achieve this purpose, a research was performed in plot of Valencia orange trees of citrus fruits of Dezful in 2013. This project was done in the form of randomized complete block with 16 treatments in 3 repetitions. The treatments were mechanical control, Weedmaster herbicide, glyphosate herbicide, vigna unguiculata, vigna radiate, panicum miliaceum L., sorghum bicolor (L) moench, vigna unguiculata+ Weedmaster , vigna radiate+ Weedmaster, panicum miliaceum L.+ Weedmaster, sorghum bicolor (L) moench+ Weedmaster, vigna unguiculata+ glyphosate, vigna radiate+ glyphosate, panicum miliaceum L.+ glyphosate, sorghum bicolor (L) moench+ glyphosate and wetness (uncontrolled). **Results:** Results showed that sorghum bicolor (L) moench and it's combining with glyphosate and Weedmaster have the highest height, leaf area, and dry weight, and panicum miliaceum L. and its combining with glyphosate and Weedmaster herbicides have the highest density of covering crops. Weeds had the least leaf area in treatments of sorghum bicolor (L) moench, sorghum bicolor (L) moench+ Weedmaster and panicum miliaceum L., panicum miliaceum L.+ Weedmaster, and the least productive dry weight of weeds was in treatments of sorghum bicolor (L) moench, sorghum bicolor (L) moench+ Weedmaster and panicum miliaceum L., panicum miliaceum L.+ Weedmaster, and panicum miliaceum L.+ glyphosate. Also, the highest Index CCW belonged to treatments of sorghum bicolor (L) moench+ Weedmaster.

1.INTRODUCTION

Weed is one of the main problems of Citrus orchards in early of growth period, and chemical herbicides are used against it that is accompanied with environmental pollutions (Olorunmiye et al., 2011). The weeds in Citrus orchards decrease available water and nutrients of soil. They also may be host of a variety of pests, diseases, and even funguses (Weller et al., 1985). Presence of two amaranth bushes (of hybridus specie) in almost one square meter decreases tree growth, rate of fruit production, commencement of blossoming, and resistance to frostbite in a nectarine garden in which trees have been recently cultivated (Weller et al., 1985). According to the importance of Citrus orchards in economy of the country, it is required to investigate more the new non-chemical methods of controlling weeds. Using covering crops is one of the important chemical ways to control weeds of gardens and weed cultural grasses. Covering crops have a special position due to short and long term effects on fertility of soil and other agricultural operations. Covering crops occupy ecological

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habitat of weeds and decreases their abundance (Knezevic et al., 2002). These grasses cut life cycle of insects, grass pathogens, and weeds (Blum et al., 1977). Furthermore, they help to maintain the moisture of soil by decreasing Runoff and improving water penetration (Calkins and Swanson, 1995). Presence of Covering crops and green fertilizer decrease erosion of soil and improves soil quality. Moreover, covering crops of cereals family can increase fertility of soil and remedy its physical specifications by adding organic nitrogen to soil (Abdin et al., 2000). Knezevic et al. (2002) showed that in treat of covering crops of soybean and alfalfa, the most and the least biomasses of weeds were produced, respectively. The most suitable treat to decrease density of weeds was use of Barley straw mulch and Clover cover crop, and cover crop of alfalfa had the least effect of controlling weeds. Among the all treatments, covering crops of soybean and Rotivator were the most suitable treat, and covering crops of alfalfa was the most unsuitable treat to control weeds. A study was performed to determine the effect of common Mung as live mulch on weeds and considering its effect on producing organic Citruses. The results showed that applying alive mulch decreases weed density and covering ratio to 42.8 and 45.9 percent, respectively, than the control group. Biomass and dry weight of weeds are decreased by live mulch during all the year. The results showed that applying live mulch by using common vigna radiate is one of the most important alternative ways to suppress weeds in environmental management of weeds (Kitis, 2011). In another study, it was shown that covering crops treat+ half of nitrogen fertilizer, and omission of herbicide is a suitable alternative for managing the common grass cover of gardens surface in the north of Michigan (Sirrine et al., 2008). The importance of managing weeds of gardens is one of the issues that unfortunately has less been considered by weed researches of the country. The Citrus orchards of north of Khuzestan, having an area of about 5000 hectares, are very important in respect of crop diversity and quality. This research was conducted aiming at considering effect of summer covering crops and comparing it with chemical and mechanical ways on density and biomass of weeds in Citrus orchards of north of Khuzestan.

2. MATERIALS AND METHODS

This research was performed in Citrus orchards of Shahid Beheshti cultivation and industry corporate, located at Safi Abad of Dezful city, and in plot of Valencia orange trees, in 2013. The project was performed in the form of randomized complete block with 16 treatments in 3 repetitions, and thus there were 48 plots. There was an empty distance between repetitions as long as the distance between 2 rows of trees that was used as an access road. The plots were of dimensions of 2 trees by 3 trees (72 square meters). The target trees were 6 to 8 years old. The experimental treatments included: 1-mechanical control, 2-Weedmaster herbicide, 3-glyphosate herbicide, 4-*vigna unguiculata*, 5-*vigna radiate*, 6-*panicum miliaceum L.*, 7-*sorghum bicolor (L) moench*, 8-*vigna unguiculata*+ Weedmaster , 9-*vigna radiate*+ Weedmaster, 10-*panicum miliaceum L.*+ Weedmaster, 11-*sorghum bicolor (L) moench*+ Weedmaster, 12-*vigna unguiculata*+ glyphosate, 13-*vigna radiate*+ glyphosate, 14-*panicum miliaceum L.*+ glyphosate, 15-*sorghum bicolor (L) moench*+ glyphosate and 16-wetness (uncontrolled).

Late April was the time of culturing covering crops. The rate of used seeds was almost 1.5 to 2 times of cultural case, because of their usage as covering crops and the need to dense culture to more compete with weeds. *Vigna unguiculata*, *vigna radiate* and *panicum miliaceum L.*, amounting to 47 kilogram per hectare and *sorghum bicolor (L) moench* amounting to 60 kilogram per hectare was cultivated. In respect of mechanical control treat, cutting weeds, and leaving them on the land were performed once a month. Weedmaster and glyphosate herbicide amounting to 1.5 liter per hectare was used as pre plant in the time of blossoming of weeds. Sampling of weeds and covering grasses to compute biomass was done in two phases. The first sampling was done in August and the second in September. A Quadrate of dimensions 1 by 1 meter was used for sampling. In any phase, density, height and leaf area of weeds were computed. The dry weight of samples was measured by digital scale after being maintained a week in laboratory. To compute efficacy of covering crops and index of biomass of covering crops to weed, the following equation was used (Linares et al., 2008). Finally, the obtained data was analyzed using software MSTAT-C.

CCWI= Biomass Cover Crop / Biomass Weeds

Table 1.

Quantitative description of the relationship between the cover crop to weed (CCW) index with cover crop and weed growth dynamics (Linares et al., 2008).

CCW Index	Cover crop	Weeds	Weed control
<0.5	CC not competitive	Weeds dominate (>70% weeds)	Very poor (30%)
0.5-1	CC coexists	Weeds coexists	Poor
1-3	CC prevails	Weed growth reduced	Moderate
3-5	CC greatly prevails	Weed growth greatly reduced	Adequate
5-15	CC dominate (70-90%)	Weed repression (10-30% weeds)	Excellent
>15	CC completely dominate	Near-complete weed control/elimination (<10% weeds)	Outstanding (>90%)

3. RESULT AND DISCUSSION

3.1. Covering crops

Comparing data variance analysis showed that the difference of treatments in respect of density, height, leaf surface, and dry weight at probability level of 1% has been meaningful (P< 0.01). Comparing average by Duncan multi ranges test at probability level of 1% showed that treatments of Panicum miliaceum L.+ Weedmaster, Panicum miliaceum L.+ glyphosate, and Panicum miliaceum L. were placed in the same group and had the best density of covering crops (Table 2). Comparing average of height showed that the most height of covering crops was observed in treatments of Sorghum bicolor (L) Moench+ Weedmaster, Sorghum bicolor (L) Moench, and Sorghum bicolor (L) Moench+ glyphosate treatments of Sorghum bicolor (L) Moench+ glyphosate, Sorghum bicolor (L) Moench , Sorghum bicolor (L) Moench+ Weedmaster, Vigna unguiculata+ Weedmaster, Vigna unguiculata+ glyphosate, Vigna radiate, Panicum miliaceum L.+ Weedmaster, Vigna radiate+ glyphosate, and Panicum miliaceum L. were in the same group and allocated themselves the most leaf surface, and treat of Vigna radiate+ Weedmaster had the least leaf surface (Table 2). The treat of Sorghum bicolor (L) Moench+ glyphosate, and Sorghum bicolor (L) Moench+ Weedmaster had the most rate of dry weight, and Vigna radiate+ Weedmaster had the least rate of it (Table 2). In an experiment that was performed on Organic Lettuce during two years, treat of raceme Sorghum produced more dry matter than other species during both years. Also, raceme Sorghum bicolor (L) Moench had less weed species and less weed density than covering grass during both years (Isik, 2009). Allopathic ability difference among covering crops has been reported as a solution to successfully control weeds, and selecting suitable covering crops can increase crop in addition to decrease chemical poisons consumption (Linares et al., 2008).

Table 2.

Mean comparison of investigated properties of cover crops and Amaranthus retroflexus

Treatments	Cover crop				Amaranthus retroflexus		
	Density (plant/m²)	Height (cm)	Leaf area (cm²/m²)	Dry weight (gr/m²)	Density (plant/m²)	Height (cm)	Leaf area (cm²/m²)
mechanical control	0	0	0	0	80.00a	22.33bcd	2025bc
Weedmaster herbicide	0	0	0	0	45.67b	40.23abc	9950a
glyphosate herbicide	0	0	0	0	30.00c	36.33abc	6327ab
vigna unguiculata	16.33bc	140.0bc	31730c	359.2e	0.00g	0.00d	0.00e
vigna radiate	18.33bc	142.8bc	59190ab	336.9ef	2.00efg	22.33bcd	248.3de
panicum miliaceum L.	294.7a	104.8c	47090abc	464.7d	0.00g	0.00d	0.00e
sorghum bicolor (L) moench	36.67b	246.9a	93970a	1774b	0.00g	0.00d	0.00e
vigna unguiculata+ Weedmaster	19.33bc	152.9b	77330ab	638.3c	3.667def	25.30abc	286.0de
vigna radiate+ Weedmaster	13.00c	136.8bc	6040d	146.2g	6.333d	28.37abc	461.0cd
panicum miliaceum L.+ Weedmaster	322.7a	106.8c	66130ab	334.1ef	0.6667fg	15.27bcd	326.7de
sorghum bicolor (L) moench+ Weedmaster	33.33bc	248.6a	94770a	2333a	0.00g	0.00d	0.00e
vigna unguiculata+ glyphosate	21.00bc	157.0b	61470ab	592.7c	4.00de	48.23ab	2197bc
vigna radiate+ glyphosate	17.33bc	134.2bc	58030ab	277.2f	1.667efg	9.333cd	153.3de
panicum miliaceum L.+ glyphosate	310.7a	106.5c	38680bc	643.7c	0.3333g	17.20bcd	43.33de
sorghum bicolor (L) moench+ glyphosate	38.00b	244.2a	96540a	2433a	0.00g	0.00d	0.00e
wetness (uncontrolled)	0	0	0	0	79.00a	103.5a	21300a

Means in each column followed by different letters are significantly different (α=1%, Duncan)

3.2. Weeds

Comparing data variance analysis showed that the difference of treatments in respect of density, height, leaf area, and dry weight in weeds of Amaranthus retroflexus, Sorghum halepnse, Setaria viridis, and Cleome viscose at probability level of 1% has been meaningful (P<0.01).

3.3. Amaranthus retroflexus

Comparing averages by Duncan multi ranges test at probability level of 1% specified that treatments of Vigna unguiculata, Sorghum bicolor (L) Moench+ glyphosate, Panicum miliaceum L., Sorghum bicolor (L) Moench+ Weedmaster, Sorghum bicolor (L) Moench, Panicum miliaceum L.+ glyphosate, Panicum miliaceum L.+ Weedmaster, Vigna radiate+ glyphosate, and Vigna radiate were the most effective treatments and had the least density, height, and leaf area of Amaranthus retroflexus than uncontrolled witness (table 2).

3.4. Sorghum halepnse:

Comparing averages of treatments in weeds of Sorghum halepnse showed that the least density, height, and leaf area were observed in treatments of Panicum miliaceum L., Sorghum bicolor (L) Moench+ Weedmaster, Vigna unguiculata+ glyphosate, Panicum miliaceum L.+ Weedmaster, Sorghum bicolor (L) Moench, and Vigna unguiculata (table 3). Narrow-leaf covering crops have been recommended due to have good competitive effects for controlling weeds of peach gardens (Mervin & stiles, 1995).

Table 3.

Mean comparison investigated properties of Sorghum halepnse and Setaria viridis

Treatments	Sorghum halepnse			Setaria viridis		
	Density (plant/m^2)	Height (cm)	Leaf area (cm^2/m^2)	Density (plant/m^2)	Height (cm)	Leaf area (cm^2/m^2)
mechanical control	23.33ab	38.47ab	1248abc	bc15.33	abc24.37	b466.7
Weedmaster herbicide	13.33bc	67.47ab	1600ab	f0.00	c0.00	d0.00
glyphosate herbicide	21.00ab	67.37ab	2230a	ef3.667	abc23.97	bcd360.0
vigna unguiculata	12.33bcd	74.17ab	3533abc	def5.333	a84.50	b576.7
vigna radiate	7.667cd	153.0a	2224a	b19.33	a85.97	b676.7
panicum miliaceum L.	1.667d	17.00b	136.7d	ef4.000	ab66.33	bcd180.7
sorghum bicolor (L) moench	5.667cd	55.17ab	517.3abcd	f0.00	c0.00	d0.00
vigna unguiculata+ Weedmaster	22.67ab	67.47ab	2333a	cde8.000	ab66.17	bc408.0
vigna radiate+ Weedmaster	14.33bc	84.83a	723.7abcd	f0.00	c0.00	d0.00
panicum miliaceum L.+ Weedmaster	5.667cd	75.00ab	424.3abcd	f0.00	c0.00	d0.00
sorghum bicolor (L) moench+ Weedmaster	1.667d	20.33b	270.0cd	f0.3333	bc22.03	cd33.00
vigna unguiculata+ glyphosate	2.000d	36.33ab	221.0bcd	bcd13.67	ab65.57	a2987
vigna radiate+ glyphosate	13.67bc	96.20a	2523a	cde8.333	ab56.37	bc580.0
panicum miliaceum L.+ glyphosate	12.00bc	94.13a	1082abcd	f0.00	c0.00	d0.00
sorghum bicolor (L) moench+ glyphosate	1.667d	103.3a	730.0abcd	f0.3333	bc22.00	cd32.67
wetness (uncontrolled)	39.33a	99.93a	833.7abcd	a44.33	a93.70	a5180

Means in each column followed by different letters are significantly different (α=1%, Duncan)

3.5. Setaria viridis

Comparing averages of the treatments specified that the most effective treatments to control *Setaria viridis* in respect of density, height, and leaf area were *Panicum miliaceum L.*+ glyphosate, *Sorghum bicolor (L) Moench*, *Panicum miliaceum L.*+ Weedmaster, *Vigna radiate*+ Weedmaster, Weedmaster herbicide, *Sorghum bicolor (L) Moench*+ Weedmaster, and *Sorghum bicolor (L) Moench*+ glyphosate (table 3). Sorghum as a covering crop resistant to dryness is used solely in annual summer cultures or as mixed cultures in the warm season. All kinds of *Sorghum bicolor (L) Moench* have a potential ability to choke weeds, suppress Nematodes, and penetrate into compressed soils (Clark, 2007). This grass can be used as covering crop in culture system of *Sorghum bicolor (L) Moench* (Magdoff and Van, 2009).

3.6. Cleome viscose

Comparing averages of treatments specified that treatments of *Vigna unguiculata*+ Weedmaster, *Sorghum bicolor (L) Moench*+ Weedmaster, *Panicum miliaceum L.*+ glyphosate, *Vigna radiate*+ glyphosate, *Panicum miliaceum L.*+ Weedmaster, *Panicum miliaceum L.*, Weedmaster herbicide, *Vigna unguiculata*+ glyphosate, *Sorghum bicolor (L) Moench*+ glyphosate, glyphosate herbicide, and *Sorghum bicolor (L) Moench* are in the same group and had the best performance in respect of controlling density, height, and leaf area of *Cleome viscose* (table 4).

3.7. All weeds

Comparing data variance analysis showed that density, height, and leaf surface for all of weeds have been meaningful at probability level of 1% ($P<0.01$). Comparing average by Duncan multi range test at probability level of 1% specified that treatments of *Sorghum bicolor (L) Moench*+ Weedmaster and *Panicum miliaceum L.* has been in the same group and had the least leaf area of weeds. Treatments of Weedmaster herbicide, glyphosate herbicide, *Vigna unguiculata*+ glyphosate, *Vigna unguiculata*, mechanical control, *Vigna radiate*, *Vigna radiate*+ glyphosate, *Vigna unguiculata*+ Weedmaster, have had the highest leaf surface of weeds (table 4). Comparing average by Duncan multi range test at probability level of 1% specified that treatments of *Sorghum bicolor (L) Moench*+ Weedmaster, *Panicum miliaceum L.*, *Panicum miliaceum L.*+ Weedmaster, *Panicum miliaceum L.*+ glyphosate, and *Sorghum bicolor (L) Moench* have the least productive dry weight of weeds (table 4). Smeda and Putnum (1988) showed that narrow-leaf weeds were controlled well by *Sorghum bicolor (L) Moench.* Different kinds of *Sorghum bicolor (L) Moench* produce 4000 to 5000 pounds of dry matter per hectare (Clark, 2007).

Table 4.

Mean comparison of investigated properties of Cleome viscose, all weeds and CCW Index

Treatments	Cleome viscose			All weeds		CCW Index
	Density (plant/m^2)	Height (cm)	Leaf area (cm^2/m^2)	Leaf area (cm^2/m^2)	Dry weight (gr/m^2)	
mechanical control	ab6.667	abc35.50	abc355.3	abcd4095	abc131.6	0
Weedmaster herbicide	c0.00	c0.00	d0.00	a11550	a454.0	0
glyphosate herbicide	c0.6667	bc20.33	cd122.7	ab9039	ab201.7	0
vigna unguiculata	b5.667	ab84.33	a970.3	abcd5080	abc121.0	b3.622
vigna radiate	a12.00	a93.53	ab515.7	abcd3664	ab211.3	b1.638
panicum miliaceum L.	c0.00	c0.00	d0.00	fg317.3	bcd34.30	b40.76
sorghum bicolor (L) moench	c1.333	abc54.63	bcd256.7	def774.0	abcd93.23	b51.98
vigna unguiculata+ Weedmaster	c0.00	c0.00	d0.00	abcde3027	abc135.9	b5.810
vigna radiate+ Weedmaster	ab8.667	abc41.07	ab580.0	bcde1765	abc375.0	b2.485
panicum miliaceum L.+ Weedmaster	c0.00	c0.00	d0.00	ef751.0	cd16.43	b26.53
sorghum bicolor (L) moench+	c0.00	c0.00	d0.00	g303.0	d5.667	a112.1

Weedmaster						
vigna unguiculata+ glyphosate	c0.3333	abc29.33	cd110.7	abc5515	abc102.2	b7.019
vigna radiate+ glyphosate	c0.00	c0.00	d0.00	abcd3257	abc118.7	b2.504
panicum miliaceum L.+ glyphosate	c0.00	c0.00	d0.00	cdef1125	abcd66.50	b25.02
sorghum bicolor (L) moench+ glyphosate	c0.6667	abc29.33	bcd217.0	cdef979.7	abc369.4	b49.18
wetness (uncontrolled)	c1.000	abc57.93	abcd342.3	a27660	a405.8	0

Means in each column followed by different letters are significantly different (α=1%, Duncan)

3.8. Index CCWI

Comparing data variance analysis showed that specifications of density, height, and leaf area for Index CCW at probability level of 1% have been meaningful (P<0.01). Comparing average by Duncan multi range test at probability level of 1% specified that treat of *Sorghum bicolor (L) Moench*+ Weedmaster had the best index and other treatments were in the same group (table 4).

CONCLUSIONS

In accordance with Table 1, the treat of *Sorghum bicolor (L) Moench* showed complete dominance of covering crops and decrease of weed population to 10%. Sorghums are growing quickly and have potential of making shadow or chocking of weeds in the case of dense culture. Moreover, oozes of Sorghum roots decrease growth of weeds such as velvet leaf, thorn apple, redroot pigweed, yellow foxtail and barnyard grass (Stapleton et al., 2010).

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