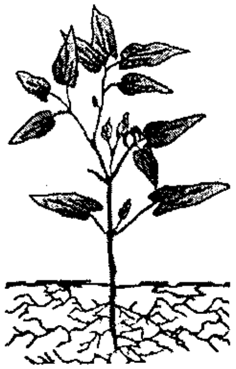

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INTEGRATED WEED MANAGEMENT IN SESAME

[4]

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Keywords: Sesame, Plant geometry, Weed biomass, Light intensity

ABSTRACT

At the Research and Experimental Station Farm, Faculty of Agriculture, Ain Shams University at Shalakan, Kalubia Governorate, Egypt, two field experiments were carried out during the 2006 and 2007 growing seasons to study the response of sesame growth, yield and the associated weeds to three manual weed management (hand hoeing twice, hoeing once and unweeded), and cultural weed management i.e., four plant geometrical distributions (planting on one side of the ridge with either 10 cm-hill distance and one plant/hill [G_1] or 20 cm-hill distance and two plants/hill [G_2] as well as planting on the two sides of the ridge with either 20 cm-hill distance and one plant/hill [G_3] or 40 cm-hill distance with two plants/hill [G_4]. Results showed that weeds that grew with hoed twice-sesame plants received less light, producing poor biomass. Also, hoeing twice was the superior weed control treatment for increasing LA, LAI, yield components and biological, seed and oil yields/fed. G_1 and G_2 patterns surpassed G_4 for reducing light intensity, and exceeded G_3 as well as G_4 for decreasing weed biomass. Moreover, G_1 and G_2 patterns were the superior and equal for enhancing LA, LAI, plant height, weight of capsules and seeds/plant as well as biological, seed and oil yields/fed. There is a significant and negative relation between sesame seed yield either with weed biomass or transmitted light. Whereas, the corresponding relation was significantly positive with LAI. Multiple regression equation referred to that the weed biomass and transmitted light increase as well as LAI decreases by one unit, the seed yield decreases by 0.68, 0.26 and 76.3 kg/fed., respectively.

INTRODUCTION

Sesame is a crucial oilseed crop in many developing countries. It could be grown under fairly high temperature and low water supply (**Weiss, 1983** and **Basavarai *et al* 2000**). In addition, it has a short growing season and its seeds are rich in oil and protein. In Egypt, sesame is a food crop rather than oilseed one being most of its seed production is directly used for manufacture products.

Increasing crop productivity could be achieved through application an effective integrated weed management program. Integrated weed management is an approach utilizes two or more of weed control techniques to reduce weed population at levels below these causing economic injuries. In this concern, sesame plant has a low growth rate at the early stages, so encountering severe competition from weeds for light and other environmental resources. Through light deprivation, less energy is available to crop plants for metabolic production and hence growth, yield and quality will be reduced. Weeds cause enormous damage to the sesame yield and the magnitude of loss ranges from 23.8 and 71.2 % (**Chauhan & Gurjar, 1998** and **Singh *et al* 2003**). So, managing weeds is essential. In this regard, manual and cultural weed management methods are remarkable, especially under sustainable agriculture conditions, where the agro-chemicals are not applied. Herein, hoeing still a conventional weed control pattern in row spacing crops, but hand labor is becoming scarce and their wages have been increased. This in turn presents

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to view the needs of another reasonable alternative method for weed control. Modification of plant geometry by choosing the optimal plant distribution as a cultural weed control, with potentiality, might be considered. Spatial distribution of the crop canopy may be important for weed suppression, but literature cited related to the effect of geometrical distribution of sesame on the associated weeds are so scarce

It was necessary to conduct this study with the objective of determining the influence of weed management (integrating hand hoeing with plant geometrical distribution) on sesame productivity and the associated weeds.

MATERIALS AND METHODS

At the Research and Experimental Station Farm, Faculty of Agriculture, Ain Shams University at Shalakan, Kalubia Governorate, Egypt, two field experiments were carried out during the 2006 and 2007 growing seasons to study the response of sesame growth, yield and the associated weeds to the following:

1- Three manual hoeing treatments: hand hoeing twice at 25 and 40; hoeing once at 25 days after sowing in addition to the unhoed; and
2- Four plant geometrical distributions: planting on one side of the ridge with either 10 cm-hill distance and one plant/hill (G_1) or 20 cm-hill distance and two plants/hill (G_2) as well as planting on the two sides of the ridge with either 20 cm-hill distance and one plant/hill (G_3) or 40 cm-hill distance with two plants/hill (G_4). Thus, it is noted that the four distributions produce the same theoretical plant density (66666 plants/fed.).

A randomized complete block design was used with four replicates. Each plot area was 12.96 m^2 and contained 6 ridges (3.6 m length and 60 cm apart).

The soil texture of the experimental site was clay loam, with 1.2 % organic matter, 0.13 % total nitrogen and pH of 7.4. The preceding crop was clover in both seasons.

Seeds of sesame (c.v. Shandawel-4) were drilled in hills at a rate of 3.0 kg/fed., then sowing irrigation was applied. The sowing date was May 11^{th} and 21^{st} in the 1^{st} and 2^{nd} seasons, respectively. At 25 days after sowing, plants were thinned (to secure the number of plants/hill according to the distribution treatment) followed by irrigation. Phosphorus fertilizer (in the form of calcium super phosphate, 15 % P_2O_5) was applied during the soil preparation at the rate of 100 kg/fed. Also, nitrogen fertilizer (in the form of ammonium sulfate, 20 % N) was applied at the rate of 30 kg/fed. at three equal portions: after thinning, before the second and the third irrigation. All other recommended cultural practices were adopted throughout the two seasons.

Measurements

1- Light intensity

After 80 days from sowing, light intensity was measured at noon (using lux meter LX-101) at 50 cm height from soil surface. In this respect, three observations were recorded from each plot under the canopy of sesame plants, then the average of these three readings was calculated.

2- Weed biomass

Weeds were hand pulled from one length meter of middle ridge of each plot after 90 days from sowing. Biomass of weeds expressed in dry weight per square meter was calculated after air drying for 6 days and oven drying at 105° C for 24 hours.

3- Sesame plants

a- Growth traits

At 80 days from sowing, five guarded plants were randomly chosen from each experimental unit to estimate leaf area "LA", leaf area index "LAI" and specific leaf weight "SLW".

b- Yield and its attributes

At harvest, five guarded plants were taken randomly from each experimental plot to measure plant height, fruit zone length, capsules and seeds weight/plant and weight of 1000 seeds. Moreover, plants of one middle ridge of each plot were collected to evaluate biological and seed yields/fed.

c- Seed oil content

Oil percentage in seeds was measured by extraction using Soxhlet Apparatus with hexane as an organic solvent according to A.O.A.C. (1995), then oil yield was calculated.

Regression analysis

Simple and multiple regression relationships and determination coefficient (R^2) among sesame seed yield (dependent variable) and weed biomass, transmitted light and sesame LAI (independent variables) were estimated as described by **Draper & Smith (1998)**.

Statistical analysis

All the obtained data from each season were exposed to the proper statistical analysis of variance according to **Gomez & Gomez (1984)**. The combined analysis of variance for the data of the two seasons was performed after testing the error homogeneity, and LSD at 0.05 level of significance was used for the comparison between means.

RESULTS AND DISCUSSION

I- Light intensity and weed biomass

It is important to mention that the most commonly surveyed weeds in the experimental situations through the two growing seasons were grasses, i.e. jungle rice (*Echinochloa colonum*, (L.) Link.) and crowfoot grass (*Dactyloctenium aegyptium*, (L.) P. Beauv.)

There are remarkable impacts of hoeing treatments and geometrical distribution as well as their interaction on light intensity and weed biomass **(Table, 1)**.

Hoeing twice or once reduced light intensity and weed biomass comparing to the unhoed treatment. In this regard, sesame plants that hoed two times intercepted more sunlight. So, such pattern recorded the lowest value of light intensity, which was measured under the canopy (i.e., 50 cm from the soil surface). Accordingly, weeds that grew with hoed twice-sesame plants received less light, producing poor biomass. Such exceeded treatment decreased the two aforementioned traits by 78.0 and 89.7 %, respectively, over the unhoed. This illustrates the favorable effects of hoeing on weed elimination and on crop plant growth. Reduction in dry matter accumulation of weeds due to application of hand weeding twice was amounted to 60.4-84.6 %, over the control **(Chauhan & Gurjar, 1998** and **Kumar & Thakur, 2005)**. On the contrast, the severity of weeds (especially in the unhoed plots) appeared in competing crop plants (reducing their potential growth) and simultaneously receiving more light that enhanced weed biomass.

With respect to the effect of the geometrical distribution patterns on light intensity and weed biomass, G_1 and G_2 patterns surpassed G_4 for reducing light intensity, and exceeded G_3 as well as G_4 for decreasing weed biomass. These results may be attributed to the high competition against weeds exerted by closing the distance among crop plants on the same ridge side (as in G_1 or G_2) especially in the early stages where sesame plants are more sensitive to weed competition.

Considerable interaction impacts between hoeing treatments and geometrical distribution on light intensity and weed biomass were obtained **(Table, 1)**. Hoeing twice x G_1 attained the best effect for diminishing such two traits, while the unhoed x G_4 was the inferior one in this respect. This reflects the beneficial integration between manual (hoeing) and cultural (plant distribution) weed control for depressing weeds.

II- Sesame growth traits

Data in **Table (2)** show the influence of the two studied factors and their interactions on LA, LAI and SLW of sesame plants after 80 days from sowing.

The available results indicate that hand hoed treatments exceeded the unhoed one for promoting LA and LAI. Also, hoeing twice surpassed hoeing once in such two traits. Unlike, SLW values were significantly higher with hoeing once or no hoeing than when hoeing was applied twice. This confirms the relative low of metabolites translocated from leaves (source) to other plant parts (sink), in addition to the reduction in leaf expansion in the two former treatments. While, the increase in LA accompanied more translocation for plants hoed twice. This also reflects that hoeing twice adjusts between the vegetative growth and the physiological responses of crop plants.

LA and LAI were statistically responded to geometrical distribution, while SLW was not affected. G_2 along with G_1 were the distinctive patterns for enhancing both LA and LAI. This might be due to that sesame plants in G_2 and G_1 plots captured more environmental growth factors (they were more effective against weeds) than that of in the other distributions. Crop geometry of 30 x 30 cm^2 proved superior to 45 x 20 cm^2 in enhancing sesame LAI **(Sarkar & Pal, 2005)**.

The combination between hoeing treatments and geometrical distribution had a significant effect on LA and LAI, while did not affect SLW. Hoeing twice x G_2 was the effective interaction for improving such two traits, but unhoed x G_4 recorded the minimal values.

Table 1. Light intensity and weed biomass as influenced by hoeing treatments, plant geometrical distribution and their interaction in sesame

Variables	Geometrical distribution (G)				Mean
	G_1	G_2	G_3	G_4	
Hoeing treatments (H)					
		Light intensity (lux)			
Hoeing twice	138.4	235.5	232.8	179.2	*196.5*
Hoeing once	236.2	378.1	279.4	491.3	*346.2*
Unhoed	986.7	653.0	899.3	1041.5	*895.1*
Mean	***453.8***	***422.2***	***470.5***	***570.6***	
LSD (0.05):	H: 90.7,	G: 104.7	HxG: 181.3		
		Weed biomass ($g.m^{-2}$)			
Hoeing twice	5.6	6.4	74.3	102.0	*47.1*
Hoeing once	148.7	153.5	272.1	316.8	*222.8*
Unhoed	283.6	402.5	570.4	612.4	*467.2*
Mean	***146.0***	***187.5***	***305.6***	***343.7***	
LSD (0.05):	H: 21.0,	G: 24.3	HxG: 42.1		

Table 2. Sesame growth traits as influenced by hoeing treatments, plant geometrical distribution and their interaction

Variables	Geometrical distribution (G)				Mean
	G_1	G_2	G_3	G_4	
Hoeing treatments (H)					
		LA (cm^2)			
Hoeing twice	3325.4	3634.5	1724.7	1583.4	*2517.5*
Hoeing once	1400.3	2090.5	1187.0	1634.7	*1578.9*
Unhoed	694.4	1010.5	589.2	349.4	*660.9*
Mean	***1806.7***	***2179.2***	***1167.0***	***1189.2***	
LSD (0.05):	H: 372.5	G: 430.2	HxG: 745.0		
		LAI			
Hoeing twice	5.54	5.72	2.87	2.63	*4.19*
Hoeing once	2.33	3.48	1.97	2.72	*2.62*
Unhoed	1.15	1.68	0.98	0.58	*1.09*
Mean	***3.00***	***3.62***	***1.94***	***1.98***	
LSD (0.05):	H: 0.62	G: 0.71	HxG: 1.24		
		SLW ($mg.cm^{-2}$)			
Hoeing twice	5.25	4.63	4.94	5.12	*4.99*
Hoeing once	6.07	5.87	5.09	5.63	*5.66*
Unhoed	5.97	6.09	5.71	5.61	*5.84*
Mean	***5.76***	***5.53***	***5.24***	***5.45***	
LSD (0.05):	H: 0.32	G: n.s	HxG: n.s		

III- Sesame yield and its attributes

Sesame yield and its attributes as well as seed oil content were significantly affected by hoeing treatments, geometrical distribution and their interaction as shown in **Tables (3 & 4)**.

As expected, hoeing twice was the superior weed control method (comparing to other hoeing treatments) for increasing plant height, fruit zone length, weight of capsules and seeds/plant, weight of 1000 seeds as well as biological and seed yields/fed. On the contrary, the unhoed treatment was the inferior in this respect. Moreover, hoeing once and twice recorded the maximum oil % and oil yield, respectively. Hoeing, as effective tool for weed elimination, minimizes weed competition and increases the capacity of crop plants to utilize light, water, nutrients, CO_2 and other environmental factors. This in turn increases the amount of metabolites synthesized, enhancing plant growth, and consequently yields and its attributes. Similar observations were obtained by **Yadav (2004)** and **Kumar & Thakur (2005)**.

Table 3. Sesame yield components as influenced by hoeing treatments, plant geometrical distribution and their interaction

Variables	Geometrical distribution (G)				Mean
	G_1	G_2	G_3	G_4	
Hoeing treatments (H)					
		Plant height (cm)			
Hoeing twice	153.9	168.7	130.7	144.9	***149.6***
Hoeing once	157.7	142.2	119.1	131.5	***137.6***
Unhoed	124.8	119.3	107.6	116.5	***117.1***
Mean	***145.5***	***143.4***	***119.1***	***131.0***	
LSD (0.05):	H: 3.4	G: 4.0	HxG: 6.8		
		Fruit zone length (cm)			
Hoeing twice	98.3	115.1	84.9	93.9	***98.1***
Hoeing once	94.2	94.6	62.5	90.4	***85.5***
Unhoed	50.4	57.1	47.7	58.1	***53.3***
Mean	***81.0***	***88.9***	***65.0***	***80.3***	
LSD (0.05):	H: 3.5	G: 4.1	HxG: 7.1		
		Capsules weight/plant (g)			
Hoeing twice	31.3	46.0	24.7	25.3	***31.8***
Hoeing once	29.3	21.3	13.7	14.7	***19.8***
Unhoed	9.3	11.0	7.3	8.0	***8.9***
Mean	***23.3***	***26.1***	***15.2***	***16.0***	
LSD (0.05):	H: 2.8	G: 3.2	HxG: 5.6		
		Seeds weight/plant (g)			
Hoeing twice	14.1	19.2	10.3	10.1	***13.4***
Hoeing once	13.1	8.5	4.7	6.2	***8.1***
Unhoed	2.9	3.4	1.4	1.8	***2.4***
Mean	***10.0***	***10.4***	***5.5***	***6.2***	
LSD (0.05):	H: 1.3	G: 1.5	HxG: 2.7		
		Weight of 1000 seeds (g)			
Hoeing twice	4.16	4.28	4.01	4.03	***4.12***
Hoeing once	4.11	4.06	3.82	3.92	***3.98***
Unhoed	4.06	3.60	3.60	3.90	***3.79***
Mean	***4.11***	***3.98***	***3.81***	***3.95***	
LSD (0.05):	H: 0.07	G: 0.08	HxG: 0.15		

Table 4. Sesame yields and seed oil % as influenced by hoeing treatments, plant geometrical distribution and their interaction

Variables	Geometrical distribution (G)				Mean
	G_1	G_2	G_3	G_4	
Hoeing treatments (H)					
		Biological yield (ton fed^{-1})			
Hoeing twice	2.85	2.98	2.38	2.06	*2.57*
Hoeing once	2.20	2.09	1.59	1.42	*1.82*
Unhoed	0.87	0.89	0.60	0.57	*0.73*
Mean	***1.97***	***1.99***	***1.52***	***1.35***	
LSD (0.05):	H: 0.17	G: 0.20	HxG: 0.34		
		Seed yield (kg fed^{-1})			
Hoeing twice	985.0	1069.4	783.3	694.5	*883.1*
Hoeing once	764.1	651.4	438.3	446.1	*575.0*
Unhoed	190.5	213.1	81.3	104.6	*147.4*
Mean	***646.5***	***644.6***	***434.3***	***415.1***	
LSD (0.05):	H: 70.2	G: 81.1	HxG: 140.4		
		Oil %			
Hoeing twice	53.7	55.1	55.4	56.4	*55.1*
Hoeing once	56.1	55.4	55.7	57.0	*56.1*
Unhoed	55.3	54.7	52.2	53.9	*54.0*
Mean	***55.0***	***55.1***	***54.4***	***55.8***	
LSD (0.05):	H: 0.53	G: 0.61	HxG: 1.06		
		Oil yield (kg fed^{-1})			
Hoeing twice	528.9	589.2	433.9	391.7	*485.9*
Hoeing once	428.7	360.8	244.1	254.3	*321.9*
Unhoed	105.3	116.6	42.4	56.4	*80.2*
Mean	***354.3***	***355.5***	***240.1***	***234.1***	
LSD (0.05):	H: 39.1	G: 45.2	HxG: 78.2		

Concerning the effect of geometrical distribution on yield and its attributes, G_2 recorded the significantly highest value of fruit zone length, while G_1 was the effective for improving weight of 1000 seeds. Also, the two aforementioned practices were superior and equal for enhancing plant height, weight of capsules and seeds/plant as well as biological, seed and oil yields/fed., exceeding other patterns. Furthermore, G_4 gave the highest seed oil %. Being G_1 and G_2 achieved the highest values of LA and LAI (**Table, 2**), enhancing net assimilation and crop growth rates, so increasing yield and its components are expected. Under the same plant populations, crop geometrical distribution significantly varied in yield and its attributes (**Sarkar & Pal, 2005** and **Rahnama & Bakhshandeh, 2006**).

Hoeing twice x G_2 was the most effective combination being produced the maximum values of all yield attributes as well as biological, seed and oil yields/fed. (**Tables, 3 & 4**). This shows that choosing the suitable plant distribution needs to well hand hoed i.e., hoeing twice and vice versa, for saving noticeable sesame yields. Furthermore, hoeing once x G_4 showed the maximal seed oil %. Under weedy conditions, G_3 was the inferior practice in plant height and fruit zone length, while G_1 was the superior in weight of 1000 seeds.

Regression analysis

By studying the simple regression relationships and computing coefficient of determination (R^2) between sesame seed yield, as a dependent variable, and each of weed biomass, transmitted light and LAI, as independent ones, it is shown that the suitable mathematical uniform is the linear one (**Fig. 1**).

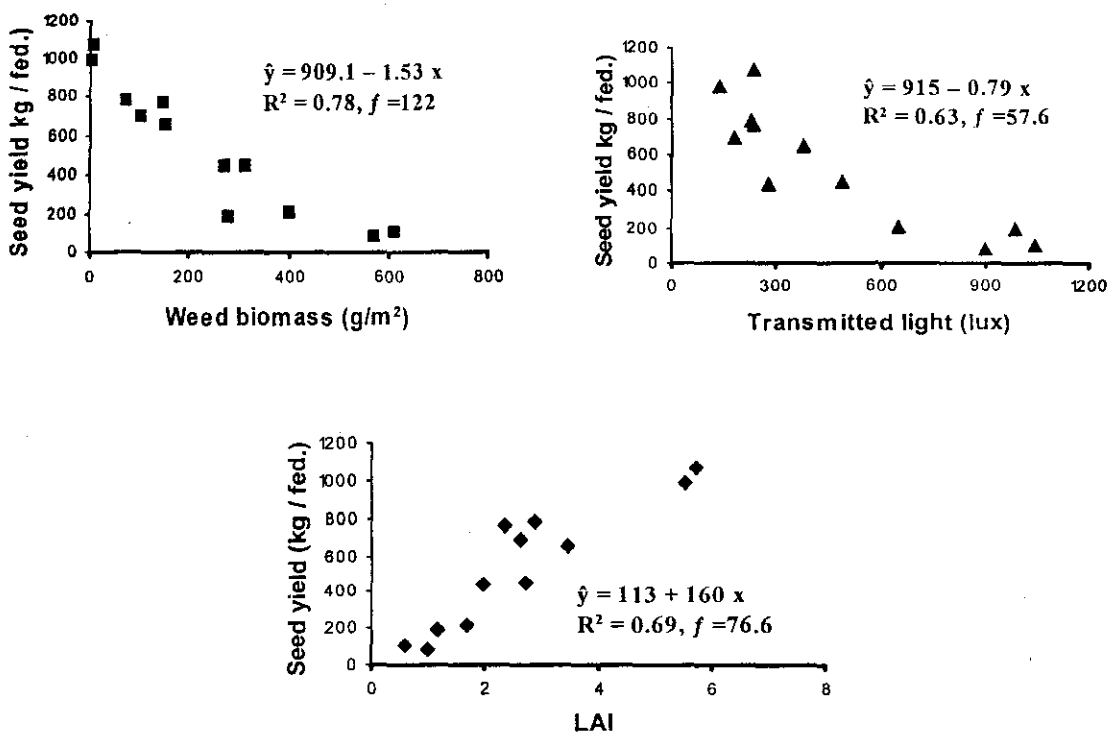

Fig. 1. Simple regression relationships of sesame seed yield with each of weed biomass, transmitted light and LAI

According to regression equations, there is a significant and negative relation between sesame seed yield either with weed biomass or transmitted light. Whereas, the corresponding relation was significantly positive with LAI. From R^2 value of each, it is observe that weed biomass parameter is more effective in exhibiting changes in seed yield than transmitted light, where 78% of these changes were attributed to weed biomass and 63% of them resulted only from transmitted light.

Additionally, regression equations predict that the more the weed biomass and transmitted light increase as well as LAI decreases by one unit, the more the seed yield decreases by 1.53, 0.79 and 160.0 kg/fed., respectively.

From multiple regression equation ($\hat{y}$ = 623 – 0.68 x_1 – 0.26 x_2 + 76.3 x_3, R^2 = 0.88, f =78.9), 88 % of the changes of sesame seed yield due to weed biomass, transmitted light and LAI together. Moreover, the model refers to the weed biomass and transmitted light increase as well as LAI decreases by one unit, the seed yield decreases by 0.68, 0.26 and 76.3 kg/fed., respectively.

Calculated values of f in simple and multiple regression relationships reveal the significance of the applied model and it is suitable for the data of studied traits.

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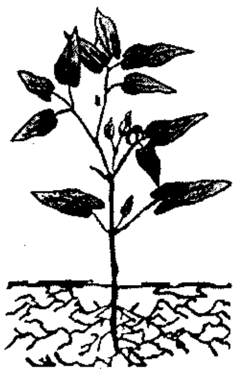
حوليـــات العلـــوم الزراعية
جامعة عين شمس ، القاهرة
مجلد(٥٤)، عدد (١)، ٤٩-٥٧، ٢٠٠٩



المكافحة المتكاملة للحشائش فى السمسم

[٤]

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١- قسم المحاصيل - كلية الزراعة - جامعة عين شمس - شبرا الخيمة - القاهرة - مصر

الموجـــز

أقيمت تجربتان حقليتان خـلال موسـمى ٢٠٠٦ و٢٠٠٧ بمحطة التجارب و البحوث الزراعية بشلقان - كلية الزراعة - جامعة عين شـمس - محافظـة القليوبية لدراسة تأثير ثلاث معاملات للمكافحة اليدوية للحشائش (العزيق مرتين، العزيق مرة واحدة، بـدون عزيق) و معاملات مكافحة زراعية اشتملت أربعـة توزيعات نباتية {الزراعة على ريشة واحـدة للخـط والمسافة بـين النباتـات ١٠سـم و نبـات واحـد بالجورة [G_1]، الزراعة على ريـشة واحـدة للخـط والمسافة بين النباتات ٢٠سم و نباتين بالجورة [G_2]، الزراعة على ريشتى الخط و المسافة بـين النباتـات ٢٠سم و نبات واحد بالجورة [G_3]، الزراعـة علـى ريشتى الخط و المسافة بين النباتات ٤٠سم و نبـاتين بالجورة [G_4]} و ذلك على نمو و محصول السمـسم والحشائش المصاحبة. و قد أوضـحت النتـائج أن معاملة العزيق مرتين كان لها أفضل الأثر فى خفض مقدار الضوء الواصل للحشائش النامية مـع نباتـات السمسم ، كما سجلت أقل وزن جاف للحشائش. حقق أيضا العزيق مرتين أعلى زيادة فى مـساحة أوراق نبات السمسم و دليل مـساحة الأوراق و محـصول البذور والزيت/فدان. تفوقت معاملتى G_1 وG_2 علـى معاملة G_4 فى خفـض مقـدار الـضوء الواصـل للحشائش، كما تفوقتا أيضا على معـاملتى G_3 و G_4 فى تقليل الوزن الجاف للحشائش. كانت معاملتى G_1 وG_2 هى المتفوقة فى تحسين مـساحة أوراق نبـات السمسم ودليل مساحة الأوراق وارتفاع النبات ووزن الكبسولات والبذور/نبـات والمحـصول البيولـوجى ومحصول البذور والزيت/فدان. كانت هناك علاقـة سالبة معنويا بين محصول بذور السمسم و كل مـن الوزن الجاف للحشائش و مقدار الضؤ الواصل اليها، بينما كانت هذه العلاقة موجبة معنويا مع دليل مساحة الأوراق. وقد أشـار النمـوذج الرياضـى لمعادلـة الانحدار المتعدد الى ان الزيادة فى كل مـن الـوزن الجاف للحشائش ومقدار الضؤ الواصل والنقص فـى دليل مساحة الأوراق بمقدار الوحدة يسبب نقصا فـى محصول بذور السمسم بمقدار ٠,٦٨ و ٠,٢٦ و٧٦,٣ كجم/فدان على الترتيب.

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