



# **Integrated Weed Management in Summer Sesame (*sesumun indicum L.*)**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

A field research was evaluated at the Seed Technology, S. D Agricultural University, Sardarkrushinagar-385506, Banaskantha (North Gujarat) in the year between *summer* 2019 to 2021 to study the effect of weed management practices in summer sesamum. Experimental plot was loamy sand in texture with low organic carbon and available N, medium in available P<sub>2</sub>O<sub>5</sub> and high in available K<sub>2</sub>O.

Treatments were weed free (IC fb HW at 20 and 40 DAS), weedy control, pendimethalin 30 EC 0.750 kg/ha PE application fb IC+HW at 30 DAS, pendimethalin 30 EC 1.0 kg/ha PE application fb IC+HW at 30 DAS, oxadiargyl 6 EC 75 g/ha PE fb IC + HW at 30 DAS, oxadiargyl 6 EC 90 g / ha PE fb IC+HW at 30 DAS, quizalofop-ethyl 5 EC 40 g/ha PoE 20 DAS fb IC+ HW at 40 DAS, quizalofop-ethyl 5 EC 50 g/ha PoE at 20 DAS fb IC+ HW at 40 DAS, pendimethalin 30 EC 0.75 kg/ha PE fb quizalofop-pethyl 5 EC 40 g/ha at 30 DAS and pendimethalin 30 EC 1.0 kg/ha PE fb quizalofop-ethyl 5 EC 40 g/ha at 30 DAS.

The results revealed that significantly maximum seed yield (0.90 t/ha), stalk yield (2.14 t/ha), number of capsules per plant (73.1) and number of branches per plant (5.2) were obtained under

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weed free (IC fb HW at 20 and 40 DAS) treatment with maximum net realization (₹52322/ha). Minimum weed density at harvest/m<sup>2</sup> and weed dry weight/m<sup>2</sup> (67.17/m<sup>2</sup> and 32.51g/m<sup>2</sup>) and maximum weed control efficiency (71.62%) were found under weed free (IC fb HW at 20 and 40 DAS).

**Keywords:** Day after sowing (DAS); sesame; weedy control efficiency; weed index.

## 1. INTRODUCTION

“Oilseeds are one of the most important for agricultural economy of India since long and considered as the second largest agricultural commodity in India after cereals” [1]. “Edible oils and oil meals play vital role in solving the problem of malnutrition and securing the calorie nutrition for whole animal kingdom including human beings. Sesamum (*Sesamum indicum* L.) which is also popular as til, simsim, benised, gingelly, gergelim, etc. In India sesame cover in large area after groundnut. Oilseed are good source of energy and nutrition. All the crops of oilseeds occupy an area of 28.05 million hectares with total production of 32.74 million tonnes and productivity 1168 kg/ha at national level in the year of 2013-14” [2,3]. “Only Sesamum recorded an area of 1.7 million hectare with the total production of 0.7 million tonnes and productivity of 426 kg ha<sup>-1</sup> during 2013-14 among all the major oilseed crops” [4,5]. “In India the Gujarat stands at 6.84 million tonnes production of oilseeds with first position. In Gujarat, Sesamum occupies an area of 2.36 lakh hectares in Gujarat with the total production of 2.21 lakh tonnes and productivity of 513 kg ha<sup>-1</sup> during 2013-14” [6,7]. Amreli, Mahesana, Sabarkantha, Banaskantha, Kheda, Surendranagar, Junagadh and Bhavnagar districts are covered largest in sesame cultivated area in Gujarat.

“Especially, At the early stage of crop high infestation of weeds growth poses considerable risk in achieving the low yield of crop. Maximum weed competition in this crop between 15 to 45 DAS” [8]. Inter-culturing and hand weeding are very effective for weed control the weed infestation but always associated with regeneration of weeds which require frequent cultural operations which are not only sometime costly, but also always not feasible due to physical conditions of the soil. In initial stage of weed growth the chemical control of weed is very to be effective and economical. However,

herbicides make a unfit for full of weeds control because of their selectivity. Due to lake of information regarding on sesame cultivation in North Gujarat, a research was frame out.

## 2. MATERIALS AND METHODS

In order to evaluate the effect of different weed management practices on growth and yield attributes, yield, economics and quality of summer sesame. An experiment was formulated During summer 2019-20 to 2020-2021 at the Seed Technology Departmnet, S. D Agricultural University, Sardarkrushinagar-385506, Banaskantha (North Gujarat) to pursue the management of weed in *summer* sesame (*sesumun indicum* L.). The experimental site of soil was loamy-sand in texture with EC of 0.11 dS/m and pH 7.61. The soil was low in available N (136.56 kg/ha), OC (0.31%), medium in available potassium (253.02 kg/ha) and medium in available phosphorus (43.41 kg/ha). Experiment laid out in complete randomized block design (RBD) three replications and 12 treatments. Treatments were weed free (Inter-Culturing fb Hand weeding at 20 and 40 DAS), weedy control, pendimethalin 30 EC 0.750 kg/ha Pre emergence application fb IC+HW at 30 DAS, pendimethalin 30 EC 1.0 kg/ha Pre emergence application fb IC+HW at 30 DAS, oxadiargyl 6 EC 75 g/ha Post emergence fb IC + HW at 30 DAS, oxadiargyl 6 EC 90 g/ha PE fb IC+HW at 30 DAS, quizalofop-ethyl 5 EC 40 g/ha Post emergence 20 DAS fb IC+ HW at 40 DAS, quizalofop-ethyl 5 EC 50 g/ha Post emergence at 20 DAS fb IC+ HW at 40 DAS, pendimethalin 30 EC 0.75 kg/ha Pre emergence fb quizalofopethyl 5 EC 40 g/ha at 30 DAS, pendimethalin 30 EC 1.0 kg/ha Pre emergence fb quizalofopethyl 5 EC 40 g/ha at 30 DAS, oxadiargyl 6 EC 75 g/ha Pre emergence fb quizalofopethyl 40 g/ha at 30 DAS and Oxadiargyl 6 EC 90 g/ha Pre emergence fb quizalofopethyl 40 g/ha at 30 DAS. The research was carried out in randomized block designed with 3 replications. ‘GT 3’ variety was sown in 45m apart with using 2.5 kg/ha seed rate and sown 15<sup>th</sup> February, 2020 and 24 February 2021 with application of recommended

fertilizer dose of 50 kg/ha N and 25 kg/ha P<sub>2</sub>O<sub>5</sub>. Full dose of phosphorus and 1/3 of nitrogen was applied as basal in the form of DAP and Urea and remain two dose of nitrogen was applied in equal split at 30 and 5 days after sowing of crop. Before the sowing sesame seed was treated with thiram & captan@ 3.0 g per kg seed to protect the crop against fungal diseases. End of May and first week of June the crop was harvested in 2019-2021 respectively. On economics basis All the weed management treatments was calculated considering the weeding cost of each treatment over weedy check and gross return was worked out on the basis of prevailing market price of sesame. Pesticide residue analysis done by Modified QuEChERS LCMS method. This method increased availability of a number of pesticides and lack of knowledge about the proper dosage to apply for the crop leads to residues not only attaching the surface of leaves. Therefore, the extraction method efficiency should be high for real samples than the examining spiked sample extraction. From the literature review, it was found that QuEChERS sample preparation method suitable for analysis of pesticide residues in different crops and vegetable. The original QuEChERS method was modified for different analytes in various food samples. QuEChERS method is required to optimize for specific sample analyte in order to reduce errors as well as to increase the extraction efficiency. Normally, the solvent selection plays an important role in a sample preparation, based on nature of pesticides. Some solvents can be nominated as the extraction solvents namely ethyl acetate, acetone and acetonitrile<sup>24</sup> for optimization. Among these solvents acetonitrile solvent has extra advantages such as less interference from proteins, lipids, and co extracted matrix, therefore achieves high recovery efficiency. In view of the stated advantages, MeCN was selected as the extraction solvent in the QuEChERS method. In this extraction method, MgSO<sub>4</sub> and NaCl salts were used for better partitioning the layers and upper layer had given significant volume which was explored for high recoveries.

### 3. RESULTS AND DISCUSSION

The weed flora identified in our experiment was *Digitaria sanguinalis*, *Trianthema portulacastrum*, *Cyperus rotundus*, *Tribulus terrestris*, *Digera arvensis*, *Physalis minima*, *Tridax procumbens* and *Cynodon dactylon*.

#### 3.1 Effect of Weed Management Treatment on Crop Growth

Significant variation of growth and yield attributing parameters due to different weed treatments (Table 1). Plant height (30 DAS & At harvest), number of branch/plant, capsules per plant and were recorded under the T<sub>1</sub> (Inter-Culturing *fb* Hand weeding at 20 and 40 DAS), however pendimethalin 30 EC 0.750 kg/ha Pre emergence application *fb* IC+HW at 30 DAS, pendimethalin 30 EC 1.0 kg/ha Pre emergence application *fb* IC+HW at 30 DAS was remained at par with T<sub>1</sub>. Whereas, weedy control registered significantly the lowest values of growth and yield attributes. During critical period for growth and development Suppressed the weeds by application of herbicide and removal of weeds periodically by hand weeding and inter-culturing by weeding and inter culturing, which in enhance the crop growth and make available weed free environment to the crop. These results corroborate the findings of Mathukiya et al [9].

Plant stand during season was succeeding greengram crop, herbicidal study was reported satisfactory in all plots. No phytotoxic effect due to any of the herbicidal treatment on succeeding greengram was observed (Table 1). Persistence of the herbicides was found BDL.

#### 3.2 Effect of Weed Management Treatment on Crop Yield

Seed yield of sesame significantly reported during individual years and in pooled results (Table 1). Seed yield of (895, 920 and 907 kg/ha) with T<sub>1</sub> weed free (Inter-Culturing *fb* Hand weeding at 20 and 40 DAS) yielded significantly the highest during 2020, 2021 and in pooled results, respectively followed by application of pendimethalin 0.750 kg/ha Pre- emergence application *fb* IC+ HW at 30 DAS, pendimethalin 1.0 kg/ha Pre-emergence application *fb* IC+ HW at 30 DAS, quizalofopethyl 40 g/ha Post-emergence 20 DAS *fb* IC+HW at 40 DAS and quizalofop ethyl 50 g/ ha post-emergence at 20 DAS *fb* IC+ HW at 40 DAS. Whereas unweeded control was observed Significantly the lowest seed yield (331, 494 and 441 kg/ha) the during both the individual years as well as in pooled result, respectively. Treatments T<sub>1</sub>, T<sub>3</sub> & T<sub>4</sub> yield was increased over the control was emphasized of 104, 81 and 74 per cent, respectively.

Stalk yield found Significantly the highest (2102, 2177 and 2140 kg/ha) was under T<sub>1</sub> weed free

**Table 1. Effect of integrated weed management on growth and yield attribute of sesame**

Treatments	Dose g/ha	Plant height (cm)		Branch/plant	Capsule/plant	Plant stand at 15 DAS/metrerow length	Phyto-toxicity rating (0 to 10 scale)	Residue analysis (2021)		
		30 DAS	At harvest					pendi	oxy	quiz
Weed free (IC fb HW at 20 and 40 DAS)	-	26.97	102.83	5.2	73.1	11.08	0.0	BDL	BDL	ND
Weedy control	-	20.26	74.17	3.2	37.8	10.68	0.0	BDL	BDL	ND
Pendimethalin + IC and HW at 30 DAS	750	24.89	97.50	4.8	68.0	10.72	0.0	BDL	-	-
Pendimethalin + IC and HW at 30 DAS	1000	24.25	99.67	4.8	70.5	11.50	0.0	BDL	-	-
Oxadiargyl + IC and HW at 30 DAS	75	24.32	77.83	4.3	51.7	10.82	0.0	-	BDL	-
Oxadiargyl + IC and HW at 30 DAS	90	25.23	81.63	4.3	54.8	9.88	0.0	-	BDL	-
Quizalofopethyl + IC and HW at 40 DAS	40	19.96	92.27	4.6	63.9	10.53	0.0	-	BDL	-
Quizalofop ethyl + IC and HW at 40 DAS	50	19.77	94.96	4.7	66.4	10.90	0.0	-	BDL	-
Pendimethalin + quizalofopethyl at 30 DAS	0.75+40	23.37	81.73	4.5	54.1	10.07	0.0	BDL	BDL	ND
Pendimethalin + quizalofopethyl at 30 DAS	1000+40	25.46	84.09	4.6	55.4	9.93	0.0	BDL	BDL	ND
Oxadiargyl + quizalofopethyl at 30 DAS	75+40	24.69	76.33	4.2	49.1	10.26	0.0	BDL	BDL	ND
Oxadiargyl + quizalofopethyl at 30 DAS	90+40	24.81	76.27	4.0	49.0	9.90	0.0	BDL	BDL	ND
<b>SEm±</b>		<b>0.72</b>	<b>2.56</b>	<b>0.12</b>	<b>2.19</b>	<b>0.24</b>	<b>0.0</b>			
<b>C.D. at 5%</b>		<b>2.07</b>	<b>7.28</b>	<b>0.33</b>	<b>6.23</b>	<b>NS</b>	<b>0.0</b>			

\* Pendimethalin, Oxadiargyl, Quizalofopethyl, Day after sowing (DAS)

**Table 2. Effect of integrated weed management on yield and economic of sesame**

Treatments	Dose g/ha	Seed yield kg/ha			Stalk yield (kg/ha)			Net return (₹/ha)	B:C
		2020	2021	pooled	2020	2021	pooled		
Weed free (IC fb HW at 20 and 40 DAS)	-	895	920	907	2102	2177	2140	52322	1.72
Weedy control	-	391	494	443	891	1138	1014	17998	0.80
Pendimethalin + IC and HW at 30 DAS	750	706	849	777	1654	1969	1811	42432	1.49
Pendimethalin + IC and HW at 30 DAS	1000	726	880	803	1724	1993	1858	44420	1.54
Oxadiargyl + IC and HW at 30 DAS	75	538	664	601	1223	1431	1327	26022	0.91
Oxadiargyl + IC and HW at 30 DAS	90	567	682	625	1284	1544	1414	27934	0.96
Quizalofopethyl + IC and HW at 40 DAS	40	624	821	723	1429	1908	1668	37243	1.30
Quizalofop ethyl + IC and HW at 40 DAS	50	683	833	758	1546	1843	1695	40163	1.39
Pendimethalin + quizalofopethyl at 30 DAS	0.75+40	567	651	610	1336	1533	1434	29829	1.16
Pendimethalin + quizalofopethyl at 30 DAS	1000+40	572	639	606	1417	1278	1347	29051	1.11
Oxadiargyl + quizalofopethyl at 30 DAS	75+40	508	602	555	1132	1326	1229	24450	0.94
Oxadiargyl + quizalofopethyl at 30 DAS	90+40	506	625	566	1223	1508	1366	25217	0.95
<b>SEm±</b>		<b>42</b>	<b>45</b>	<b>29</b>	<b>128</b>	<b>120</b>	<b>76</b>	-	-
<b>C.D. at 5%</b>		<b>124</b>	<b>133</b>	<b>83</b>	<b>389</b>	<b>364</b>	<b>217</b>	-	-

Day after sowing (DAS)

**Table 3. Effect of integrated weed management on weed parameters, weed control efficiency and weed index**

Treatments	Dose g/ha	Weed density/m <sup>2</sup>			Weed dry weight at harvest g/m <sup>2</sup>			WCE (%)	WI (%)
		2020	2021	pooled	2020	2021	pooled		
Weed free (IC fb HW at 20 and 40 DAS)	-	8.47 <sup>f</sup> (71.33)	7.96 <sup>d</sup> (63.00)	8.21 <sup>g</sup> (67.17)	5.95 <sup>e</sup> (34.91)	5.51 <sup>e</sup> (30.10)	5.73 <sup>f</sup> (32.51)	71.62	00
Weedy control	-	15.06 <sup>a</sup> (225.33)	14.01 <sup>a</sup> (196.00)	14.50 <sup>a</sup> (210.67)	10.89 <sup>a</sup> (118.60)	10.51 <sup>a</sup> (110.17)	10.70 <sup>a</sup> (114.38)	00	51.23
Pendimethalin + IC and HW at 30 DAS	750	9.47 <sup>ef</sup> (89.33)	8.75 <sup>cd</sup> (76.33)	9.11 <sup>f</sup> (82.83)	7.03 <sup>d</sup> (49.29)	6.47 <sup>d</sup> (41.55)	6.75 <sup>e</sup> (45.42)	60.43	14.32
Pendimethalin + IC and HW at 30 DAS	1000	9.18 <sup>ef</sup> (84.33)	8.71 <sup>cd</sup> (75.67)	8.94 <sup>fg</sup> (80.00)	7.02 <sup>d</sup> (48.82)	6.40 <sup>d</sup> (40.54)	6.71 <sup>e</sup> (44.68)	61.16	11.51
Oxadiargyl + IC and HW at 30 DAS	75	12.11 <sup>bc</sup> (147.00)	10.89 <sup>b</sup> (118.33)	11.50 <sup>bc</sup> (132.67)	8.88 <sup>bc</sup> (78.70)	7.95 <sup>c</sup> (62.78)	8.41 <sup>cd</sup> (70.74)	38.33	33.80
Oxadiargyl + IC and HW at 30 DAS	90	11.63 <sup>bc</sup> (135.00)	10.97 <sup>b</sup> (120.00)	11.30 <sup>c</sup> (127.50)	8.78 <sup>c</sup> (76.70)	7.94 <sup>c</sup> (62.56)	8.36 <sup>cd</sup> (69.63)	39.27	31.18
Quizalofopethyl + IC and HW at 40 DAS	40	10.02 <sup>de</sup> (100.00)	9.19 <sup>c</sup> (84.67)	9.61 <sup>def</sup> (92.33)	7.06 <sup>d</sup> (49.43)	6.98 <sup>d</sup> (48.50)	7.02 <sup>e</sup> (48.97)	57.15	20.37
Quizalofop ethyl + IC and HW at 40 DAS	50	9.75 <sup>ef</sup> (95.33)	8.94 <sup>cd</sup> (79.67)	9.35 <sup>ef</sup> (87.50)	6.92 <sup>d</sup> (47.50)	6.43 <sup>d</sup> (41.03)	6.67 <sup>e</sup> (44.27)	61.35	16.44
Pendimethalin + quizalofopethyl at 30 DAS	0.75+40	11.33 <sup>cd</sup> (128.00)	9.58 <sup>c</sup> (92.33)	10.45 <sup>d</sup> (110.17)	8.55 <sup>c</sup> (72.73)	8.05 <sup>c</sup> (64.75)	8.30 <sup>d</sup> (68.74)	39.96	32.84
Pendimethalin + quizalofopethyl at 30 DAS	1000+40	11.25 <sup>cd</sup> (126.33)	8.93 <sup>cd</sup> (79.33)	10.09 <sup>de</sup> (102.83)	8.49 <sup>c</sup> (71.78)	8.17 <sup>bc</sup> (66.83)	8.33 <sup>d</sup> (69.31)	39.41	33.26
Oxadiargyl + quizalofopethyl at 30 DAS	75+40	12.95 <sup>b</sup> (168.00)	11.45 <sup>b</sup> (131.00)	12.20 <sup>b</sup> (149.50)	9.68 <sup>b</sup> (93.20)	8.94 <sup>b</sup> (79.65)	9.31 <sup>b</sup> (86.43)	24.56	38.81
Oxadiargyl + quizalofopethyl at 30 DAS	90+40	12.29 <sup>bc</sup> (151.67)	11.12 <sup>b</sup> (123.33)	11.70 <sup>bc</sup> (137.50)	9.10 <sup>bc</sup> (82.79)	8.71 <sup>bc</sup> (75.43)	8.90 <sup>bc</sup> (79.11)	30.86	37.67
<b>SEm±</b>		<b>0.46</b>	<b>0.33</b>	<b>0.28</b>	<b>0.28</b>	<b>0.26</b>	<b>0.178</b>	-	-
<b>C.D. at 5%</b>		<b>1.34</b>	<b>0.98</b>	<b>0.80</b>	<b>0.81</b>	<b>0.76</b>	<b>0.50</b>	-	-

\*Figures in the parenthesis are original values. All Figures are square root( $\sqrt{x + 0.5}$ ) transformed values, Day after sowing (DAS)

(Inter-Culturing *fb* Hand weeding at 20 and 40 DAS) in 2020, 2021 & in pooled results, respectively, followed by application of pendimethalin 0.750 kg/ha Pre-emergence application *fb* IC+ HW at 30 DAS, pendimethalin 1.0 kg/ha Pre-emergence application *fb* IC+ HW at 30 DAS, quizalofopethyl 40 g/ha Post-emergence 20 DAS *fb* IC+HW at 40 DAS and quizalofop ethyl 50 g/ ha post-emergence at 20 DAS *fb* IC+ HW at 40 DAS. Due to under this treatment Seed yield and stalk yield were reflected in increased through efficient control of weeds and improved growth and yield attributes. Whereas, significantly the lowest stalk yield of (891, 1138 and 1091 kg/ha) was found under the weedy control in individual years as well as in pooled results, respectively. These results are findings of Gnanavel and Anbhazhagan [10] and Mathukiya et al. [9].

### 3.3 Effect on Weed

Effect on dry weight of weeds during 2020, 2021 in pooled results (Table 3) showed significant in different weed management treatment. Significantly reduced dry weight of weeds in weed-free treatment over the weedy control during individual years as well as in pooled results, the  $T_1$  weed free (Inter-Culturing *fb* Hand weeding at 20 and 40 DAS) treatment recorded significantly the lowest weed dry weight (34.91, 30.10 and 32.50 g/m<sup>2</sup>) followed 1.0 kg/ha pendimethalin as a pre emergence application *fb* IC+ HW at 30 DAS and application of pendimethalin 0.750 kg/ha as a pre emergence *fb* IC+ HW at 30 DAS. Whereas, the dry weight of weeds recorded highest in weedy control (118.60, 110.17 and 114.38 g/m<sup>2</sup>).

Inter-Culturing *fb* Hand weeding at 20 and 40 DAS showed that significantly the lowest weed density (67 per m<sup>2</sup>) pooled over three years (Table 3), which was statistically at par with by pendimethalin 1.0 kg/ha PE application *fb* IC+ HW at 30 DAS (80 per m<sup>2</sup>) and followed by pendimethalin 0.750 kg/ha PE application *fb* IC+ HW at 30 DAS (82 per m<sup>2</sup>) and quizalofop ethyl 50 g/ha PoE at 20 DAS *fb* IC+ HW at 40 DAS (87 per m<sup>2</sup>). Where in, (210 per m<sup>2</sup>) weed population means density of weed significantly the highest was showed under the weedy control ( $T_2$ ). (Table-2) showed that the inter-Culturing and hand weeding at 20 and 40 DAS estimated highest weed control efficiency (70.62 %) and lowest in weed index (WI), followed by of application of 1.0 kg/ha pendimethalin as pre emergence *fb* IC+ HW at 30 DAS and 50 g/ha

quizalofop ethyl as post emergence at 20 DAS *fb* IC+ HW at 40 DAS recorded WCE of 60.43 and 61.35 %, with weed index recorded 11.51 and 14.32 %, respectively Sukhadia et al [11] and Gnanavel and Anbhazhagan [10].

### 3.4 Economics

Maximum net returns of ₹52,322/ha recorded under the treatment of Inter-Culturing *fb* Hand weeding at 20 and 40 DAS ( $T_1$ ) followed by pendimethalin 30 EC 1.0 kg/ha pre emergence application *fb* IC+ HW at 30 DAS, pendimethalin 30 EC 0.750 kg/ha pre emergence application *fb* IC+ HW at 30 DAS, which gave net return of ₹44,420/ha and ₹42,432/ha, respectively. Weed-free (IC *fb* HW at 20 and 40 DAS) reordered the maximum B:C ratio of 1.72, followed by pendimethalin 1.0 kg/ha PE application *fb* IC+ HW at 30 DAS, pendimethalin 0.750 kg/ha PE application *fb* IC+ HW at 30 DAS by recording B:C ratio of 1.54 and 1.49, respectively (Table 2) Mathukiya et al. [9].

## 4. CONCLUSION

It was Concluded that effective control of weeds in summer sesame along with higher yield could be achieved by weed-free (IC *fb* HW at 20 and 40 DAS) as and when required or application of pendimethalin 30EC 1.0 kg/ha PE application *fb* IC+ HW at 30 DAS, pendimethalin 30EC 0.750 kg/ha PE application *fb* IC+ HW at 30 DAS under North Gujarat agro-climatic conditions of Gujarat.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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