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Effect of seed rate and manual weeding on weed infestation and subsequent crop performance of sesame (*Sesamum indicum* L.)

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Abstract

Crop-weed competition has a profound effect on the seed yield of sesame. We evaluated the effects of both the seed rate and weeding regime on the weed infestation and crop performance of sesame. Two factors *viz* seed rate (6, 7, 8, 9 or 10 kg ha^{-1}) and weeding regimes (no weeding, single-weeding, weeding twice, and complete weeding) were included in the experiment. The experiment was implemented in a split-plot design accommodating seed rate in the main plot and weeding regime in the subplot with three replications. Mean data from the two-year experiment showed that weed density and weed dry weight were significantly affected by seed rate: these two variables decreased with the increase in the seed rate ($p < 0.01$). The seed rate significantly influenced myriad different variables that included: the plant population, plant height, number of branches per plant, number of infertile flowers per plant, number of seeds per capsule, 1000 seed weight, seed yield, stove yield and harvest index. Two factors, number of seeds per capsule and 1000 seed weight, were significantly decreased by variations in weeding regime ($p < 0.01$). The plant population decreased significantly with increasing weeding frequency. Seed yield, stover yield and their attributes were significantly improved in the weeded crop than in the non-weeded one. The "weed free" and "two weeding" treatments resulted in better yield performance compared to the weeding treatments. Overall, the interaction effect of seed rate and weeding regime was not significant in respect to the plant characteristics and seed yield. Nevertheless, a seed rate of 9 kg ha^{-1}, coupled with twice manual weeding, illustrated the best seed yield. Therefore, crop competition can be explored as an effective alternative weed management strategy and achieving optimal yield of sesame.

Keywords: Crop: Weed competition, Seed yield, *Sesamum indicum* L., Weed control.
Abbreviations: BARI_ Bangladesh Agricultural Research Institute; DMRT_ Duncan's Multiple Range Test; IV_ Importance value of weed.

Introduction

Sesame (*Sesamum indicum* L; Pedaliaeace family) is an oil seed crop that has been grown since ancient times. Sesame seed has the highest oil content of any seed. It grows well in tropical and subtropical areas, while its yield performance is relatively high in temperate climate (Blair, 2008). Sesame is not only an oil-rich seed (42-45%) but also in protein (20%) and carbohydrates (14-20%). Sesame oil is used mostly for edible purpose; the seeds are used in baking, candy making, and other food industries (Martin and Leonard, 1964; Verma et al., 2013). Sesame oil also possesses anti-aging properties (Arslan et al., 2007; Uzun et al., 2007; Chayjan, 2010).The oil is highly resistant to oxidative deterioration because of antioxidant lignans such as sesamin and sesamolin (Yoshida and Takagi, 1997; Moazzami and Kamal-Eldin, 2006; Erbas et al., 2009). Despite its myriad uses, sesame yield potential is not optimized in farmers' field due to low-seed yield (Robbelen et al., 1989) diseases (El-Bramawy, 2006); stress factors (Sarwar et al., 2007); and un-mechanized features (Uzun et al., 2003, 2004; Uzun and Cagirgan, 2006, 2009). In developing countries, weed infestation is a major concern for sesame production; this is particularly the case where modern agricultural practices such as mechanical weeding and the application of herbicides are limited. Weed species generally have better nutrition efficiency and typically dominates and weakens crop plants, which negatively affects plant morphology and eventually crop yield. In particular, there is an initial slow growth phase during the first four weeks of the sesame life cycle. This delicate period makes sesame seedlings particularly vulnerable to weed competition and severely affects the seedling establishment (Bennett et al., 2003). Therefore, insufficient weed control during the early growth period of sesame may cause yield reduction. However, mechanical/manual weeding is difficult during the early-stage seedling of sesame. Cultural practices are often effective for enhancing weed competition in crops (Khaliq et al., 2012). The critical period for weed competition to improve crop yields vary considerably with the nature and status of the crop grown, the weed flora composition, the extent of weed infestation, and the prevailing environment (Weaver et al., 1992; Knezevic et al., 2002). For sesame, this critical period is between 10 and 30 days after seedling emergence (Amare et al., 2009). Thus, understanding the level of occurrence and the composition of the weed community under each cropping system is critical for achieving yield potential. Overall, mechanical weed control is expensive in developing countries due to prohibitive initial investment costs and chemical methods often leads to environmental pollution (Omezzine et al., 2011); in addition, many weed species have developed resistance against herbicide. Thus, alternative weed control could be an important way to increase sesame yield by reducing the initial cost of investment and maintaining environmental integrity. Both crop and weeds compete for limited resources in the field (light, water, nutrients etc.). Crop density significantly influences the incidence of weeds due to their competition for resources. As a consequence, the contribution of each individual plant to the overall may not be optimized. Indeed, higher plant densities result in reduced branch and seed numbers per plant even though the overall yield per area may remain the same (Lemerle et al., 1996). Thus, optimal plant density and weeding regimes need to be established to reduce crop-weed competition. The aim of this study was to investigate the effect of seeding density and manual weeding regime on the yield performance of sesame.

Results and Discussions

Diversity in weed species

Seventeen different weed species belonging to 10 families were found growing in the experimental field. Fourteen species were annuals, while three were perennial. Among these, the grass family was the most common with five species. The scientific name, family and classification of weed types of these weeds are presented in the Table 1. Among the infesting species of weeds *Polygonum hydropiper*, *Cyperus rotundus*, *Lindernia procumbens*, *Chenopodium album*, *Echinochloa colonum*, and *Physalis heterophylla*, were the most important ones in terms of value.

Effect of seed rate on the density and biomass accumulation of weed

As the crop population brings competition for limited resources with the weeds, we tested different seeding rates to increase crop plant density as a measure to control weeds. The weed population was significantly affected by seed rate ($p < 0.01$; Table 2): The highest weed density (m^{-2}) was observed in the area with the lowest seed rate (i.e. 6 kg ha^{-1}). The lowest weed density was recorded in the area with the seed rate of 10 kg ha^{-1}. However, the weed density for this area was also very close to those in 9 kg ha^{-1} seeding rate. There were no significant difference in weed densities between areas with a seed rate of 7 kg ha^{-1} and 8 kg ha^{-1}. In general, however, there was an inverse relationship between a decreasing weed density ($p < 0.01$) and an increasing seed rate. The increased seed rate resulted in a higher crop plant population providing less space for weeds to grow and offering much higher competition for light, nutrient and other growth factors. These factors collectively resulted in lower weed density. Increasing seed rate of sesame significantly decreased ($p < 0.01$) weed dry weight. The seeding rate also has a profound effect on the weed dry weight in sesame. The highest weed dry weight was recorded in the seed rate of 6 kg ha^{-1} and the lowest was found in 10 kg ha^{-1}, which was identical with that in the seed rate of 9 kg ha^{-1}. There are several reasons why there was a lower density of weed infestation in areas that had a higher seed rate. Guillermo et al. (2009) showed that areas with higher plant densities might have a competitive advantage over weeds due to fast canopy development. A higher seeding rate may keep the weed flora under check through a smothering effect (Mahajan et al., 2010). Mohler (1996) revealed that a higher seeding rate may provide a competitive advantage to crop over weeds because crop plants will absorb limited resources at a faster rate. However, an increased seeding rate may not always increase the weed competitiveness of a crop, and greater intra-crop competition may arise. This may lead to negative effects on crop production, especially under stressful environmental conditions (Krikland et al., 2000). Therefore, an optimal seed rate, along with some weed control, is frequently practiced. For instance, Khaliq et al. (2012) showed that higher seeding density and herbicide tank mixture furnished effective weed control in direct seeded rice.

Effect of seed rate on yield related to characteristics of sesame

A number of variables were significantly influenced ($p < 0.01$) by seed rate: Plant population, plant height, number of branch $plant^{-1}$, number of capsules $branches^{-1}$, number of capsules $plant^{-1}$, number of infertile flowers $plant^{-1}$, number of seeds $capsule^{-1}$, 1000 seed weight, seed yield, stover yield and harvest index (Table 3). The plant population increased with the seed rate: The tallest plant observed was at seed 10 kg ha^{-1}; and the shortest plant was at 6 kg ha^{-1}, but 7, 8 and 9 kg ha^{-1}, the seed rate produced roughly similar height plants (Table 3). The number of branches per $plant^{-1}$ decreased with the increase of the seed rate from 6 kg ha^{-1}, to 10 kg ha^{-1}. The highest number of branches per plant $plant^{-1}$ (8.37) was recorded at the seed rate of 6 kg ha^{-1}, which was not statistically different from 7 and 8 kg ha^{-1}. The lowest number of branches per $plant^{-1}$ was recorded at the 10 kg ha^{-1} seed rate. The production of higher number of branches per $plant^{-1}$ at a lower seed rate was probably due to myriad factors such as availability of more space and water available to the plants. The highest number of capsules $branch^{-1}$ was produced at a lower seed rate (6 kg ha^{-1}), which was statistically similar to the number of capsules $branch^{-1}$ in 7 kg and 8 kg ha^{-1} seed rate. The highest number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, and 1000 seed weight was observed in the seed rate of 6 kg ha^{-1}, illustrating a decreasing trend with an increasing seed rate. On the other hand, the highest number of sterile flowers $plant^{-1}$, seed and stover yield was found in the seed rate of 10 kg ha^{-1}, while the lowest values were in the seed rate of 6 kg ha^{-1}. However, the harvest index was the highest for the 6 kg ha^{-1} seed rate followed by the 7, 8 and 10 kg ha^{-1} seed rate. This contributed to the maximum yield, which was due to a more dense plant population with moderately higher fertile flowers than that of lower plant population with a higher fruit set. There is a relationship between seed rate and yield related characteristics and our results closely resemble numerous extant research findings (Zhao et al., 2007; Lin et al., 2009; Mahajan et al., 2010). Linghe and Michael (2000) revealed

Table 1. Weed species found growing in the no weeding plots of the experimental field with their importance value.

Sl No	Species	Family	Classification	Density (no m^{-2})	Dry weight (g m^{-2})	Importance value (%)
1	*Alternanthera sessilis*	Amaranthaceae	Annual, broadleaf	5.31	3.71	2.94
2	*Amaranthus spinosus*	Amaranthaceae	Annual, broadleaf	3.81	1.46	1.16
3	*Amaranthus viridis*	Amaranthaceae	Annual, broadleaf	4.22	1.66	1.31
4	*Commelina benghalensis*	Commelinaceae	Perennial, broadleaf	4.37	1.87	1.47
5	*Cynodon dactylon*	Gramineae	Perennial, grass	4.28	1.36	1.07
6	*Cyperus rotundus*	Cyperaceae	Perennial, sedge	56.44	19.71	15.53
7	*Chenopodium album*	Chenopodiaceae	Annual, broadleaf	45.11	14.70	11.58
8	*Digitaria sanguinalis*	Gramineae	Annual, grass	6.81	3.43	2.70
9	*Eclipta alba*	Compositae	Annual, grass	5.74	3.26	2.57
10	*Eleusine indica*	Gramineae	Annual, broadleaf	6.31	3.79	2.99
11	*Echinochloa colonum*	Gramineae	Annual, broadleaf	41.88	12.06	9.50
12	*Lindernia procumbens*	Scrophulariaceae	Annual, broadleaf	69.73	17.70	13.94
13	*Polygonum hydropiper*	Polygonaceae	Annual, broadleaf	57.54	23.60	18.62
14	*Panicum repens*	Gramineae	Annual, broadleaf	4.67	2.76	2.17
15	*Physalis heterophylla*	Solanaceae	Annual, broadleaf	26.26	11.07	8.72
16	*Rumex maritimus*	Polygonaceae	Annual, broadleaf	5.25	1.08	0.85
17	*Vicia sativa*	Leguminosae	Annual, broadleaf	5.32	3.66	2.88

Table 2. Effect of seed rate on weed density and weed dry weight in sesame.

Seed rate (kg ha^{-1})	Weed density (no m^{-2})	Weed dry weight (g m^{-2})
6	100.6^{a}	32.20^{a}
7	69.66^{b}	28.13^{b}
8	65.81^{bc}	24.64^{c}
9	60.14^{cd}	21.60^{d}
10	56.84^{d}	20.37^{d}
S_x	1.47	0.37
CV (%)	6.48	8.15
Significance level	0.01	0.01

Data represents the mean values of three independent obserbation. Mean in the same column with different superscripts indicate statistically significant difference (p <0.01). S_x = Least Significant Difference (LSD) value.

that the increased seeding density of rice decreased the overall grain yield. Under dense populations due to reduced light interception and CO_2 accumulation, the overall yield may be limited (Wells and Faw, 1978). Baloch et al. (2002) revealed that under increased plant density, intra-specific competition for light and nutrient leads to a reduction in grain yield. Mahajan et al. (2010) showed that with increased rice plant density, beyond the optimal level, might lead to high dilution effect resulting in lower yield. On the other hand, lower yield at less-than-optimal densities is probably due to the inability to intercept maximum available light due to poor stand establishment. In fact, intra-specific competition due to different seeding densities may vary in their intensity and compensatory growth of individual plants, when grown at lower densities, results in similar grain yield over a broad range of densities (Bond et al., 2005).

Effect of weeding regime on the crop characters of sesame

As presented in Table 4, a number of different characteristics were statistically significant with the weeding regimen (p <0.01): plant population, plant height, number of branches plant^{-1}, number of capsules branch^{-1}, number of capsules plant^{-1}, number of infertile flowers plant^{-1}, number of seed capsule^{-1}, 1000 seed weight, seed yield, stover yield and harvest index. The highest plant population (21.27 m^{-2}) was observed in a no weeded plot, which was followed by one weeding, two weeding and weed free plot. The two weeding and weed free treatment resulted significantly superior performance over no weeding in respect of plant height, number of branches plant^{-1}, number of capsules branch^{-1}, number of capsules plant^{-1}, number of seeds capsule^{-1}, 1000 seed weight, seed yield and harvest index. The tallest plant was observed in weed free plot with similar value with two hands- weeding, whereas the lowest value was in non-wedded plots. In the case of number of branches plant^{-1}, all treatments (except the non-weeded plots) produced statistically identical (that is, not statistically significant difference) in branches. The number of capsules branch^{-1}, number of capsules plant^{-1} and number of seed capsule^{-1} resulted in a similar trend giving the highest value in the weed free group followed by two weeding and one weeding group; the no-weeding group was last. The number of infertile flowers plant^{-1} was statistically identical in no-weeding and one weeding whereas it subsided by two and three weeding with no significant variation. The highest 1000 seed weight was recorded in the weed free conditions followed by single-weeded and subsequently by non-weeded plots. Weed competition was severe in no-weeding plots and thus plant height was reduced. On the other hand, in areas without weeds, competition of weeds with crop plants for growth factors was absent or negligible; thus, their height was increased. For the weed-free condition, plant height and number of branches increased notably, primarily due to lack of crop-weed competition. This contributed to the increase in stover yield. High seeding rates generally increase the crops' ability to compete with weeds up to a certain point. Nevertheless, the high seeding rate may not always result in a

Table 3. Effect of seed rate on the crop characters of sesame.

Seed rate Kg ha^{-1}	Plant population (No m^{-2})	Plant height (cm)	No of branches $plant^{-1}$	No of capsules $branch^{-1}$	No of capsules $plant^{-1}$	No of infertile flowers $plant^{-1}$	No of seeds $capsule^{-1}$	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
6	12.25^{e}	83.64^{c}	8.38^{a}	8.42^{a}	70.82^{a}	2.81^{d}	72.55^{a}	2.60^{a}	709.2^{c}	2254^{d}	23.67^{a}
7	15.92^{d}	87.25^{b}	8.13^{ab}	8.20^{ab}	66.92^{b}	3.01^{cd}	67.96^{b}	2.41^{ab}	810.0^{b}	2898^{c}	22.73^{b}
8	18.58^{c}	88.53^{b}	7.93^{ab}	7.97^{ab}	63.56^{c}	3.31^{bc}	67.96^{b}	2.28^{bc}	860.0^{b}	3004^{c}	22.02^{c}
9	21.42^{b}	88.23^{b}	7.56^{b}	7.75^{bc}	63.51^{c}	3.52^{b}	67.46^{b}	2.23^{bc}	957.5^{a}	3368^{b}	21.98^{c}
10	23.75^{a}	91.49^{a}	7.30^{c}	7.30^{c}	53.81^{d}	4.28^{a}	62.16^{c}	2.08^{c}	930.8^{a}	4264^{a}	18.75^{d}
S_X	0.48	0.43	0.09	0.13	0.69	0.07	0.63	0.06	11.50	23.86	0.13
CV (%)	7.57	2.43	6.17	2.98	3.89	7.06	2.49	9.59	3.92	2.34	2.11
Significance level	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Data represents the mean values of three independent observations. Mean in the same column with different superscripts indicate statistically significant difference ($p < 0.01$).

Table 4. Effect of weeding regime on the crop characters of sesame.

Weeding regime	Plant population (No m^{-2})	Plant height (cm)	No of branches $plant^{-1}$	No of capsules $branch^{-1}$	No of capsules $plant^{-1}$	No of infertile flowers $plant^{-1}$	No of seeds $capsule^{-1}$	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
No weeding	21.27^{a}	84.03^{c}	7.00^{b}	6.75^{d}	47.54^{d}	3.68^{a}	5959^{d}	1.65^{c}	544.0^{c}	2195^{d}	20.18^{d}
One weeding	19.33^{b}	87.05^{b}	7.97^{a}	7.97^{c}	63.52^{c}	3.52^{a}	65.65^{c}	2.43^{b}	813.3^{b}	3168^{c}	21.45^{c}
Two weeding	17.67^{c}	89.24^{a}	8.14^{a}	8.35^{b}	68.39^{b}	3.27^{b}	7137^{b}	2.53^{ab}	1016.0^{a}	3807^{a}	22.28^{b}
Weeding free	15.27^{d}	91.00^{a}	8.18^{a}	8.65^{a}	73.04^{a}	3.07^{b}	75.42^{a}	2.67^{a}	1041.0^{a}	3461^{b}	23.41^{a}
Sx	0.36	0.55	0.13	0.06	0.63	0.06	0.44	0.06	8.63	19.10	0.12
CV (%)	7.57	2.43	6.17	2.98	3.89	7.06	2.49	9.59	3.92	2.34	2.11
Significance level	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Data represents the mean values of three independent observations. Mean in the same column with different superscripts indicate statistically significant difference ($p < 0.01$).

Table 5. Effect of interaction of seed rate and weeding regime on the crop characters of sesame.

Seed Rate × weeding regime		Plant population (No m^{-2})	Plant height (cm)	No of branches $plant^{-1}$	No of capsules $branch^{-1}$	No of capsules $plant^{-1}$	No of infertile flowers $plant^{-1}$	No of seeds $capsule^{-1}$	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
6 kg ha^{-1}	No weeding	14.67	79.13	7.50	7.40	55.50	3.10	65.77	2.00	400.00	1400^{m}	22.10
	One weeding	12.67	81.17	8.40	8.45	70.98	3.95	67.87	2.70	666.70	2218^{k}	23.20
	Two weeding	11.33	86.03	8.70	8.81	76.64	2.70	76.25	2.80	870.00	2740^{j}	24.10
	Weed free	10.33	88.23	8.90	9.01	80.18	2.50	80.30	2.90	900.00	2657^{j}	25.30
7 kg ha^{-1}	No weeding	18.33	83.30	7.30	7.20	52.56	3.30	61.20	1.85	500.00	1847^{i}	21.31
	One weeding	16.67	86.20	8.10	8.10	65.61	3.15	68.10	2.50	770.00	3346^{ef}	22.50
	Two weeding	16.67	86.20	8.10	8.10	65.61	3.15	68.10	2.50	770.00	3346^{ef}	22.50
	Weed free	13.33	90.20	8.70	8.92	77.34	2.70	77.20	2.70	1000.00	3149^{gh}	24.10
8 kg ha^{-1}	No weeding	20.00	85.20	7.00	6.87	48.30	3.60	59.10	1.62	550.00	2186^{k}	20.10
	One weeding	20.33	88.40	8.01	7.98	63.91	3.45	66.20	2.40	820.00	2994^{hi}	21.50
	Two weeding	17.00	89.50	8.20	8.33	68.06	3.20	71.25	2.50	1020.00	3483^{e}	22.65
	Weed free	15.00	91.02	8.50	8.70	73.95	3.00	75.30	2.60	1050.00	3353^{ef}	23.85
9 kg ha^{-1}	No weeding	23.67	84.30	6.80	6.50	44.20	3.81	58.60	1.60	650.00	2616^{j}	19.90
	One weeding	22.00	88.10	7.92	7.81	61.62	3.66	65.70	2.35	950.00	3310^{efg}	21.75
	Two weeding	21.00	89.20	8.01	8.20	65.68	3.41	70.75	2.45	1126.67	3825^{cd}	22.65
	Weed free	19.00	91.33	8.30	8.50	70.55	3.21	74.80	2.55	1133.33	3723^{d}	23.60
10 kg ha^{-1}	No weeding	27.67	88.20	6.40	5.80	37.12	4.60	53.30	1.20	620.00	2923^{i}	17.50
	One weeding	25.00	91.40	7.40	7.50	55.50	4.40	60.40	2.20	890.00	3973^{c}	18.30
	Two weeding	23.67	92.16	7.60	7.82	59.43	4.15	65.45	2.30	1093.33	5737^{a}	19.00
	Weed free	18.67	94.20	7.80	8.10	63.18	3.95	69.50	2.60	1120.00	4425^{b}	20.20
Sx		0.80	1.23	0.28	0.14	1.42	0.14	0.98	0.13	19.31	42.71	0.13
CV (%)		7.57	2.43	6.17	2.98	3.89	7.06	2.49	9.59	3.29	2.34	0.11
Significance level		NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01	NS

Data represents the mean values of three independent observations. Mean in the same column with different superscripts indicate statistically significant difference ($p < 0.01$).

higher economic return, especially when seed costs are high (Upadhyay, 2006). The relationship between crop seeding rate and the effects of reducing herbicide rates for weed control have been studied: Increasing barley and canola seeding rates allowed for good control of wild oat, wild mustard, and wild buckwheat with one-half to three-quarters the registered herbicide doses, without sacrificing crop yield and without allowing weeds to produce large numbers of seeds. Using reduced herbicide rates resulted in higher net returns for barley (O'Donovan et al., 2001). Our results are also in agreement with Singh and Faroda (1977) and Sarker and Mandal (1985). Weeding facilitates plants to have more resources for growth. Bedry (2007) and El Naim et al. (2010) found that increasing weeding times increased plant height due to efficient weed control. The highest number of branches per plant was obtained in weeding twice and in weed free plot. This result may be attributed to vigorous plant with less competition for light, nutrients, and free space in weed free environment. Yadava and kurnar (1981) found that weed control in peanut led to increased number of branches per plant compared to non-weeded plots.

Interaction of seed rate and weeding regime on the crop characters of sesame

There was no significant variation in respect of crop characteristics among the treatment combinations, except for stover yield. The highest stover yield was recorded in seed 10 kg ha^{-1} with a two weeding regime, while the lowest was in 6 kg ha^{-1} seed with no weeding regime. Interaction between the seed rate and wedding regime was statistically insignificant in influencing yield (Table 5). A weed-free regime for a prolonged growing period resulted in higher straw yield as a result of higher plant height and number of capsules. An increased weed competition period resulted in decreased biomass accumulation in terms of plant dry matter. It has been reported that increased plant density enhanced water-use efficiency and plant nutrition in corn (Murphy et al 1996). Thus, our results are in agreement with those obtained in green gram (Bayan and Saharia, 1998) and in maize (Martinkova and Honek, 2001). Weed free treatment compared to other wedding regime resulted in the highest yield in all seed rate. The highest seed yield amounting 1133.33 kg ha^{-1} was found when sowing was 9 kg ha^{-1}. In contrast, no-wedding regime resulted in lowest yield. This study was prompted by the need for reliable and cost-effective methods for controlling weeds in sesame production through simple alterations in agronomic practices. Our initial idea was: either increasing the crop's competitive ability against weeds through manipulation in seeding rate, or increasing weed removal through the addition of selective weed control would provide superior weed management compared with current regional production methods. However, we hypothesized; increased competition and selective weed control would provide increased net returns, relative to standard regional practice, only when weed density was sufficient to significantly reduce yield. This would be due to a modest increase in crop yield observed when either method is employed in the absence of weeds (Geleta et al., 2002; Kolb et al., 2010). Since early seedling growth is very slow in sesame, our results support the use of increased crop-weed competition through increases in seeding rate.

Materials and Methods

Plant material, experimental site and period

Seeds of sesame (BARI till-3) were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh. The experiments were conducted for two years at the Agronomy Field, Patuakhali Science and Technology University, Bangladesh (24° 43" 08' N and 90° 25" 35' E) during the period from 2009 - 2010 and 2010 - 2011.

Experimental details

The experiment was performed according to the spilt-plot design with three replications assigning the seed rate randomly in the main plots, while the weeding regime in the sub plots. Plot size was 5.0 m x 5.0 m. Sesame variety BARI till-3 was used as a test crop. The experiment was composed of two factor namely seed rate having five treatments: 6, 7, 8, 9 and 10 kg ha^{-1} and weeding regime having four treatments; no weeding, one hand weeding at 15 days and 30 days and weed free (removal of weed as soon as they were visible).

Measurements and data analyses

Data on weed infestation were taken at the maximum flowering stage of the sesame plant by 0.25 m^2 quadrate, placing it randomly at thee different places in each plot outside the central 5 m^2 area that was kept for obtaining yield data. The weeds growing in each plot were identified by their type of their species and their density per square meter was counted. The weight of dry weeds dry weight was taken; the importance value of weed was calculated by using the following formula (Khan et al., 2011).

Importance value of weed (IV) =

$$\frac{\text{Weight of a given (oven dried) weed species}}{\text{Weight of all (oven dried) weed species}} \times 100$$

Yield contributing characters such as plant height, number of branches plant^{-1}, number of capsules branch^{-1}, number of capsules plant^{-1}, and number of infertile flowers plant^{-1}, number of seeds capsule^{-1} and 1000 seed weight were recorded by placing 1 m^2 quadrate in each plot. Ten plants from each plot (excluding border plants), outside the central 5 m^2 area were collected randomly. Weed infestation data were collected from the central 5 m^2 area. The results of both years showed the similar trend, hence data were pooled and analyzed with computer package MSTAT-C and differences among treatment means were adjudged by Duncan's Multiple Range Test (DMRT). A p-value <0.01 was considered statistically significant.

Conclusion

The seed rate and weed density significantly influenced the plant growth and yield parameter. The plant population significantly increased with an increasing seed rate, while the number of branches per plant, number of seeds per capsule, and 1000 seed weight were significantly affected by weeding regime. The sesame population decreased significantly with increasing the weed frequency. Stover yield and their attributes were significantly higher in the weeded crop than the no-weeded one. Weed free and two weeding treatments leads to better yield performance compared to no weeding.

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