Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Research Article
Volume 24 Issue 4 - June 2020
DOI: 10.19080/ARTOAJ.2020.24.556273

Agri Res & Tech: Open Access J

No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce

Maicon Domingues de Vargas, Mônica Josene Barbosa Pereira, Julian Martinho da Silva, Douglas Piovezan dos Santos, Rivanildo Dallacrot, Oscar Mitsuo Yamashita, Darley Tiago Antunes and Santino Seabra Júnior

Universidade Federal de Mato Grosso – UFMT, Brazil

Submission: May 08, 2020; **Published:** June 05, 2020

***Corresponding author:** Darley Tiago Antunes, Universidade Federal de Mato Grosso – UFMT, Brazil

Abstract

The experiments were conducted in randomized blocks, arranged in subdivide parcels scheme, the main factor is the presence and absence of the surrounding sorghum band and in the sub parcels of the soil cover (spontaneous vegetation, millet, goosegrass and sorghum) and the conventional (without cover), with four repetitions. The evaluated variables were biomass production of cover crops, composition rate, weed elimination, pest population variants, natural enemies and lettuce production. The millet showed lower rate of decomposition and longer half-life. The sorghum indicated higher litterfall and greater efficiency in weed elimination during the cycles. The predominant pests in the area were whitefly and thripes, regardless of the management used. The presence of the sorghum-surrounding band provided an increase of the natural enemies, mainly in the lettuce second cycle. As well as the increase of lettuce production when grown with millet and grass goosegras in the first cycle and sorghum in the second cycle. The conservation practices evaluated in this research can be indicated as a phytosanitary management strategy in the lettuce crop.

Keywords: *Lactuca sativa L; Sorghum sp; Pennisetum glaucum (L.)* R. Brown*; Eleusine coracana (L.) Gaertn; Weed Management*

Introduction

Lettuce *(Lactuca sativa L.)* belongs to the asteraceous family, originating in a temperate climate region, is the most consumed vegetable in Brazil and in the world [1]. To meet the demand, the farmer intensifies the cultivation, which is usually carried out in the conventional production system, based on the use of irrigation, chemical fertilizers, intense soil revolving in the preparation and formation of beds, exposing them to climatic conditions, accelerating the process of water erosion leading to degradation. This cultivation model favors the development of weeds, interferes in crop productivity due to competition for nutrients, light, water, allelochemical release. In addition, weeds can serve as a shelter and food source for insect pests and disease hosts [1-3]. Because it is a short cycle vegetable, several consecutive cycles are performed during the year, which favors the permanence of pests in the cultivation medium. Among these pests stand out the whitefly *(Bemisia tabaci)* and thrips *(Frankliniella schultzei)*, main responsible for causing direct damage due to sap sucking and toxin injection, affecting its vegetative development and causing indirect damage through transmission of viruses (GUIMARÃES et al., 2013). The control of these pests in conventional vegetable production is done through the application of chemical insecticides, which leads to the death of natural enemies, reduces biological control. Data from ANVISA [4] indicate lettuce as one of the vegetables with the highest rates of contamination with pesticides (45% of the samples), levels above those allowed and/or with active ingredients not recommended for the species.

Therefore, it is necessary to use conservation practices that promote a reduction in the use of pesticides and an increase in vegetable productivity. No-tillage can be highlighted as an alternative due to soil benefits, addition of organic matter, reduction of surface erosion, mitigation of high temperature and the possibility of weed suppression [3]. Another conservationist practice that increases pest control and can reduce the demand for insecticides is the use of the surrounding sorghum band *(Sorghum sp.)*, for being an attractive species to natural enemies [5] (MEDEIROS et al., 2010). Thus, the objective of this work was to evaluate the soil cover and surrounding range as phytosanitary management strategies in two lettuce production cycles.

Material and Methods

The experiment was carried out in the municipality of Nova Mutum - MT, in the experimental area of the University Campus of Nova Mutum - State University of Mato Grosso (UNEMAT). The municipality is located at south latitude 13º 05' 04" and west longitude 56º 05' 16". The climate of type Aw (Kóppen), tropical, with concentrated rains in summer (October to April). The average annual rainfall is 1900mm and the average temperature is 26 °C [6]. The soil is classified as dystrophic Yellow Red Latosol (EMBRAPA, year). Two consecutive lettuce cycles were conducted, using the cultivar of the crespa type, cv. Crispy SRV 2005. The experimental design was in randomized blocks, in subdivided plots, with four replications. The factor of the main plot was the presence and absence of the surrounding strip with broom sorghum *(Sorghum vulgare L. Moench)*, the plot presented dimension of 12.5 × 24 meters (m). In the subplot, the following soil coverings were implanted: millet *(Pennisetum glaucum (L.)* R. Brown), forage sorghum *(Sorghum bicolor L. Moench)*, chicken-foot grass *(Eleusine coracana L.)* Gaertn, spontaneous vegetation and conventional cultivation (with soil revolving and incorporation of weeds, procedure performed in both cycles of lettuce). The subplots consisted of two beds with dimensions of 1.2 × 1.0 m each, allocating 32 lettuce plants.

The soil sample of the experimental area was collected at the depth 0-20 cm and after the analysis presented the following characteristics: sand 82.5%; silt 3.7%; clay 13.8%; pH ($CaCl_2$) = 6.9; H+Al = 1.2 cmolc dm^{-3}; Al = 0.0 cmolc dm^{-3}; Mg = 1.0 cmolc dm^{-3}; Ca = 3.8 cmolc dm^{-3}; K = 0.04 cmolc dm^{-3}; P = 99.7 mg dm^{-3}; CTC = 6.0 cmolc dm^{-3}; V = 80%; MO = 15.0 g dm^{-3}. Soil preparation was performed with a harrowing and leveling grid, and subsequent lifting of the beds. After this stage, in all subplots, the planting fertilization of the cover species was carried out, 30 kg ha^{-1} of N (urea - 44% N), 400 kg ha^{-1} of P_2O_5 (simple superphosphate - 18% P_2O_5),150 kg ha^{-1} of K_2O(potassium chloride - 58 % K_2O) and 15t ha^{-1} of chicken manure.

The sowing of the cover species was carried out on the beds, in the spacing between lines of 0.30 m, using 40 kg ha^{-1} of millet seeds cv. Adr 300; 35 kg ha^{-1} of sorghum seeds cv AD 200 and 20 kg ha^{-1} of chicken foot grass seeds cv. ANPG 207. The sowings were carried out on different dates so that the plants were dried and mowed on the same day (January 18, 2016), due to the difference in the cycle, cycles of 74, 60 and 45 days after sowing (DAS) were obtained for crow's foot grass, sorghum and millet, respectively. The soil cover plants were dried with glyphosate herbicide at 1L ha^{-1} dosage and then mowed at 0.05m from the soil. The broom sorghum was sown on October 26, 2015 for the formation of the surrounding strip around the plots. This range consisted of three 0.50 m spaced cultivation lines between rows, with a population of 10 plants m^{-1}, distant 2m from the subplots and 5m from the plot with no surrounding broom sorghum band.

In the first cycle, lettuce sowing was carried out on January 6, 2016 and, in the second cycle, on February 4, 2016, in trays of 162 black polyethylene cells, filled with commercial substrate (VIVATTO®),kept in a protected environment, covered with agricultural film, with a thickness of 150 micras and black shading screen with 50% in the windows. The transplant of the seedlings was performed at 24 days after sowing, when the seedlings had three or four definitive leaves in both cycles. The spacing used was 0.30 × 0.25m.

Planting fertilization was performed one week before the transplant of lettuce seedlings, using 30 kg ha-1N (urea - 44% N); 400 kg ha^{-1} of P_2O_5 (simple superphosphate - 18% P_2O_5) and102 kg ha^{-1} of K_2O (potassium chloride - 58 % K_2O). The cover fertilizers the dosages:15, 15, 30, 30 and 30 kg ha^{-1} of N, at 5, 10, 15, 20 and 25 days after transplantation (DAT) and potassium applied at doses of 12, 18 and 18 kg ha-1 of K_2O, at 10, 15 and 20 DAT. The planting and cover fertilizations for lettuce, in both cycles, were released on the straw, in the treatments under no-tillage. Planting fertilization was incorporated in the treatment with soil revolving (conventional cultivation).

Irrigation was performed using microperforated laser hoses, type Santeno 01. The water management of the crop was performed according to the need of the crop, monitored through vacuometer tensiometers, following the methodology proposed by Marquelli (2008). Due to the high whitefly infestation, weekly sprays of neem leaf extract (*Azadirachta indica* A. Juss) were performed at a concentration of 1%. These were performed after the replacement of adhesive traps, so as not to interfere with the samples of natural enemies. The biomass (shoot dry) of the cover plants was evaluated at the beginning of flowering. For this, four samples of 0.25 m^2 per plot were randomly collected. After collection, the material was submitted to drying in a forced circulation oven, at 65 ºC, for 72 hours, obtaining constant weight [7].

To evaluate the decomposition rate, 20g Branches of plant material, of each sample, in decomposition bags. These were made with shading mesh (5mm) with a dimension of 0.20 × 0.20 m. Four decomposition bags have been placed on the surface of each subploer the. Two bags were evaluated in the harvest of each lettuce cycle. The determination of decomposition (k) in g^{-1} plant waste was obtained by Thomas' methodology and Asakawa [8].

Where:

X: amount of dry matter remaining after a period of time t, in days

Xo: initial amount of dry matter or nutrient

k: biomass decomposition constant

The determination of the half-life time (T1/2) on days of plant residues was obtained by the methodology of Paul and Clark [9].

Weed suppression was evaluated in the two lettuce cycles at 15 and 30 DAT. The identification of weed species was performed with the aid of the "Manual of identification of weeds" [10]. The relative frequency of the predominant weed species in the plots

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

was sized, after the measurement of the fresh and dry mass of the shoot, in an area of one m^2 per plot, considering the total weeds during the two cycles [11]. After each evaluation in all plots, manual weeding was performed. Between the first and second lettuce cycles, the area with glyphosate herbicide was desiccation at the dosage 1 L ha^{-1}.

To quantify the insects, associated with lettuce crop in areas with and without surrounding range, yellow and blue adhesive traps with dimension of 0.15 × 0.24 m, installed under the canopy of lettuce plants, were used 0.20 m from the soil. The traps were distributed in the plots, four blue and four yellow in the crops with presence and absence of the surrounding broom sorghum range, totaling 16 traps. These were replaced every seven days and the plates, containing insects, were sent to the Laboratory of Entomology - UNEMAT / Campus Tangará da Serra, for screening, quantification. The specimens were identified at the family level, with the aid of a taxonomic key. However, individuals of the orders Hymenoptera and Diptera were stored in 70% alcohol and sent for identification at the National Institute of Amazonian Research. To characterize the population fluctuation of pests in the area, in the evaluated period (7.14, 21, 28 and 35 DAT), the pest populations were obtained and the mean number of individuals/trap present in each color (blue and yellow) was considered in each harvest. To quantify the whitefly during the two cycles, due to the high infestations in the yellow traps, the count was performed by extrapolation in 1 cm^2 (OLIVEIRA and LABINAS, 2008).

Six central plants were collected to evaluate lettuce production, per subplot, at the harvest point, 35 and 42 DAT, for the first and second cycles, respectively. The number of leaves (total and commercial) and the total and commercial production (g $plant^{-1}$) were evaluated. For commercial production, only undamaged leaves were considered. Regarding the number of commercial leaves, the number of commercial leaves were considered larger than 5cm [12]. During lettuce cycles, precipitation data were collected with the aid of a rain gauge. Soil temperatures were measured using a digital skewer thermometer (model HM-600), and the average, maximum and minimum air temperature with thermohygrometer (model HM-02), taken daily at 2 p.m. For fresh mass and dry mass of weeds, data transformation $(\sqrt{X}+1)$ was used. The data were submitted to analysis of variance (F test) and the means compared by the Scott-Knott test ($p<0.05$) in the Assistat program (SILVA and AZEVEDO, 2016).

Results and Discussion

For biomass and decomposition rate of cover crops there was no significant interaction between the factors presence and absence of surrounding range and soil cover. The highest biomass value was obtained with crow's foot grass and sorghum. The values obtained in this study of biomass of chickengrass and millet were higher than the work of Boeret al. (2008). Millet was the species that presented the lowest rate of decomposition (k) resulting in a longer half-life time(T1/2) both in the first and second lettuce cultivation cycle (Table 1).

Table 1: Decomposition rate (K) in (g g^{-1}) and half-life time T1/2, (days) of cover plants due to absence and presence of surrounding broom sorghum ranges at the harvest of the 1st (35 days) and 2nd cycles (77 days) of lettuce.

Covers	1st Cycle (35 days)			2nd Cycle (77 days)	
	Biomass	K	T1/2	K	T1/2
Ground cover	t ha-1	(gg -1)	(days)	(gg -1)	(days)
Spontaneous vegetation	1.9 d	0.0196 to	35	0.0098 to	70
Millet	6.8 b	0.0164 b	42	0.0082 b	84
Chicken foot	12.3 to	0.0228 to	31	0.0114 to	61
Sorghum	10.8 to	0.0203 to	34	0.0101 to	68
CV%		14,94		14,94	

Means followed by the same lowercase letter in the column did not differ statistically from each other, by the Scott-Knott test ($p<0.05$).

It was observed that the decomposition rate (k) in the first cycle was twice as high as the second lettuce cultivation cycle (Table 1). This fact can be explained by the climatic period of the first cycle in which the accumulated precipitation was 622 mm and in the second cycle 90mm. Torres, Pereira and Fabian [7] found that in the periods of 42 and 98 days, after the management of the roofs, under different climatic conditions, with an average temperature of 22.5 °C, the decomposition rate (k) was also lower than this work, for the millet (0.005 and 0.007 g^{-1}) and sorghum (0.005 and 0.006 days), respectively. Boer et al. [13] evaluating the biomass decomposition of soil cover, 240 days after the management of cover plants, with accumulated precipitation of 9.2mm and average temperature of 22, 8 °C, verified that the decomposition rate was also lower than the results for the millet 0.006 days and for the chicken-foot grass 0.006 days. The lower decomposition rate (k) value observed may be related to the climatic conditions of the evaluation period, the management time of the roofs and the variety used.

During the two lettuce growing cycles, the relative frequency of weeds identified were: 39.66% of Santa-Luzia grass *(Chamaesyce hirta L.)* 32.21% marmalade grass *(Brachiaria plantaginea L.)*, 14.06% chicken-foot grass *(Eleusine indica L.)* and the others represented 13.97% (puts out fire (*Alternanthera tenella L.* , roundworm *Chenopodium ambrosioides L.*, caruru *Amaranthus*

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

viridis L. and beldroega *Portulaca oleracea L.*). For the variables fresh and dry weed mass there was no significant interaction between factors, presence and absence of surrounding broom sorghum range and soil cover (Table 2). In general, it was observed that the soil cover is more efficient than spontaneous vegetation in weed suppression, with sorghum being the species that presented the highest efficiency in suppression. The efficiency of sorghum in weed suppression, this effect may be linked to the substance sorghumone, considered allopathic. In addition to the species presenting great biomass production (10.8 t ha^{-1}) (SANTOS et al., 2012) [3] (Table 1). For the variable, Dry Mass, there was no significant difference between sorghum and crow's foot grass for weed suppression in the first cycle (15 and 30 DAT) (Table 2), this may have occurred due to the better performance regarding biomass production by these species. In the second cycle, significant differences were observed in weed suppression by soil cover, only at 30 DAT. The reduction of the efficiency of crow's foot grass in the second lettuce cultivation cycle may be related to the decomposition rate (k), resulting in the decrease of biomass with inhibition of the physical effect of weed suppression. The millet presented the lowest decomposition rate (k), maintaining the suppression effect for the second cycle due to the permanence of the straw on the soil, longer half-life time (T1/2). The low production of fresh and dry weed mass at 15 DAT, in the second cycle, may have occurred by reducing precipitation and effect of glyphosate application, which reduced weed development.

Table 2: Fresh mass (MF) and dry mass (DM) in g m² of weeds in the 1st and 2nd lettuce cycle as a function of absence and presence of surrounding broom sorghum and soil cover.

Treatments	1st Cycle				2nd Cycle			
	g m²							
	15TH DAT		30 DAT		15TH DAT		30 DAT	
	Mf	Ms	Mf	Ms	Mf	Ms	Mf	Ms
No track	7.8 to	3.5 to	6.8 to	3.1 to	1.5 to	1.0 to	12.9 to	5.2 to
Track presence	6.2 to	2.7 to	8.2 to	3.5 to	1.8 to	1.0 to	12.1 to	5.4 to
CV%	62,5	50,4	68,2	52,2	41,5	7,6	55,5	45,7
Conventional	13.1 to	5.7 to	11.8 to	5.4 to	2.0 to	1.1 to	14.6 to	6.3 to
Spontaneous vegetation	10.0 b	4.3 b	9.1 b	3.8 b	1.7 to	1.0 to	16.5 to	6.5 to
Millet	7.2 c	2.9 c	7.5 c	3.2 b	1.4 to	1.0 to	10.8 b	4.7 b
Chicken foot	3.6 d	1.8 d	6.1 c	2.7 c	1.7 to	1.0 to	12.5 to	5.3 to
Sorghum	1.0 d	1.0 d	2.9 d	1.5 c	1.2 to	1.0 to	8.0 b	3.6 b
CV%	36,2	33,6	31,4	24,4	42,2	8	25,1	22,3

Means followed by the same lowercase letters in the column do not differ from each other by the Scott-Knott test ($p<0.05$).

The predominant pests in the area were whitefly and thrips, captured in yellow and blue traps, respectively (Figure 1). In the first lettuce cultivation cycle, it was observed that whitefly adults had a population peak of 53,460 and 49,320 individuals/trap at 14 DAT in the plot with and without surrounding range, respectively (Figure 1). In the second lettuce cycle, the whitefly population was less than 5,000 individuals/trap (Figure 1). The high population peak of whitefly, in the first lettuce cycle, is probably associated with the migration of this insect from the surrounding soybean areas, since the population was very high. According to Harterreitem-Souza et al. [14] cultivated areas near large (monoculture) soybean and bean crops may favor the dispersal of whitefly populations, infesting the surrounding vegetable cultivation.

During the population peak of whitefly there was direct damage in the leaf blade of lettuce plants, such as chlorosis, mainly close to the central rib, in the leaf stem, due to the continuous suction of nymphs and the reduced growth of plants, drastically affecting production (Figure 2). Guimarães et al., [15] verified similar damage in lettuce production fields with changes in vegetative and reproductive development of the crop. It was verified in the first lettuce cycle that the peak population of thrips was 392 (28 DAT) and 330 (21 DAT) individuals/trap in the plots with presence and absence of surrounding range, respectively (Figure 1). In the second lettuce cycle, there was a population increase of thrips at 28 DAT with 503 and 404 individuals/trap) in the plots with and without the surrounding range, respectively (Figure 1). Despite the increase in the thrips population, in the second cycle, the presence of these insects in the crop was not recorded, probably the collected individuals migrated from host plants, attracted by the blue color of the traps. As observed by Gaertner and Borba [16] in hydroponic lettuce cultivation, the blue color was attractive for adults of thrips.

It is noteworthy that despite the absence of thrips damage in the area, monitoring with traps is important, as several authors report this insect as a key pest in lettuce crop, causing direct

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

damage due to sap suction and indirect damage by transmission of viruses such as the turn vira-cabeça [1,15,16]. The presence of the surrounding range favored the occurrence of natural enemies in the cultivation area in the two cycles evaluated. In the first lettuce cycle, the predators of the family *Asilidae* (Diptera) and *Vespidae* (Hymenoptera) predominated in the blue trap. In the second cycle, there was a greater abundance of ants (Formicidae) and predators of the families *Dolichopodidae* (Diptera) and *Carabidae* (Coleoptera). In the plot with absence of surrounding range, the natural enemies, with greater abundance, in the blue trap were the predators Formicidae (Hymenoptera), *Asilidae* (Diptera) and *Dolichopodidae* (Diptera) in both lettuce cycles. The predator *Carabidae* (Coleoptera) and the parasitoids of the family *Figitidae* and *Platygastridae* showed the highest number in the second lettuce cycle. In the yellow trap the collections were more abundant, in the second lettuce cycle, with predominance of predators of the family *Dolichopodidae* (Diptera) *Formicidae*, *Vespidae* (Hymenoptera) and the parasitoid hymenoptera *Figitidae*, *Platygastridae*, *Pompilidae*, *Eulophidae*, *Diapriididae* and *Bethylidae*, in addition to the parasitoid dipterans of the hybotidae family (Table 3).

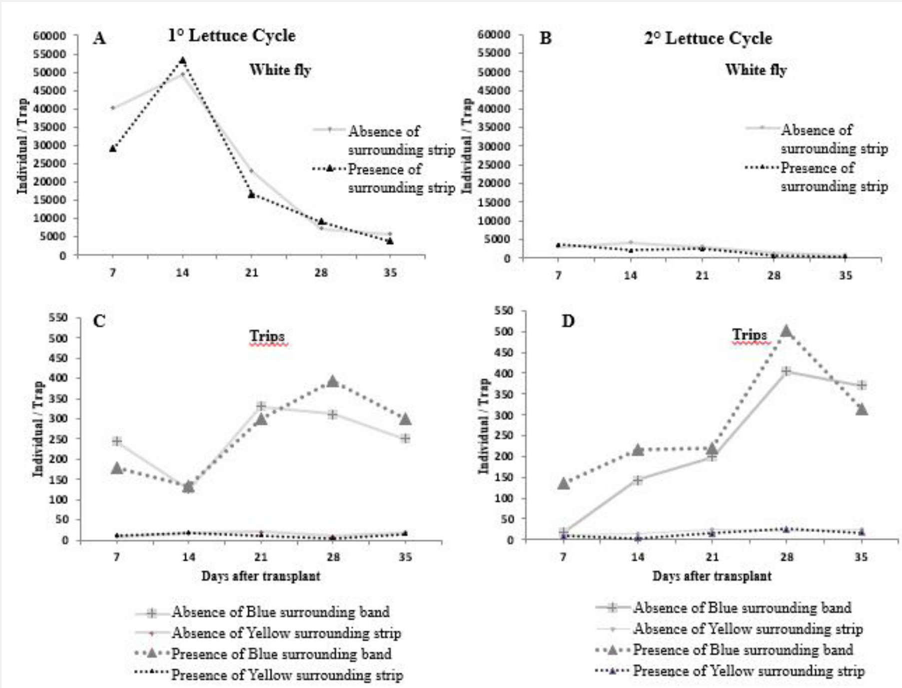

Figure 1: Fluctuation of the average population of whitefly (A and B) and thrips (C and D) individuals / trap, due to the absence and presence of broom sorghum surrounding band, in the 1st and 2nd lettuce cycle.

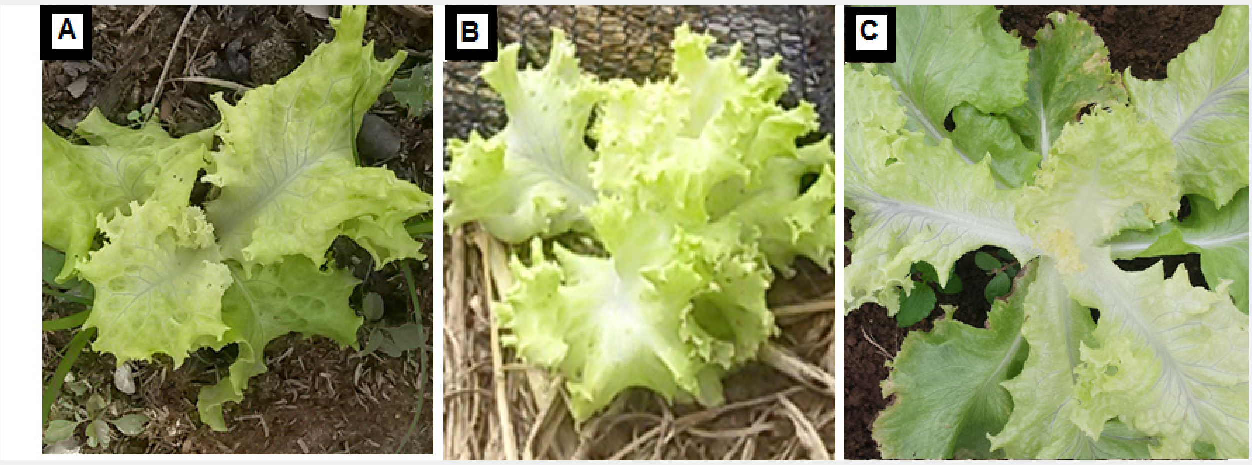

Figure 2: Lettuce plants with symptoms of chlorosis in leaves due to sucking of whitefly nymphs (A, B and C).

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

Table 3: Total number of natural enemies in the blue and yellow traps, due to the presence and absence of the surrounding strip of sorghum broom, in the 1st and 2nd cycles of lettuce cultivation. UNEMAT, Nova Mutum/MT, 2016.

	Natural Enemies	Track Presence			Absence of Track		
		Az	Am	Total	Az	Am	Total
1st Lettuce Cycle	Hymenoptera	122	138	260	59	117	176
	Bethylidae*	5	1	6	3	4	7
	Diapriidae*	34	22	56	17	16	33
	Eulophidae*	0	18	18	0	6	6
	Figitidae*	8	26	34	0	16	16
	Platygastridae*	15	10	25	8	11	19
	Pompilidae*	2	14	16	3	29	32
	Trichogrammatidae*	2	0	2	0	0	0
	Formicidae**	37	32	69	21	29	50
	Vespidae**	19	15	34	7	6	13
	Coleoptera	12	16	28	13	13	26
	Carabidae**	4	11	15	5	10	15
	Coccinelidae**	8	5	13	8	3	11
	Diptera	132	22	154	143	62	205
	Dolichopodidae**	2	2	4	48	51	99
	Asilidae**	118	16	134	89	8	97
	Hybotidae*	1	1	2	0	3	3
	Syrphidae**	11	3	14	6	0	6
	Total	266	176	442	215	192	407
2nd Lettuce Cycle	Hymenoptera	350	888	1238	308	724	1032
	Bethylidae*	2	7	9	0	24	24
	Chalcididae*	1	5	6	0	13	13
	Diapriidae*	19	43	62	18	33	51
	Eulophidae*	7	76	83	6	49	55
	Figitidae*	87	505	592	55	268	323
	Trichogrammatidae*	7	4	11	3	2	5
	Pompilidae*	4	48	52	10	66	76
	Platygastridae*	46	60	106	46	83	129
	Ichneumonoidea*	2	12	14	1	0	1
	Formicidae**	170	108	278	159	161	320
	Vespedae**	5	20	25	10	25	35
	Coleoptera	49	16	65	31	23	54
	Cicindelidae**	1	0	1	1	1	2
	Carabidae**	43	11	54	29	18	47
	Coccinelidae**	5	5	10	1	5	6
	Diptera	170	830	1000	147	713	860
	Hybotidae*	15	45	60	6	21	27
	Dolichopodidae**	48	766	814	22	674	696
	Asilidae**	85	13	98	90	12	102
	Syrphidae**	22	6	28	29	6	35
	Total	562	1730	2292	483	1459	1942

*Parasitoid, **Predator, Blue Az-Trap, Yellow Am-Trap.

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

The highest number of natural enemies were collected in yellow traps in the second lettuce cycle, probably due to the high whitefly infestation in the first lettuce cycle (Figure 1), preventing the adhesion of other insects to the plate. In addition, the high precipitation (Figure 3) occurred in the period influenced the amount of insects captured, because the strong spatter of raindrops in the soil resulted in the reduction of the adhesive area of the traps, were covered with soil particles, consequently reducing the efficiency of the traps in the capture of insects. The results indicate that regardless of the presence or absence of the surrounding range and lettuce cycle, the yellow trap was efficient in collecting the parasitoids and predators of the hymenoptera and *Dolichopodidae* diptera families. The blue trap showed specificity in the collection of asylides (Diptera). The efficiency of yellow color in the capture of insects was also observed by Silva et al. [17].

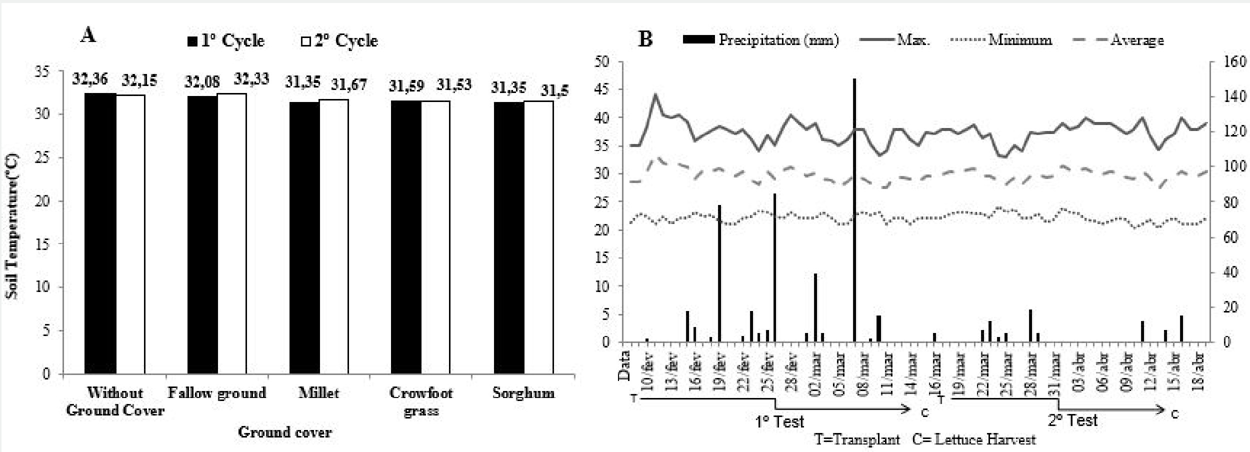

Figure 3: Soil temperature (A), maximum, minimum and average air temperature (oC) and rainfall (mm) (B) measured between February 8 and April 19, 2016. Growing seasons of the 1st and 2nd lettuce cycles.

The most abundant family was *Dolichopodidae* (Diptera), which may be related to the presence of prey in the area (aphid and thrips) [18], since in the second cycle a higher aphid infestation was observed in the surrounding sorghum band. Carvalho, Bueno and Mendes, [19] observed that the increase in predators and parasitoids coincided with the population peaks of aphids in chrysanthemum cultivation. Thus, the higher concentration of phytophagous insects in the crop also favors the increase of their predators in the area. Another important factor is that the lettuce growing area was near the edge of the forest (20m) favoring the *Dolichopodidae* family in biological control, as verified by BORTOLO et al., (2016). There was a greater abundance of natural enemies in the plot with surrounding sorghum strip, which may be related to the attractiveness of this species as a food source (nectar and pollen) and shelter. According to the record of Pincanço and Paula et al. [5] for hymenoptera predators in tomato cultivation. Regarding the number of total leaves (NFT) and commercial (NFC), in both cultivation cycles, there was no significant interaction for the factors studied, presence and absence of the surrounding strip of sorghum broom and soil cover plants (Table 4). For lettuce cultivation, in the first cycle, the number of commercial leaves (NFC) and totals (NFT) were higher in the cultivation system with the presence of the surrounding broom sorghum range. However, this difference was not observed in the second cycle.

Table 4: Number of commercial leaves (NFC) and total leaves (NFT) of lettuce plants due to the use of different cover crops and in the absence or presence of the surrounding broom sorghum range, in the 1st and 2nd Crop cycles. UNEMAT, New Mutum, 2016.

	Treatments	Nfc	Nft
1st Cycle	Absence of surrounding track	5.33 b	8.31 b
	Presence of surrounding track	8.13 to	10.72 to
	CV%	26,80	18,68
	Conventional	6.5 b	9.12 b
	Spontaneous vegetation	5.91 b	9.14 b
	Millet	7.87 to	10.90 to
	Chicken foot	7.72 to	10.25 to
	Sorghum	5.65 b	8.18 b
	CV%	13,16	10,36

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

2nd Cycle	Absence of surrounding track	16.75 to	19.45 to
	Presence of surrounding track	17.35 to	20.67 to
	CV%	29,05	25,95
	Conventional	16.39 to	19.41 to
	Spontaneous vegetation	18.04 to	20.68 to
	Millet	17.00 to	20.00 to
	Chicken foot	15.95 to	19.16 to
	Sorghum	17.87 to	21.04 to
	CV%	9,45	9,38

Means followed by the same letters in the column do not differ statistically from each other for each factor and cycle of cultivation, by the Scott-Knott test ($p<0.05$).

As for soil cover, lettuces grown under no-tillage with millet and chicken-foot grass showed higher number of total and commercial leaves in the first cycle (Table 4). However, in the second cycle the soil cover did not provide significant difference for these variables. The high temperature and precipitation of the experiment period may have affected the development of lettuce reducing the number of commercial and total leaves. The lettuce plant is sensitive to the occurrence of high temperatures. Combined with the occurrence of rains, plants of smaller size and quality are obtained. When lettuce receives temperatures above its ideal range it begins to lose water through the transpiration process, affecting the development of leaves [20]. Seabra et al. [21] reports the main difficulties of lettuce production in the region, and high temperatures and high rainfall are the main problems. In addition, high whitefly infestation and weed competition may have influenced development. The damage caused by the whitefly may compromise the appearance and impair the commercialization of the product [15]. According to Machado et al. [22], lettuce crop is affected, in its initial phase, by weed competition, affecting its leaf area.

For the characteristics of total production and commercial production, there was significant interaction between the factors studied, presence and absence of the surrounding strip of broom sorghum and soil cover for the two lettuce cultivation cycles (Table 5). It was observed higher total and commercial production of lettuce plants when they were cultivated under no-tillage, with soil cover, associated with the surrounding broom sorghum range. This trend was observed in both cultivation cycles (Table 5). In the first cycle, lettuce grown under no-tillage with soil cover of chicken foot and millet grass, associated with the surrounding broom sorghum range, showed higher total and commercial production. In the second cycle, the best response in terms of lettuce production occurred using sorghum as soil cover. The biomass of cover plants promoted plant suppression and consequently lower weed competition. Some studies conducted with lettuce demonstrate good agronomic performance when grown over no-tillage [17,23].

Table 5: Total and commercial production (g plant^{-1}) of lettuce plants as a function of the use of different cover crops in the absence or presence of the surrounding broom sorghum range, in the 1st and 2nd crop cycles.

	Ground cover	**Surrounding strip** Total Production Commercial Production (g plants^{-1})			
		Absence	Presence	Absence	Presence
1st Cycle	Conventional	15.00 Bb	29.79 Ba	7.44 Bb	20.83 Ca
	Spontaneous vegetation	15.00 Bb	33.33 Ba	7.70 Bb	22.50 Ca
	Millet	22.49 Ab	55.41 Aa	14.11 Ab	42.29 Aa
	Chicken foot	24.44 Ab	53.33 Aa	16.66 Ab	42.70 Aa
	Sorghum	14.72 Bb	37.33 Ba	6.34 Bb	30.20 Ba
	CV% (F. surrounding)	22,41		25,35	
	CV% (Coverage P.)	13,55		17,48	

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

2nd Cycle	Conventional	220.62 Aa	147.91 DB	197.08 Aa	120.62 DB
	Spontaneous vegetation	188.25 Ab	266.70 Aa	164.37 Bb	232.29 Aa
	Millet	188.12 Ab	233.16 Ba	161.66 Bb	201.45 Ba
	Chicken foot	197.50 Aa	195.41 Ca	163.12 Ba	155.83 Ca
	Sorghum	202.37 Ab	274.41 Aa	184.79 Ab	236.04 Aa
	CV% (F. surrounding)	17,93		20,84	
	CV% (P.de coverage)	8,85		11,44	

Means followed by the same uppercase letter in the column and lowercase in the row do not differ statistically from each other for each factor and cycle of cultivation, by the Scott-Knott test ($p<0.05$).

Millet was the soil cover species used that produced the lowest amount of biomass (6.8 t ha^{-1}). This resulted in less accumulation of straw in the soil, providing better accommodation of the straw, reducing the shading on the plant, since the accumulation of biomass in the soil can cause shading effect that compromises the development of seedlings [23]. Which may explain the higher lettuce production in the first cycle. On the other hand, the biomass of the millet remained longer in the soil due to the lower rate of decomposition in relation to the other studied cover species. This justifies, at the end of the second cycle, the greatest effect of weed suppression and, consequently, higher production, compared to the conventional, in the cultivation with the presence of surrounding ranges. In turn, the chicken foot grass produced twice as much biomass as millet (12.3 t ha^{-1}), the low size of the plants facilitates the accommodation of straw in the soil, so there is no shading effect on lettuce. A factor associated with the reduction of weed infestation justifies the higher production in the first cycle. However, the decomposition rate of crow's foot grass was higher than millet, reducing the weed suppression effect [22], justifying in the second crop cycle the lowest lettuce yield.

Sorghum also produced a large amount of biomass (10.8 t ha^{-1}) allowing greater accumulation of straw on the soil, which resulted in greater shading in lettuce, affecting development in the first cycle. This may have negatively influenced the initial development of lettuce causing seedling losses [23], and justifies in the first cycle the lower lettuce production obtained in treatments with sorghum as a cover plant. In the second cycle, there was accommodation of straw on the soil, possibly due to partial biomass decomposition in the period, which may justify the higher production of lettuce grown on sorghum. As for the yields obtained, total and commercial, it was found that in the first cycle the production was low, with averages ranging from 15.0 to 55.4g plant -1 and 7.4 to 42.7 g plant-1,respectively. The yields obtained in the second cycle were 10 to 15 times higher than those obtained in the first cycle, this was due to lower rainfall (90 mm) when compared to the first cycle (622 mm) (Figure 3).

The low production obtained in the first cycle can be justified by the higher incidence of weeds at the beginning of the cultivation cycle (Table 2), associated with high whitefly infestation (Figure 1) and high rainfall (Figure 3). Evidencing the difficulty of lettuce cultivation in February, requiring the use of conservation practices and development of technologies that favor the increase in production in this period. The temperatures, in general, presented similar averages in both cycles, with a mean for the first cycle, maximum and minimum of 29.7, 37.2 and 22.1 °C, respectively, and for the second cycle of 29.7, 37.3 and 22, 1 °C, respectively (Figure 3). Santos et al. [24] when evaluating the performance of 13 lettuce cultivars of the crespa type, in the period of high precipitation, in the municipality of Cáceres - MT, obtained lower results than, with the average temperature ranging from 35.3 °C; between 27.2 and 41.2 °C; between 10.7 and 24.4 °C, with total production of 52.5 to 111.5 g plant-1. Silva et al. [24] when studying the effect of different soil cover, under temperature conditions in which the minimum varied from 20.5 to 25 °C and the maximums of 28.6 to 39.2 °C, obtained yield from 204, 78 to 276.67 g lettuce plant-1. de alface.

When lettuce is subjected to high temperatures and high precipitation, its development is affected, causing the anticipation of the reproductive phase, compromising production [20]. According to Bezerra Neto et al. (2005), the ideal temperature for lettuce cultivation is 15 to 20 °C, which did not occur in the period of two cycles, with an average temperature of 29.7 °C. There was a reduction in soil temperature when lettuce was grown on the cover plants (Figure 2), and the average soil temperatures during the two cycles were 32.25, 32.20, 31.50, 31.50 and 31.40 °C for conventional cultivation, spontaneous vegetation, millet, chickengrass and sorghum, respectively [25-27].

Thus, soil temperature was lower in beds with implanted soil cover (millet, crow's foot grass and sorghum), which reduced from 0.8 to 1.1°C, respectively, for the first and second cycle, when compared to treatment without soil cover (Figure 2). Thus, the reduction of soil temperature can contribute to the production of lettuce grown on cover crops in periods of high temperatures. Among the conservation practices evaluated, the surrounding range of broom sorghum can be used in lettuce production areas, contributing to the organization of productive systems, increasing natural biological control, due to its attractiveness of natural enemies, influencing lettuce production in the period of high whitefly infestation.

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

No-tillage resulted in reduced soil temperature, weed suppression and consequent increase in lettuce production. In addition, it contributes to reduce the erosion of the beds, preserving their structures, in periods of high precipitation [2]. Therefore, the use of this technique allows a smaller workforce with soil revolving, construction site formation, manual weeding or herbicide use in the area [26].

Conclusion

Sorghum and chicken grass as cover crops were the species with the highest biomass production and the sorghum the highest weed suppression effect. The surrounding strip of sorghum broom increases pest control, increasing the population of natural enemies in the area. The use of no-tillage associated with the surrounding broom sorghum range provides higher lettuce production.

Thanks

I thank FAPEMAT (Mato Grosso Research Support Foundation) for funding a scholarship to carry out this work and researchers Karine Schoeninger and Alexandre Emanuel Camargo Silveira of the National Institute of Amazonian Research-INPA for identifying insects of the order Hymenoptera and Diptera.

Acknowledgement

We would like to thank the Coordination for the Improvement of Higher Education Personnel-CAPES (Process 224287/2015), the Mato Grosso State Research Support Foundation - FAPEMAT (Universal Call 005/2015 FAPEMAT) and the State University of Mato Grosso - UNEMAT for their support in the integration for the execution of this work and scientific technical development.

References

1. Filgueira FAR (2013) New manual of olericulture: modern agrotechnology in the production and marketing of vegetables. 3rd Ed. Rev. Ampl. Viçosa: UFV pp. 421.
2. Ferreira RLF, Araújo NSE, Silva SS, Abud EA, Rezende MIFL, et al. (2009) Combinations between cultivars, environments, tillage and soil cover in agronomic characteristics of lettuce. Horticulture Brasileira 27: 383-388.
3. Gomes DS, Bevilaqua NC, Silva FB, Monquero PA (2014) Suppression of spontaneous plants by the use of crotalaria and sorghum vegetation cover. Brazilian Journal of agroecology 9: 206-213.
4. ANVISA (National Health Surveillance Agency) (2012) Supplementary report on the second stage of analysis of samples collected in Brasilia, p. 1-33.
5. Paula SV, Pincanço MV, Oliveira IR, Gusmao MR (2004) Control of tomato fruit broochers using surrounding crop ranges. Bioscienc Journal, Uberlândia 20(1): 33-39.
6. Nogueira SF, Quartaroli CF, Greek CR, Andrade RG, Holler WA (2010) Estimation of carbon stock in soybean production systems in the northern region of Mato Grosso. Campinas, EMBRAPA (Research and Development Bulletin 15) p. 31.
7. Torres JLR, Pereira MG, Fabian JA (2008) Phytomass production by cover plants and mineralization of their residues in no-tillage. Revista Agropecuária Brasileira, Brasília 43(3): 421-428.
8. Thomas RJ, Asakawa NM (1993) Decomposition of leaf litter from tropical forage grasses and vegetables. Soil Biology and Biochem 25: 1351-1361.
9. Paul EA, Clark FE (1989) Soil microbiology and biochemistry 2nd Ed. New York, Academic Press. 340p.
10. Moreira HJC (2011) Weed Identification Manual: Hortifrúti. Horlandezan Beleides Nippes Bragança-São Paulo: FMC agricultural Products, p. 1017.
11. Fonatanétti A, Carvalho GJ, Morais AR, Almeida K, Duarte WF (2004) Green fertilization in the control of invasive plants in american lettuce and cabbage crops. Agrotechnical Science. Lavras 28(5): 967-973.
12. Silva FWM, Leite RJV, Carregaro JB (2013a) Composition of insects in the dry season with the use of colorful trap dishes in typical cerrado and cerrado park. Ensaios e Ciências, Campo Grande, 17(6): 19-88.
13. Boer CA, Assis RL, Silva GP, Braz AJBP, Barroso ALL, et al. (2008) Biomass, decomposition and soil cover caused by crop residues of three plant species in the midwest region of Brazil. Journal Soil Science. Viçosa 32(2) p. 843-851.
14. Harterreiten SES, Araujo LKP, Pinto RA, Pires CSS, Pujol LJR, et al. (2014) Influence of local agroecological practices and surrounding landscape on the population fluctuation of the whitefly Bemisia tabacino Distrito Federal. Agroecology notebook. Brasilia 9(3).
15. Guimaranhães JA, Michereff FM, Liz RS (2011) Pest management in vegetable seed production fields. Brasília: EMBRAPA Horta p. 23 (Circular Técnica 94).
16. Gaertner C, Borba RS (2014) Different colors of adhesive traps in monitoring pests in hydroponic lettuce. Thema magazine 11: 1-11.
17. Silva LB, Nodari IDE, Seabra JS, Dias LDE, Neves JF (2013b) Lettuce production in the no-tillage system with live and dead cover under high temperature conditions. Revista Encyclopedia Biosphere, Goiânia 9(16):17-43.
18. Harterreiten SES, Pires CSS, Carneiro RG, Sujii ER (2011) Predators and lysoids: Allies of the rural producer in the process of agroecological transition. Brasília, DF: Emater, Embrapa Genetic Resources and Biotechnology, CNPq 92.
19. Carvalho LM, Bueno VHP, Mendes SM (2006) Occurrence and population fluctuation of thrips, aphids and natural enemies in cut chrysanthemum in a greenhouse. Bragantia, Campinas 65(1):139-146.
20. Santos CL, Seabra JS, Lalla JG, Theodoro AVC, Nespoli A (2009) Performance of lettuce cultivars under high temperatures in Cáceres-MT. Revista Agrarian, Dourados 2(3).
21. Seabra SJ, Vargas MD, Ponce FS, Queiroz RFN, Antunes DT, et al. (2016) Vegetable production in Mato Grosso. In: Brazilian Congress of Olericultura, 54. Annals Recife: ABH, p. 236.
22. Machado MH, Athanásio JC, Giancotti PRF (2009) Influence of different periods of weed control on lettuce. Horticulture Brasileira 27: 1762-1767.
23. Hirata ACS, Hirata EK, Barrionuevo RM, Monquero PA (2015) Management of millet for no-tillage of lettuce in summer with or without lifting of flower beds. Brazilian Horticulture 33: 398-403.
24. Santos ILVL, Silva CRC, Santos SL, Maia MMD (2009) Sorgoleone: sorghum lipid benzoquinone with allopathic effects on agriculture as herbicides. Archives of the Biological Institute, São Paulo 79(1): 135-144.

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273

25. Shrigmy MV, Paula SV, Moraes JAR, Oliveira IR, Sooth AA, et al. (2004) Financial impacts of the adoption of integrated pest management in tomato crop. Acta Scientiarum, Maringá 261(2): 245-252.

26. Silva AG, Boiça JAL, Farias PRS, Souza BHS, Rodrigues NEL, et al. (2014) Population Dynamics of Whitefly *Bemisia tabaci* (Genn.) Biotype B *(Hemiptera: Aleyrodidae)* in Feijoeiro. Entomo Brasilis Magazine 7: 5 -11.

27. Silva FAS, Azevedo CAV (2002) Version of the Assistat computer program for the Windows operating system. Brazilian Magazine of Agroindustria Products, Campina Grande 4(1): 71-78.

How to cite this article: Maicon D d V, Mônica J B P, Julian M d S, Douglas P d S, Rivanildo D, et al. No-tillage and Vegetable Barrier as a Strategy for Pest Management in the Production of Lettuce. Agri Res & Tech: Open Access J. 2020; 24(4): 556273. DOI: 10.19080/ARTOAJ.2020.24.556273