ASSESSING THE IMPACT OF DIFFERENT WEED MANAGEMENT TECHNIQUES ON WEED DENSITY AND YIELD OF SESAME (*Sesamum indicum* L.) CULTIVATION

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ABSTRACT

Sesame is a seed crop grown primarily for its oil. However, weeds severely affect the crop, resulting in poor performance in the field, making it crucial to control weeds at appropriate times. Field based research was conducted following a Randomized Complete Block Design (RCBD) with four replications to assess the effectiveness of various weed management strategies. The treatments were one hand weeding at 22 DAS, pendimethalin as a pre-emergence herbicide, two-hand weeding at 15 DAS followed by 30 DAS, and two checks (weed free and weedy checks). Crop parameters like height of the plant, leaves number, branches, capsule number, seed yield and yield determining characters were recorded. Similarly, weed population data and weed dry weight were recorded. Two-hand weeding at 15 DAS followed by 30 DAS reduced the total weed density and dry weight more effectively than the other treatments. Capsule number and seed yield (0.56 t/ha) were higher significantly in the same treatment, followed by one-hand weeding at 22 DAS (0.38 t/ha), with the least recorded under pre-emergence herbicides (0.20 t/ha). Therefore, the study suggests implementing a weed management practice involving two hand-weeding in 15 DAS followed by 30 DAS to ensure higher seed yield, lower weed density and lower weed dry matter.

Key words : Hand-weeding, pendimethalin, sesame, weed, yield

INTRODUCTION

Sesame is the major oilseed crop comprising about 15% of the total production of oilseed crops in Nepal (Jha et al., 2021). Despite that, the crop has poor yields due to several biotic and abiotic stresses including competition with weeds. Uncontrolled weed growth can result in a 50% drop in sesame output (Roy & Umesha, 2023). Similarly, according to thumb rule, 100% yield loss can be resulted by avoiding weed management in sesame depending on type of soil, weather conditions, and weed species occurrence (Karnas et al., 2019). Weed interference during the early growth phases cause significant stress in sesame, and reducing production by 65% (Zimbere et al., 2022). Sesame seedlings compete poorly with many fast-growing tropical weeds due to their delayed initial growth (Hegde, 2012). Crop-weed competition in sesame is generally observed between 15 and 30 days following seedling emergence, and weeds alone diminish sesame seed yield by 50-78% (Karnas et al., 2019; Amare et al., 2011). In sesame plants, it seems most important to manage weeds during the period of first 2 to 6 weeks after planting (Grichar et al., 2018b).

The weed management strategies, including application of pre-planting herbicide, regular hand-weeding, utilization of weed-free seeds anticipated to enhance resilience. Starting from the second

week it is necessary to maintain weed-free conditions following sesame plant emergence and should be managed, minimum for 9 weeks to avoid sesame yield losses of more than 5% (Karnas et al., 2019). A weed-free seed bed is essential for cultivating sesame seedlings because the fine, fibrous roots are readily destroyed (Hegde, 2012). Weed control (e.g., herbicide treatment) can boost sesame production by 80%; nevertheless, some pre-emergence herbicides can harm sesame plants (Grichar et al., 2011). Limited research has been conducted in Nepal regarding weed control methods specifically tailored to sesame farming. However, this study aims to address the dearth of research by providing insights into the challenges posed by weed infestation in the context of sesame yield in Nepal.

MATERIALS AND METHODS

Location

The experiment was carried out in Chitwan, Rampur at AFU farmland, from March to July 2023. In Central Terai of Nepal with 27°37′ North latitude and 84°25′ East longitude, the area lies with an elevation of 256 m above sea level.

Experiment treatments and design

The field research was applied in a randomized complete block design (RCBD) where different treatments were allocated on each plot with four replications. The research field was 320 m^2 having a plot size of 3×3 m^2.

Table1. Treatment details of experiment

Treatment no.	Treatment	Frequency doses
1	Weedy check	
2	Weed free	Hand weeding @ 7 days interval
3	One hand weeding at 22 DAS	
4	Two hand weeding at 15 DAS fb. 30 DAS	
5	Pre- emergence herbicides	

Note: DAS, Days after sowing; fb, followed by

Crop Management

The variety used was Nawalpur Khairo Til-1. Fertilizers were applied as 87.8 kg/ha urea, 65.6 kg/ha DAP and 33.33 kg/ha MOP.

Sampling and Measurements

Ten plants were selected on the random basis from each plot. For each marked plant, the height from ground surface level, the number of leaves, and the number of capsules were recorded. Additionally, twenty capsules were randomly selected from each harvested plot to analyze yield attributes. Plant height, number of leaves, number of branches per plant, and dry weight were recorded every 15 days. Similarly, weed sampling was conducted every 15 days, five times until maturity, from two quadrats of 0.3 m × 0.3 m in every plot. The weed samples obtained were oven-dried to measure dry weight. Drying was performed in an oven for 2-3 days until a constant weight was achieved, and the weight

was expressed in grams per square meter. The numbers of weeds were determined, and calculation of weed population was carried according to Odum (1971).

- $\text{Weed density } (\text{no./ m}^2) = \frac{\text{Total number of weeds}}{\text{Total survey areas } (\text{m}^2)}$
- $\text{Relative weed density} = \frac{\text{Density of each weed species}}{\text{Total density of all weed species}} \text{X } 100$
- Weed control efficiency (WCE) was calculated according to the formula dealt in Mani et al. (1973).
- $\text{WCE } (\%) = \frac{\text{WPc} - \text{WPt}}{\text{WPc}} \text{X } 100$

Where,
WPc = Weed population (Number of weeds per square meter) in control plot
WPt = Weed population (Number of weeds per square meter) in treated plot
Weed Index (WI) is measurement developed from crop yields acquired across weed management treatments in research (Gill & Vijayakumar, 1969).

- $\text{WCI} = \frac{\text{Dry weight in weedy check plot} - \text{Dry weight in treated plot}}{\text{Dry weight in weedy check plot}} \text{X } 100$

Data were arranged in Microsoft Excel 2019 program and the statistical analysis of variables were done using ANOVA with the help of R studio. ANOVA was carried out to test the significant difference for every parameter at 5% level of significance. For mean separation, Duncan's Multiple Range Test (DMRT) was conducted.

RESULTS AND DISCUSSION

Weeds

Important weed floras were observed during the experiment and were identified and classified into three broad categories namely, grasses, broadleaves and sedges as Table 2.

Table 2. Weed flora observed in the experimental field in sesame

Scientific name	Local name	Common name	Family
Grasses			
Digitaria ciliaris L.	Chittrey banso	Crab grass	Poaceae
Echinochloa colonum L.	Sama	Barnyard grass	Paniceae
Cynodon dactylon L.	Dubo	Bermuda grass	Poaceae
Eleusine indica L.	Kode jhar	Goose grass	Poaceae
Sedges			
Firmbrystylis miliacea L.	Jwane jhar	Hoorahgrass	Cyperaceae
Cyprus rotundus L.	Mothe	Purple nutsedge	Cyperaceae

Scientific name	Local name	Common name	Family
Broadleaves			
Ageratum conyzoides L.	Gandhe jhar	Billygoat weed	Asteraceae
Solanum nigrum L.	Kali gedi	Black nightshade	Solanaceae
Phyallanthus urinaria L.	Bhumi amla	Chamber bitter	Phyllanthaceae
Urena lobata L.	Dallekuro	Caesarweed	Malvaeceae
Physalis minima L.	Gangafal	Wild capegooseberry	Solanaceae
Sida rhombifolia L.	Bala	Jellyleaf	Malvaeceae
Polygonum barbatum L.	Pire jhar	Jointweed	Polygonaceae

Weed density and dry weight

In sesame crop, weed density was significantly varied by different methods of weed management at all dates after sowing (Fig. 1). Comparing different weed management methods, the least weed density was in the two-hand weeding treatment at all dates except at 25 DAS, where density was observed lowest in pre-emergence herbicide. Similarly, the weed density was highest recorded from the pre-emergence herbicide treatment at all dates after sowing except at 25 DAS and it was statistically at par with one hand weeding at 25 DAS and at all date of observation. Hand weeding involves removing weed along with their roots, disrupting growth, reducing competition with crop which tends to create a less number of weeds in the field. Two hand weeding lessened the density and dry matter of weeds by 57.5% and 60.4%, respectively (Saudy & Abd El-Momen, 2009).

Treatments significantly affected total dry weight (g/m²) of weed at 40, 55, and 75 DAS, but at 25 DAS and at harvest the effect was non-significant (Fig. 2). At 40 DAS and 70 DAS, all three treatments (one-hand weeding, Pendimethalin application, and two-hand weeding) were statistically similar but significantly lower than the weedy check. However, at 55 DAS, total dry weight of weeds in one hand weeding and two hand weeding treatment were statistically equal and lower than weedy check, also, was statistically similar to pre-emergence herbicide. Hand weeding twice at 15 DAS and 30 DAS reduces competition for nutrients, water, and light that allows sesame to exist better that minimizes the re-establishment of weeds and its biomass in the field which indirectly affect its dry weight. Lower weed density and dry weight resulted from the treatment of two-hand weeding at 20 DAS and 40 DAS than the other weed management strategies (Babu et al., 2016). Highest total weed dry weight was obtained from the weed check. At 20 and 40 DAS two hand weeding resulted in the highest weed control efficiency (95.50%) (Gupta & Kushwah, 2016).

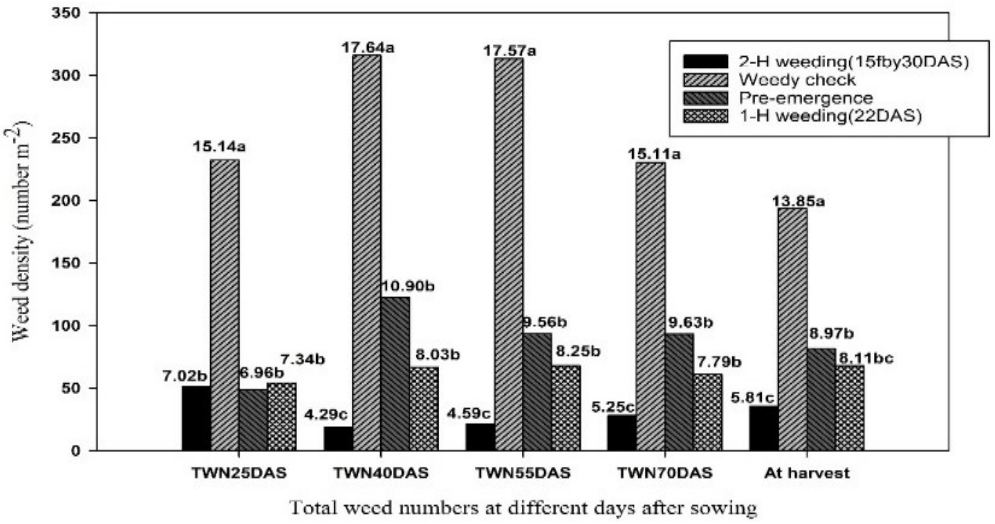

Fig. 1. Total weed density (number/m^2) as influenced by weed management practices in sesame

Note: fby, followed by ; DAS, Days after sowing; figure above bars are transformed data (subjected to square root transformation, √X+5) transformation, and bars are results of original data. Mean separated by DMRT and figures with the same letter (s) are non-significant at 5%level of significance.

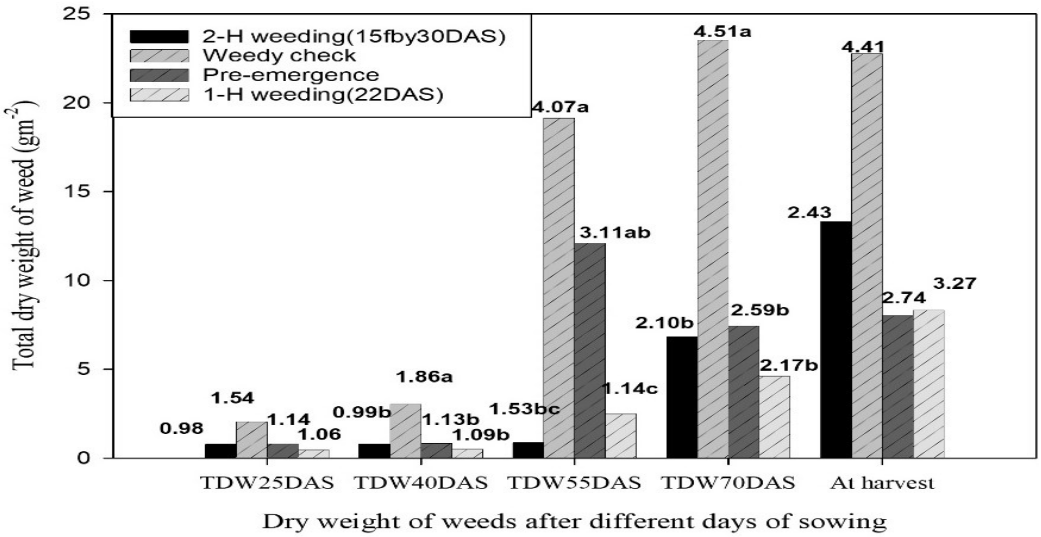

Fig. 2. Total weed dry weight (g m^{-2}) as influenced by weed management practices in sesame.

Note: fby, followed by ; DAS, Days after sowing; figure above bars are transformed data (subjected to square root transformation, √X+5) transformation, and bars are results of original data. Mean separated by DMRT and figures with the same letter (s) are non-significant at 5%level of significance.

Yield and its ascribing characters

The weight of the thousand-grain, number of seeds per capsule, and shelling percentage were found non-significant. However, capsule number per plant was significantly influenced by different weed management practices (Table 3). Among treatments, significantly higher capsules number were recorded from weed free and was statistically similar with two hand weeding followed by one-hand weeding. The lowest numbers were obtained from pre-emergence herbicide-applied plots. Removing of weeds in two hand weeding treatment made sesame plants exposed to open space for the long period growth and also, the improved nutrient availability with less weed interference led to more flowering and fruiting that consequently resulted in a greater number of capsules. The extended periods of weed-free crop growth results in a greater number of capsules per branch (Verma et al., 2023).

Different methods of weed management significantly influenced both seed yield (Fig. 3) and stalk yield (Table 3) of sesame. Among treatments, seed produced was significantly higher in weed free and was statistically identical with two hand weeding. Similarly, yield from the application of one hand weeding was statistically identical to yield of two hand weeding. On the contrary, significantly less seed yield was achieved from the plot treated with pre-emergence herbicide and it was statistically similar to the seed yield of the weedy check. In sesame, when two hand weeding is applied there is less energy loss in crop-weed competition and can center their energy in producing quality seeds. Higher seed yield in two hand weeding and one hand weeding might be due to higher number of capsules per plant resulted due to better environment for crop growth and development. Chauhan et al. (2019) finds better control of weeds in hand-weeding for extended crop growth duration, resulting higher produced. Sesame is an ineffective competitor in weedy environments, resulting in lower growth and low yields (Zimbere et al., 2022). Weeds reduce crop production because they compete with cultivated plants (Öztürk, 2019). Similarly, the yield of stalk resulted significantly higher in weed free and was statistically similar to two hand weeding. However, the lower stalk yield was recorded in the plot treated with pre-emergence herbicide which was statistically identical to one hand weeding and weedy check. Less competition for accessible resources like nutrients, light, and space may be a contributing factor to increase biological yield in the corresponding plots (Karimi et al., 2021).

Table 3. Influence of different weed control methods on yield and yield attributes of sesamum at different dates of observation at Rampur, Chitwan, 2023

Treatments	NoCp	TGW (g)	NSpC	StalkYield (t/ha)	Shelling%
One hand weeding (22DAS)	23^{bc}	2.00	42	29.00^{b}	50.35
Weed check	9^{d}	2.00	34	11.00^{c}	50.42
Pre-emergence herbicide	20^{c}	2.00	41	24.00^{b}	49.18
Two hand weeding (15DAS fby. 30DAS)	31^{ab}	2.00	39	33.00^{ab}	48.93
Weed free	37^{a}	2.00	46	42.00^{a}	51.89
LSD(=0.05)	9.23	Ns	Ns	10.78	Ns
Sem(±)	4.75	0.05	1.88	5.18	0.53
CV,%	25.23	5.91	11.74	25.45	6.25
Grand Mean	24	2.00	41	28.00	50.15

Note: fby. followed by, DAS, Days after sowing, NoCp, Number of capsules per plant, TGW, Thousand grain weight, NSpC, Number or seeds per capsule; Mean separated by DMRT and columns represented with the same letter (s) are non-significant at 5%level of significance, ;*Significant at 0.05 level of significance; **Significant at 0.01 level of significance; Ns, non-significant.

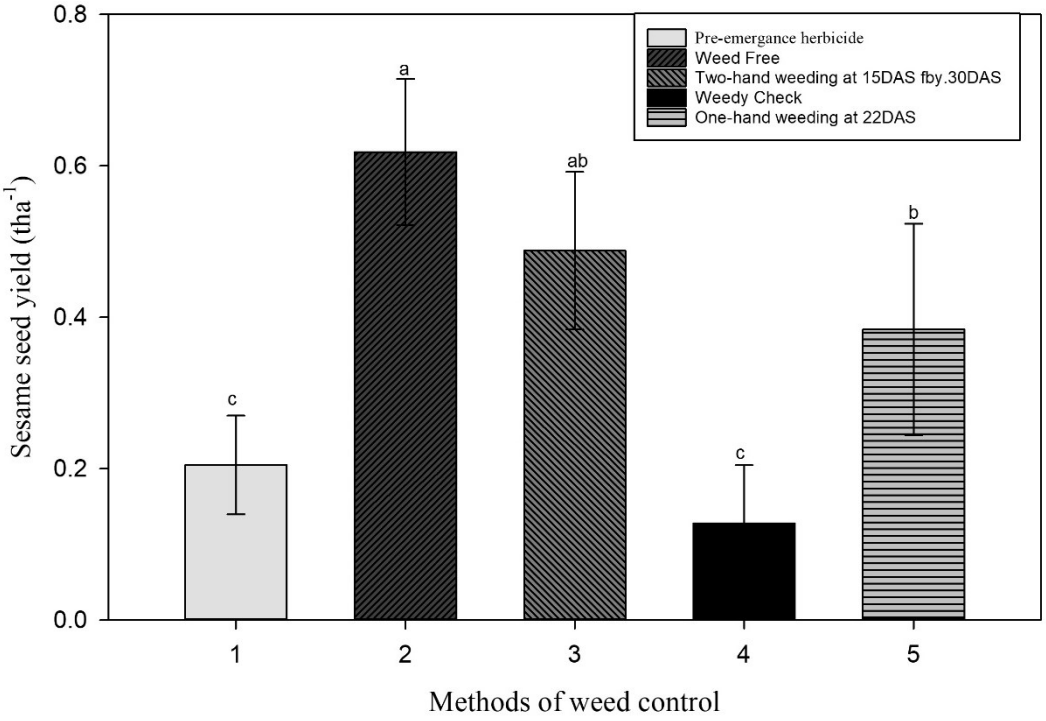

Fig. 3. Effect of different weed management practices on seed yield of sesame.

Note: Mean separated by DMRT and bars represented with the same letter (s) are non-significant at 5%level of significance, ;*Significant at 0.05 level of significance; **Significant at 0.01 level of significance, Ns, non-significant.

Weed Control Efficiency

At all dates of observations, weed control efficiency was found significantly influenced by different weed management practices. However, the higher grand mean value of WCE was recorded at 55 DAS (6.83%). Moreover, different weed management practices significantly improved the WCE on every plot. The weed control efficiency values were recorded (78.62, 93.71, 92.46, 87.50 and 78.97%) in the two-hand weeding treatment, which were significantly higher in comparison to other treatments. Two hand weeding at 15 DAS and 30 DAS produced a greater value of weed control efficiency than other treatments (Bhadauria et al., 2012). Two hand weeding at 20 DAS and 40 DAS resulted in the highest weed control efficiency (Babu et al., 2016). Sesame seedlings must be manually weeded at least twice, at 10-15 and 30-45 days after emergence, because they are prone to weed competition during the early growth stages (Terefe et al., 2012).

Table 4. Weed control efficiency as influenced by weed management practices of sesame at Rampur, Chitwan, 2023

Treatment	Weed control efficiency				
	25DAS	**40DAS**	**55DAS**	**70DAS**	**At harvest**
One hand weeding (22DAS)	8.75^{a}(76.23)	8.74^{ab}(76.62)	8.85^{ab}(77.76)	8.41^{ab}(70.99)	8.11^{a}(65.56)
Weed check	0.71^{b}(0)	0.71^{c}(0)	0.71^{c}(0)	0.71^{c}(0)	0.71^{b}(0)
Pre-emergence herbicide	8.81^{a}(77.34)	7.36^{b}(57.42)	8.11^{b}(66.34)	7.33^{b}(55.78)	7.55^{a}(57.04)
Two hand weeding (15DAS fby. 30DAS)	8.89^{a}(78.62)	9.70^{a}(93.71)	9.64^{a}(92.46)	9.38^{a}(87.50)	8.87^{a}(78.97)
Weed free	-	-	-	-	-
LSD(=0.05)	0.59**	1.70**	0.90**	1.38**	1.31**
SEm(±)	2.03(19.36)	2.03(20.38)	2.06(20.43)	1.96(18.99)	1.89(17.39)
CV, %	5.65(11.77)	16.65(25.52)	8.52(15.83)	13.82(22.28)	13.45(26.90)
Grand Mean	6.79(58.05)	6.63(56.94)	6.83(59.14)	6.46(53.57)	6.31(50.39)

Note: fby, followed by ,DAS, Days after sowing. Data subjected to square-root (√X+5) transformation, and figures in parenthesis are original values. Mean separated by DMRT and columns represented with the same letter (s) are non-significant at 5%level of significance, ;*Significant at 0.05 level of significance; **Significant at 0.01 level of significance, Ns, non-significant.

Weed Control Index

At all DAS, the weed control index was significantly different among different applied treatments. The highest weed control index was in plots treated with the two-hand weeding at 15DAS followed by 30 DAS at all DAS except for 70 DAS, where the weed control index was higher in plots treated with one hand weeding at 22 DAS (75.35) and was statistically similar to all other treatments: pre-emergence herbicides (68.92) and two hand weeding at 15 DAS followed by 30 DAS (72.95). Removing of weeds in the early stages minimized the total dry weight in the operation of two-hand weeding because of the inability of the late-growing weeds to compete with the sesame plant when reached the advanced growth stages vigorously. Reduction of weed density and dry weight was observed by increasing the period of weed removal from the field (Aadi & Almarie, 2024). Two hand weeding minimized weed density and dry matter by 57.5% and 60.4%, respectively (Kumar & Thakur, 2005). It states that the two hand weeding results in higher weed control index.

Table 5. Weed Control Index as influenced by weed management practices of sesame at Rampur, Chitwan, 2023

Treatment	Weed Control Index				
	25DAS	40DAS	55DAS	70DAS	At harvest
One hand weeding (22DAS)	7.96[a] (65.91)	8.79[a](77.72)	7.96[a](73.77)	8.55[a](75.35)	6.76[a](52.22)
Weed check	0.71[b] (0)	0.71[b](0)	0.71[b](0)	0.71[b](0)	0.71[b](0)
Pre-emergence herbicide	6.62[a](46.70)	8.45[a](71.46)	5.83[a](39.57)	8.30[a](68.92)	7.55[a](57.40)
Two hand weeding (15DAS fby. 30DAS)	8.20[a](67.70)	8.88[a](79.16)	9.11[a](82.98)	8.52[a](72.95)	8.52[a](74.03)
Weed free	-	-	-	-	-
LSD(=0.05)	2.26**	1.51**	3.57**	2.05**	3.07**
SEm(±)	1.76(15.76)	2.00(19.10)	1.86(18.84)	1.94(18.15)	1.76(15.99)
CV, %	24.95(47.01)	14.59(29.50)	39.23(53.73)	20.40(38.72)	33.89(54.94)
Grand Mean	5.87(45.08)	6.71(57.08)	5.90(49.08)	6.52(54.30)	5.89(45.91)

Note: fby, followed by, DAS, Days after sowing. Data subjected to square-root (√X+5) transformation, and figures in parenthesis are original values. Mean separated by DMRT and columns represented with the same letter (s) are non-significant at 5%level of significance, ;*Significant at 0.05 level of significance; **Significant at 0.01 level of significance ,Ns, non-significant.

CONCLUSIONS

Practicing hand weeding twice, at 15 DAS followed by 30 DAS, was found to be the most effective treatment compared to others, as it brought up lower weed density and dry weight. Additionally, weed control efficiency and the weed control index were higher in this treatment, leading to higher yields. Hence, it concludes that hand weeding twice, at 15 DAS and then at 30 DAS, is more effective than other treatments for controlling weeds in sesame crop.

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