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Seed priming for improving the weed competitiveness in sesame

S. SREEPRIYA AND T. GIRIJA

Department of Plant Physiology, College of Horticulture
Kerala Agricultural University, Vellanikkara, Trissur-680656, Kerala

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ABSTRACT

A field study was conducted at Onattukara Regional Agricultural Research Station, Kayamkulam to understand the effect of seed priming on improving weed competitiveness in sesame variety Thilak. Seed priming treatments selected were plant growth regulator, GA (gibberellic acid), micronutrients ($MnSO_4$, borax), mixture of $MnSO_4$ and borax with GA (tank mix), and water. Species wise weed count and weed dry matter production were calculated at 10 DAS and at harvest. The results revealed that the highest weed control efficiency of 38 per cent was recorded in seed priming with $MnSO_4$ followed by tank mix and borax. The improvement in weed competitiveness of sesame may be due to the enhancement in the early seedling vigour of the primed seeds. This was evident from the improved Crop growth rate (CGR), Net assimilation rate (NAR) and Leaf area index (LAI). The reduced weed density along with improvement in early growth parameters contributed to higher yield of sesame.

***Keywords* :** $MnSO_4$, seed priming, tank mix, weed competitiveness, weed control efficiency

Sesame is one of the oldest oil seed crops cultivated in India. Globally, India is the largest producer, consumer and exporter of sesame. As per the Solvent Extractors Association of India (SEAI), the area under sesame crop was 19.81 lakh hectares with a production of 8.87 lakh tonnes during 2015-16. However, its production in the country is declining due to several reasons. Weeds are a major biotic stress in sesame cultivation. This is due to slow growth of sesame seedlings during early stages of first four weeks, making it a poor competitor at the early stages of crop growth (Nazir, 1994; Bennett *et al*., 2003). Yield loss as high as 81 per cent was reported in the crop due to weed infestation (Shaalan *et al*., 2014). Insufficient weed control at early crop periods mainly at the critical period of crop weed competition, leads to yield reduction (Weaver *et al*., 1992). Upadhyay (1985) suggested that suppression of weed growth at crop establishment stage is important as early growth of sesame is slow.

One approach to weed management in sesame could be seed priming (Vafaei *et al*., 2013). Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radicle. This technique generally enhances germination rate and plant performance (Bradford, 1986). Proper seed priming treatments with micronutrients, plant growth regulators can improve early seedling vigour and establishment.

Wortmann (1993) reported that in bean (*Phaseolus vulgaris* L.) the ability to suppress weeds was found to be related to leaf size, leaf area index, and plant growth rate. Dias *et al*. (2011) reported that soybean plants which developed from seeds with high and intermediate vigour showed the best results for competition against weeds by reducing weed dry mass accumulation. Plants which developed from high vigour seeds gave the best results for grain yield for both weeded and unweeded treatments.

Experiment conducted by Vafaei *et al*. (2013) showed that a proper combination of pre- and post-emergence herbicides along with seed priming could be used to control the weeds in sesame and to obtain a seed yield comparable with weed-free conditions.

MATERIALS AND METHODS

A field experiment was conducted at Onattukara Regional Agricultural Research Station (ORARS), Kayamkulam, Kerala during summer season of 2016-17. Sesame variety used for the field study was Thilak (ACV3) released from Kerala Agricultural University (1993). Thilak is a pure line selection from Malappuram local suited for summer rice fallows of Onattukara. The experiment was laid out in spilt plot design with three replications. The main plots comprised of hand weeded and unweeded plots. The subplots comprised of five seed priming treatments along with unprimed seeds *viz*., control (unprimed seeds), water, gibberellic acid (GA-100 ppm), borax (0.1%), manganese sulphate ($MnSO_4$-0.3%) and tank mixture of 0.1 % borax, 0.3% $MnSO_4$ and 100ppm GA (tank mix). . Application rate in a hector for 5 kg seeds for GA, borax, $MnSO_4$, is 0.5g GAha^{-1}, 5g borax ha^{-1}, 15g $MnSO_4$ ha^{-1} respectively. Tank mix can be prepared by sequentially mixing the respective concentration of GA, borax and $MnSO_4$ in water. Seeds were soaked for 8 hrs in the priming solutions and after shade drying, the seeds were sown in the field. The experimental area was ploughed twice to a fine tilth. The

Email: sreepriyasanthosh88@gmail.com

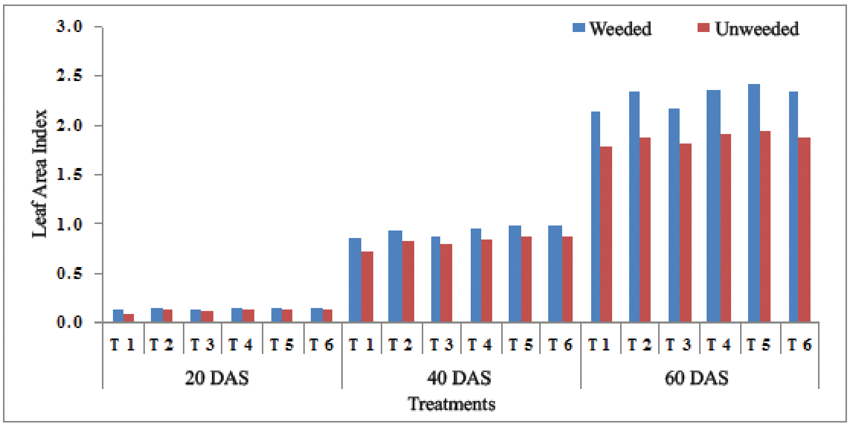
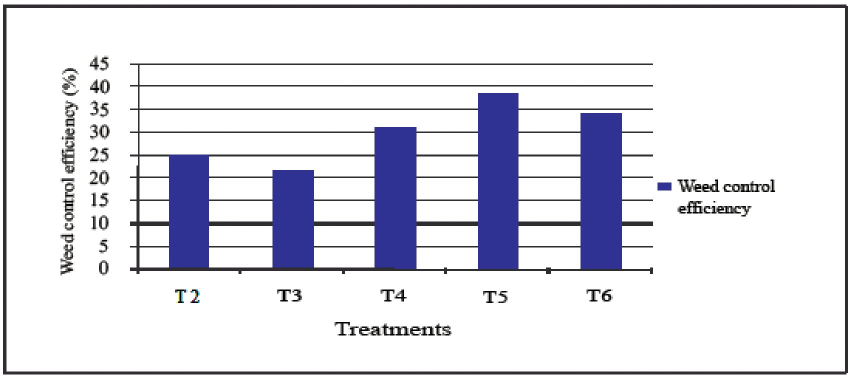


Fig.1: Effect of seed priming treatments on leaf area index



Note: T_1- control, T_2- water, T_3- GA (100ppm), T_4- borax (0.1%), T_5- $MnSO_4$ (0.3%), T_6- tank mix (T_3+T_4+T_5)

Fig. 2: Weed control efficiency of seed priming treatments

plot size was 2 m² with a spacing of 60 cm between plots. Fertilizers were applied as per the package of practices recommendations of Kerala Agricultural University (KAU, 2016). N: P: K @ 30:15:30 kg ha^{-1} was applied as basal dose at the time of sowing. After the fertilizer application seeds were dibbled at a spacing of 15 × 20 cm. The priming treatment was given one day before sowing. Thinning was done 15 days after sowing. 2 per cent foliar spray of urea was given after thinning. Growth parameters like CGR, NAR and LAI were taken at 20 days interval from sowing. The weed count and weed dry weight from different plots were taken at 10 days after sowing and also at the time of harvest. Form the data weed control efficiency of the priming treatments was calculated. Yield and yield attributes like number of capsules per plant, number of seeds per plant were recorded at harvest.

The data were analyzed in split plot design using WASP 2.0 developed by ICAR, GOA. Weeded and unweeded condition as main plots and 5 seed priming treatments along with control (unprimed) as subplots. Weed count data was square-root transformed before statistical analysis. Pair wise comparisons of the treatments were done using critical difference.

RESULTS AND DISCUSSION

Effect of seed priming on growth parameters

Weeded plots recorded significantly higher LAI than unweeded plots throughout the crop growth period and the priming treatments similarly affected weeded and un-weeded plots (Fig. 1). At all growth stages higher LAI was recorded by priming with $MnSO_4$. At 40 DAS, there was 15 per cent reduction in LAI due to weed competition in unprimed control where as in tank mix and $MnSO_4$ primed seeds the per cent decrease was only 11 and 12 per cent respectively. The lower LAI was recorded in control treatment. At the time of harvest there was reduction in LAI for all the treatments and difference between the treatments were non-significant due to natural leaf fall at the time of harvest.

Weeded plots recorded higher NAR and CGR throughout the growth period compared to unweeded plots (Table 1 and 2). The treatment response in weeded and unweeded plots was the same. At all the growth period higher NAR was recorded by priming with $MnSO_4$ (Table 1). GA and control gave the lower NAR. The NAR of the plants depends on LAI. The improvement in NAR with the priming treatment of

Table1: Effect of seed priming on net assimilation rate of sesame

Treatments	Net assimilation rate (mg cm^{-2} d^{-1})								
	20-40 DAS			40-60 DAS			60 DAS to harvest		
	W	UW	Mean	W	UW	Mean	W	UW	Mean
T_1-Control	1.8	1.1	1.5^c	1.0	0.8	0.9^c	0.3	0.3	0.3^a
T_2-Water	2.0	1.6	1.8^b	1.1	0.9	1.0^b	0.2	0.4	0.3^a
T_3-GA	2.1	1.2	1.7^{bc}	1.1	0.8	0.9^c	0.3	0.3	0.3^a
T_4-Borax	2.3	2.0	2.2^a	1.2	0.9	1.0^b	0.3	0.3	0.3^a
T_5-$MnSO_4$	2.4	2.2	2.3^a	1.3	0.9	1.1^a	0.3	0.3	0.3^a
T_6-Tank mix	2.4	2.1	2.2^a	1.1	0.9	1.0^b	0.3	0.2	0.2^a
Mean	**2.2^a**	**1.7^b**		**1.1^a**	**0.9^b**		**0.3^a**	**0.3^a**	
SEm (±)	**0.05**		**0.10**	**0.01**		**0.01**	**0.02**		**0.04**
LSD (0.05)	**0.32**		**0.31**	**0.06**		**0.04**	**NS**		**NS**

Note: T_3- 100ppm, T_4- 0.1%, T_5- 0.3%, T_6- 100ppm GA+ 0.1 % borax + 0.3% $MnSO_4$. Means with the same superscript do not differ significantly at 5% level of probability using Duncan's Multiple Range Test (DMRT), NS: The effect of treatments is non-significant

Table 2: Effect of seed priming on crop growth rate ($gm^{-2}d^{-1}$) of sesame variety Thilak

Treatments	Crop growth rate ($gm^{-2}d^{-1}$)								
	20-40 DAS			40-60 DAS			60 DAS-Harvest		
	W	UW	Mean	W	UW	Mean	W	UW	Mean
T_1-Control	7.2	6.0	6.7^d	16.9	12.7	14.8^d	2.2	3.7	2.9^a
T_2-Water	8.0	7.0	7.5^c	17.5	14.1	15.8^{bc}	3.1	3.3	3.2^a
T_3-GA	7.7	6.2	6.9^d	17.1	13.5	15.3^{cd}	3.3	1.1	2.2^a
T_4-Borax	8.5	7.1	7.8^{bc}	18.1	14.6	16.4^{ab}	3.9	4.2	4.0^a
T_5-$MnSO_4$	9.0	7.8	8.4^a	19.2	15.2	17.2^a	3.4	3.9	3.6^a
T_6-Tank mix	8.9	7.7	8.3^{ab}	19.1	15.0	17.1^a	3.6	2.8	3.2^a
Mean	**8.2^a**	**7.0^b**		**18.0^a**	**14.2^b**		**3.2^a**	**3.1^a**	
SEm (±)	**0.17**		**0.16**	**0.09**		**0.54**	**0.37**		**0.71**
LSD (0.05)	**1.14**		**0.50**	**0.63**		**1.61**	**NS**		**NS**

Table 3: Effect of seed priming on yield attributes

Treatments	Number of capsules $plant^{-1}$			Number of seeds $capsule^{-1}$			Yield (kg ha^{-1})		
	W	UW	Mean	W	UW	Mean	W	UW	Mean
T_1-Control	42.6	24.0	33.3^c	61.6	43.6	52.6^b	842.7	725.2	783.9^d
T_2-Water	44.6	37.0	40.8^{ab}	62.0	53.3	57.6^a	1105.6	1089.9	1097.2^b
T_3-GA	45.3	29.0	37.2^{bc}	54.0	53.0	53.5^b	954.6	784.6	869.1^c
T_4-Borax	44.0	38.0	41.0^{ab}	62.0	54.3	58.2^a	1144.5	1089.9	1116.7^b
T_5-$MnSO_4$	46.0	39.7	42.8^a	64.0	57.3	60.7^a	1272.9	1188.4	1230.1^a
T_6-Tank mix	44.0	37.0	40.5^{ab}	64.3	55.6	60.0^a	1222.2	1177.8	1200.0^a
Mean	**44.4^a**	**34.1^b**		**61.3^a**	**52.9^b**		**$1,090.2^a$**	**$1,008.8^b$**	
SEm (±)	**0.78**		**1.54**	**0.84**		**1.03**	**11.97**		**28.92**
LSD(0.05)	**5.14**		**4.59**	**5.50**		**3.07**	**85.93**		**78.47**

Table 4: Species wise weed count at 10 DAS and harvest

Weed species	At 10 DAS						
	T_1-Control	T_2-Water	T_3-GA	T_4-Borax	T_5-$MnSO_4$	T_6-Tank mix	LSD (0.05)
Melochia corchorifolia L.	33.3[a]	36.3[a]	36.3[a]	30.7[a]	40.7[a]	35.7[a]	NS
	(5.7)	(6.0)	(6.0)	(5.4)	(6.4)	(5.8)	
Digitaria ciliaris(Retz.) Koeler	19.0[b]	10.3[b]	5.3[c]	9.0[b]	16.3[b]	8.0[b]	NS
	(4.4)	(3.2)	(2.2)	(2.9)	(3.5)	(2.6)	
Echinochloa colona (L.) Link	17.7[bc]	4.7[c]	17.3[b]	2.0[b]	7.7[c]	8.0[b]	NS
	(4.2)	(2.1)	(4.2)	(1.5)	(2.7)	(2.8)	
Oryza sativa L.	10.0[c]	9.0[b]	6.0[c]	1.0[b]	8.0[c]	8.3[b]	NS
	(3.2)	(2.9)	(2.4)	(1.2)	(2.9)	(2.9)	
Cleome viscosa L.	2.0[d]	1.3[d]	1.3[d]	0.0	2.0[d]	2.0[b]	NS
	(1.4)	(1.1)	(1.1)	(0.7)	(1.7)	(1.3)	
SEm (±)	**0.33**	**0.25**	**0.25**	**0.50**	**0.90**	**0.65**	
LSD (P=0.05)	**1.10**	**0.82**	**0.83**	**1.67**	**2.99**	**2.14**	
At harvest							
Melochia corchorifolia L.	19.7[b]	26.0[ab]	16.3[bc]	18.0[b]	20.7[b]	20.0[b]	NS
	(4.4)	(5.0)	(4.0)	(4.1)	(4.5)	(4.4)	
Digitaria ciliaris(Retz.) Koeler	61.7[a]	51.7[a]	55.7[a]	64.7[a]	32.7[a]	48.3[a]	NS
	(7.8)	(6.9)	(7.2)	(7.7)	(5.7)	(6.7)	
Echinochloa colona (L.) Link	48.0[a]	34.0[a]	28.0[ab]	23.7[ab]	24.7[ab]	27.0[ab]	NS
	(6.6)	(5.5)	(5.2)	(4.8)	(4.9)	(5.1)	
Oryza sativa L.	2.3[c]	1.3[c]	3.3[cd]	3.0[b]	1.0[c]	3.0[c]	NS
	(1.5)	(1.1)	(1.8)	(1.9)	(1.0)	(1.7)	
Cleome viscosa L.	5.0[c]	5.0[bc]	1.0[d]	0.0	1.0[c]	1.0[c]	NS
	(2.2)	(2.2)	(1.0)	(0.7)	(1.0)	(1.0)	
SEm (±)	**0.61**	**0.94**	**0.70**	**0.89**	**0.34**	**0.65**	
LSD (0.05)	**2.01**	**3.09**	**2.30**	**2.92**	**1.14**	**2.14**	

Table 5: Effect of seed priming on weed count (no. m^{-2})

Treatments	10 DAS			Harvest		
	Grasses	Broad leaved weeds	Total	Grasses	Broad leaved weeds	Total
T_1-Control	27.0[a]	50.0[a]	77.0[a]	183.3[a]	28.0[a]	211.3[a]
T_2-Water	21.7[a]	37.0[b]	58.7[bc]	112.0[b]	27.0[a]	139.0[b]
T_3-GA	23.3[a]	37.7[b]	61.0[bc]	75.7[bc]	16.7[d]	92.3[cd]
T_4-Borax	15.3[a]	36.0[b]	51.3[c]	67.0[c]	18.0[cd]	85.0[d]
T_5-$MnSO_4$	23.3[a]	42.3[ab]	65.7[ab]	49.0[c]	20.7[b]	69.7[d]
T_6-Tank mix	19.3[a]	36.7[b]	56.0[bc]	59.7[c]	20.0[bc]	79.7[d]
SEm (±)	**2.22**	**2.82**	**4.06**	**14.23**	**0.68**	**14.42**
LSD (0.05)	**NS**	**9.01**	**12.97**	**44.84**	**2.14**	**46.30**

Table 6: Weed dry matter production (g m^{-2}) in sesame fields from different treatments

Treatments	Weed dry matter production (g m^{-2})	
	10 DAS	**Harvest**
T_1-Control	3.4^a	170.0^a
T_2-Water	2.7^a	127.4^{bc}
T_3-GA	2.9^a	133.3^b
T_4-Borax	2.1^a	116.6^{cd}
T_5-$MnSO_4$	3.0^a	104.3^e
T_6-Tank mix	2.3^a	112.0^{de}
SEm (±)	**0.67**	**9.98**
LSD (0.05)	**NS**	**11.67**

$MnSO_4$, tank mix and borax might be due to the higher LAI recorded for these treatments compared to the control. Higher assimilation of nutrients in turn would contribute to higher CGR which is evident from the results (Table 2). Weed competition reduced the CGR of all the treatment studied (Table 2). However, the reduction in the CGR (upto 2-5%) was higher in unprimed control (T_1) as compared to the treatments where primed seed were used for planting. Reduction in CGR was higher at 40-60 DAS as compared to 20-40 DAS. Among the treatments $MnSO_4$, tank mix and borax recorded higher CGR under both weeded and unweeded condition, indicating that these treatments were able to sustain the growth of sesame even under high competition from weeds. Reduction in CGR due to weed competition has been reported by Amini *et al*. (2013) in jackbean and Ghanizadeh *et al*. (2014) in corn.

Effect of seed priming on yield and yield attributes

Yield attributes such as number of capsules plant^{-1}, number of seeds capsule^{-1} and seed yield were significantly higher in plants which were subjected to seed priming (Table 3). Maximum seed yield was obtained by seed priming of MnSO4 and tank mix, which was significantly superior to all other priming treatments. The yield components such as number of capsules and seeds per capsules had improved considerably with these treatments. The increase in LAI and NAR of the crop could have accounted for the improvement in vegetative features such as number of branches as a result of which the capsule number would have also increased. Boron in turn improves the translocation efficiency of sugars thereby improving the seed filling (Davis, 1983). Tank mix is a combination of nutrients and GA which has contributed to a balanced increase of yield attributes. In the unweeded condition, plants had to compete with weeds. Priming treatments $MnSO_4$, tank mix and borax improved the competing ability of the plants which resulted in less reduction of yield under unweeded condition.

Effect of seed priming treatments on weed suppression

The major weed flora found in the sesame field was *Melochia corchorifolia* L., *Digitaria ciliaris* (Retz.) Koeler, *Echinochloa colona* (L.) Link, *Oryza sativa* L. and *Cleome viscosa*.L. At 10 DAS, *Melochia chorchorifolia* were predominant, whereas at harvest, population of *Digitaria ciliaris* was higher in all the treatment plots. Lower weed count was recorded for *Cleome viscosa*. The different treatments did not have any influence on the weed floral composition (Table 4). However there was significant variation in the population of the weed species in the different treatments.

Weed count

Weed count from different treatments in the unweeded plots of sesame are given in table 5. The weed flora present in the unweeded plots was classified under grasses and broad leaved weeds. Sedges were not observed in the field. Seed priming could suppress the weed growth. At 10 DAS, broad leaved weeds were significantly higher than grasses. There was no significant variation observed in the number of grasses with treatments. But the number of broad leaved weeds were higher in control (50.0) and $MnSO_4$ (42.3) primed plots. Among the treatments lower total weed count was observed in the priming treatment of borax (51.3), tank mix (56.0), water (58.7) and GA (61.00). At the time of harvest grasses were significantly higher than broad leaved weeds. Density of grasses was lower in the treatment of $MnSO_4$ (49.00), tank mix (59.7), borax (67.00) and GA (75.66). Broad leaved weeds were found to be lower in treatment of GA (16.7) and borax (18.0). In the treatments, $MnSO_4$ (69.7), tank mix (79.7), borax (85.0) and GA (92.3) were statistically on par and recorded significantly lower total weed count than water priming (139.0) and control (211.3).

Effect of seed priming on weed dry matter production

Priming treatments helped to suppress weed growth (Table 6). At 10, DAS there was no significant difference in weed dry weight with different treatments. At the time of harvest the lower weed dry weight was recorded for $MnSO_4$ priming (104.3 g) which was statistically similar to tank mix (112.0 g). Priming with borax (116.6 g) and water (127.4 g) were statistically on par and recorded lower weed dry weight than GA priming (133.3 g).

Weed control efficiency of seed priming

Higher weed control efficiency of 38.76 per cent was recorded from $MnSO_4$ priming. Weed control efficiency of tank mix (34.11%) and borax (31.40%) were statistically on par and superior to water (25.00%) and GA (21.60%) priming (Fig. 2). The weed count (Table 7 and 8) and weed dry weight (Table 9) showed a decreasing trend with the seed priming treatments. This indicates that improvement in seedling vigour by seed priming can lead to weed suppression. The priming treatments significantly reduced the weed count as compared to control both at 10 DAS and at harvest. Weed control efficiency was found to be maximum for $MnSO_4$ followed by tank mix and borax indicates that these priming treatments could give 30-38 per cent weed control.

The studies indicate that seed priming treatments improved the vigour of the seed. The improvement in vigour was the result of enhancement in the metabolic activities of the seed which were reflected in higher enzymatic and hormonal content of the plant. The enhancement in the metabolism of plants may have contributed to sustainable improvement in the growth rate and yield parameters. This improved growth rate of primed seeds might have suppressed the coverage and establishment of the weeds thereby improved yield. According to this study, $MnSO_4$ was the best seed priming treatment with 38 per cent weed control efficiency in sesame field.

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