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Enhancement of Vigour Status through Micronutrient Priming and Humid Invigouration in Sesame

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Oilseeds shows quicker deterioration leading to loss of seed vigour and viability, which can be improved through priming and fortification techniques. This study was aimed to assess the effect of micronutrient priming and humid invigouration technique in sesame. The duration of soaking for priming treatment was fixed by soaking the seeds for durations *viz*., 8, 10, 12, 14 and 16 h. In this the best duration was subjected to humid invigouration for durations *viz*., 0, 3, 6, 9, 12 and 15 h. Then the durations standardized earlier were subjected to micronutrient ($ZnSO_4$ and $MnSO_4$) priming of concentrations *viz*., 0.25, 0.5 and 1 %. The results revealed that seeds soaking with $MnSO_4$ 0.5 % for 12 h and followed by humid invigouration of 9 h was effective in increasing germination (22.7 %), radical protrusion (54 %), shoot length (36.4 %), root length (78 %), dry matter production (63.5 %) and vigour index (92 %) over the control.

Key words: Seed priming, Micronutrient, Humid invigouration

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae, is one of the oldest oil crops widely cultivated in Asia and Africa (Ali *et al.,* 2007). India, China, Sudan and Burma are the major producers of sesame in the world , which accounts about 60% of the total world production (El Khier *et al.,* 2008). During 2016-17, sesame is grown in 16.6 lakh ha, the production level is 74.4 lakh tonnes and the productivity of about 448 kg ha^{-1} in India and in Tamil nadu it has been grown in 28,230 ha with the production of 10840 tonnes. India is one of the potential exporter of sesame seeds in the world market and accounted 3,08,747 tonnes which valued 2707.54 crore rupees (INDIASTAT, 2018). Sesame has antioxidative agents like sesamin and sesamolin which make the oil highly stable (Suja *et al.* 2004). These antioxidants aids in lowering cholesterol level in humans (Hirata *et al.,* 1996) and prevent high blood pressure and increase vitamin E in animals.

Seed being a biological and living entity, deterioration in its quality is inevitable, irreversible and inexorable. The deterioration rate of oil seeds are very high, which decreases the vigour and quality of seeds (Afzal *et al.,* 2002). Seed priming is one of the seed treatment where the seeds are soaked in water or nutri-solutions and dried back to safe storage moisture levels. Priming improves the seedling establishment by altering pre-germination metabolic activity prior to radicle emergence and aids in enhanced germination rate and associated vigour potential of crop plants (Taylor *et al.,* 1998). Treating the seeds with micronutrients was found to be an attractive and cost effective alternative to soil reserves of these elements (Farooq *et al.,* 2012). Oil seeds posses more sulphur requirement when compared with other crops. Since sulphur is an important component of vitamins, proteins and amino acids. Deficit of sulphur in plants causes reduced growth and also reduced shoot root ratio (Hawkesford and Dekok, 2006). Inorder to extend the beneficial effect of seed priming and also to stimulate various physiological changes in soaked seeds, the seeds after priming were subjected to humid invigouration treatment (keeping the soaked seeds in dark condition for specific durations). Keeping the foresaid facts in mind, this study was conducted to investigate the interactive effect of micronutrient seed priming and humid invigouration on seedling quality of sesame seeds.

Material and Methods

Medium vigoured seeds of sesame (S*esamum indicum* L.) TMV 7 having 65 per cent germination obtained from Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore constituted the source material for the study. The experiments on humid invigouration and micronutrient priming were conducted in the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Sesame seeds of 25 g were packed in cloth bag and soaked in the water for 8, 10,12, 14 and 16 h inorder to standardise the duration of soaking for humid invigouration and the resultant seeds were analysed for seed quality parameters.

The best duration for soaking as standardised earlier was further subjected to humid invigouration for durations of 0, 3, 6, 9, 12 and 15 h. For this, primed seeds were taken out along with cloth bag and kept at dark condition on elevated structure to facilitate draining of excess solution and the seeds were evaluated for seed quality parameters. The

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resultant seeds served as humid invigoured seeds and unsoaked dry seeds treated as control.

Then the durations standardized earlier were subjected to micronutrient priming with the concentrations of 0.25, 0.5 and 1 % of $ZnSO_4$ and $MnSO_4$ each. The best treatments for micronutrient priming was fixed based on the seed quality parameters *viz.*, Speed of germination, germination (%), root length (cm), shoot length (cm), dry matter production (mg seedlings -10) and vigour index of the resultant seed. Germination percent was determined as per ISTA rules for seed testing. The seeds were placed in rolled paper towels. Hundred seeds of four replications were tested at a constant temperature of 25°C. The number of normal seedlings were evaluated on 6th day and percent germination was expressed on normal seedling basis (ISTA, 2016). From the standard germination test, ten normal seedlings were selected at random in each replication on final count. The shoot and root length was measured, sum of root and shoot length measured constitute the seedling length and mean was calculated and expressed in centimeter. Seedling vigour index was computed by adopting the formula suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index = Germination (%) x Mean seedling length (cm)

Seed germination test was conducted as described above and daily germination counts were recorded on the germinated seeds possessing radicle size of 3-5 mm. The speed of germination was calculated by using the formula suggested by Maguire (1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + ... + \frac{X_n - X_{n-1}}{Y_n}$$

Where X_1- Number of seeds germinated at first count, X_2- Number of seeds germinated at second count, X_n- Number of seeds germinated on n^{th} day,Y_1- Number of days from sowing to first count, Y_2- Number of days from sowing to second count and Y_n- Number of days from sowing to n^{th} count.

Results and Discussion

Among the durations followed for priming, the seeds soaked in water for 12 h were found to be effective in increasing speed of germination by 19.10 per cent (12.41), germination by 7.7 per cent (70 %), root length by 24.1 per cent (4.38 cm), shoot length by 9.4 per cent (3.85 cm), dry matter production by 9.1 per cent (22.20 mg $seedlings^{-10}$) and vigour index by 25.4 per cent (578); whereas, the unsoaked dry seeds (control) recorded the speed of germination (10.42), germination (65 %), root length (3.53 cm), shoot length (3.52 cm), dry matter production (20.35 mg) and vigour index (461) (Table 1). The superiority of priming over unprimed control seed might be due to soaking of seeds allows the hydration of membranes and proteins, and the initiation of various metabolic systems. These are arrested when the seeds are dried or moisture is withheld, but recommence when the seeds imbibe water for the second time (Bewley and Black, 2012). The improvements in seed germination and speed of emergence might be due to enhanced supply of soluble carbohydrates to the growing embryo, which was caused by increase in α-amylase activity.

Table 1. Effect of duration of water soaking for humid invigouration on seed quality in sesame var. TMV 7

Treatment	Speed of germination	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings -10)	Vigour index
T_0 - Control	10.42	65 (53.59)	3.53	3.52	20.35	461
T_1 - Soaking for 8 h	11.21	66 (54.18)	3.82	3.69	20.98	499
T_2 - Soaking for 10 h	11.51	67 (54.79)	4.01	3.73	21.52	523
T_3 - Soaking for 12 h	12.41	70 (56.79)	4.38	3.85	22.20	578
T_4 - Soaking for 14 h	11.30	68 (55.55)	4.12	3.71	21.21	534
T_5 - Soaking for 16 h	11.28	66 (54.34)	4.10	3.68	21.20	517
Mean	11.36	67 (54.87)	3.70	3.70	21.24	511
SEd	0.144	0.475	0.038	0.052	0.222	6.536
CD (P=0.05)	0.302	0.998	0.080	0.109	0.466	13.732

Figures in parenthesis indicate arcsine values

Inorder to extend the beneficial effect of seed priming and also to stimulate various physiological changes in soaked seeds, the seeds after priming were subjected to humid invigouration treatment. In the present study, the humid invigouration with different durations revealed that the seeds subjected to humid invigouration for 9 h performed significantly better than other treatments with the increase of 76.40 per cent (18.42) in speed of germination, 20 per cent (78 %) in germination, 57.1 per cent in root length (5.5 cm), 76.4 per cent (4.33 cm) in shoot length, 35.7 per cent in dry matter production (28.50 mg $seedlings^{-10}$) and 66.9 per cent (766) in vigour index; whereas, the control recorded speed of germination (10.44), germination (65 %), root length (3.50 cm), shoot length (3.51 cm), dry matter production (21.00 mg) and vigour index (459) (Table 2). The present study results are in line with research on the seeds of

Table 2. Effect of duration of humid invigouration on seed quality in sesame var. TMV 7

	Treatment	Speed of germination	Germination (%)	Abnormal seedlings (%)	FUG* seeds (%)	Dead seeds (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings -10)	Vigour Index
T_0	Control (Dry seeds)	10.44	65 (53.88)	01 (05.74)	14 (22.48)	20 (26.57)	3.50	3.51	21.00	459
T_1	12 h soaking	12.38	69 (56.33)	01 (05.73)	10 (18.41)	20 (26.56)	4.34	3.85	22.00	567
T_2	12 h soaking + 3 h humid invigouration	12.81	71 (57.27)	02 (08.13)	08 (16.43)	19 (25.84)	4.40	3.90	24.00	591
T_3	12 h soaking + 6 h humid invigouration	15.25	73 (58.70)	05 (12.92)	03 (09.97)	19 (25.84)	5.10	4.25	26.00	684
T_4	12 h soaking + 9 h humid invigouration	18.42	78 (62.04)	01 (05.73)	02 (08.18)	19 (25.84)	5.50	4.33	28.50	766
T_5	12 h soaking + 12 h humid invigouration	13.71	43 (40.83)	25 (30.00)	02 (08.19)	30 (33.21)	3.65	2.95	21.50	285
T_6	12 h soaking + 15 h humid invigouration	13.15	41 (39.82)	20 (26.56)	01 (5.75)	38 (38.06)	3.37	2.90	19.00	260
Mean		13.74	63 (52.70)	08 (13.54)	05.72 (12.70)	23.57 (28.85)	4.27	3.67	23.14	516
SEd		0.010	0.630	0.093	0.064	0.250	0.079	0.038	0.304	7.453
CD (P=0.05)		0.021	1.311	0.193	0.133	0.520	0.163	0.078	0.632	15.499

Figures in parenthesis indicate arcsine values * FUG- Fresh ungerminated seeds

Blackgram soaked in Nutrigold 0.5 % for 2 h and incubated for 4 h enhanced the germination by 6 % over control (Vanitha, 2017).

At 12 h humid invigouration, the seeds had started radicle protrusion. On drying, the radicles have produced more number of abnormal seedlings. It is evident that humid invigouration after 9 h had less number of normal seedlings and due to moisture stress, more number of abnormal seedlings and dead seeds have developed. The number of dead and fresh ungerminated seedlings decreased gradually upto humid invigouration of 9 h and hence more number of dead seeds and abnormal seedlings were noticed in 12 h and 15 h of humid invigouration. So, 9 h of humid invigouration was found to be the best for sesame. Increase in germination might be due to the associated effect of change in plant hormone signalling and biosynthesis. There was a report that priming has increased gibberellins or abscisic acid ratio (El-Araby *et al.,* 2006) due to gene expression pattern (Schwember and Bradford, 2010). It also increase the ethylene production during priming which may promote endo-β-mannase activity which facilitates endosperm weakening and post-priming germination (Chen and Arora, 2011) .

Table 3. Effect of micronutrient priming followed by humid invigouration on seed quality in sesame var. TMV 7

	Treatment	Speed of germination	Germination (%)	Root length (cm)	Shoot length/ (cm)	Dry matter production (mg seedlings -10)	Vigour Index
T_0	Control	10.72	66 (54.34)	3.54	3.52	21.25	467
T_1	Hydro priming	18.31	79 (62.73)	5.58	4.31	28.75	784
T_2	$MnSO_4$ 0.25 % priming	18.32	80 (63.47)	5.95	4.38	31.00	828
T_3	$MnSO_4$ 0.5 % priming	18.44	81 (64.19)	6.30	4.80	34.75	899
T_4	$MnSO_4$ 1 % priming	15.46	79 (62.74)	5.50	3.91	29.75	745
T_5	$ZnSO_4$ 0.25 % priming	12.82	76 (60.67)	4.90	3.92	21.50	673
T_6	$ZnSO_4$ 0.5 % priming	15.12	79 (62.74)	5.41	4.09	28.00	754
T_7	$ZnSO_4$ 1 % priming	14.03	78 (62.03)	5.23	4.08	27.90	729
Mean		15.40	77 (61.61)	5.31	4.13	27.86	733
SEd		0.225	0.849	0.073	0.072	0.343	7.713
CD (P=0.05)		0.464	1.752	0.151	0.148	0.708	15.918

Figures in parenthesis indicate arcsine values

Inorder to impart the beneficial effect of micronutrient through priming technique, the duration of soaking (12 h) and humid invigouration (9 h) as standardized earlier were subjected to seed priming with micronutrients. The results showed that micro nutrient seed priming ($MnSO_4$ 0.5 %) followed by humid invigouration had increased speed of germination by 72 per cent (18.44), germination by 22.7 per cent (81 %), root length by 78 per cent (6.30 cm), shoot length by 36.4 per cent (4.80 cm), dry matter production by 63.5 per cent (34.75 mg seedlings^{-10}) and vigour index by 92 per cent (899) over control. Whereas, the control recorded speed of germination (10.72), germination (66 %), root length (3.54 cm), shoot length (3.52 cm), dry matter production (21.25 mg) and vigour index (467) (Table 3). The best performance might be due to the interactive performance of seed priming with $MnSO_4$ and humid invigouration. Suma (2005) in sesame also reported that seed priming with $MnSO_4$ at 0.5 per cent improved the seed germination by 5 and 7 per cent higher than water soaking and control respectively.

During seed invigouration, the first phase of germination ends with completion of imbibition process and hence the time taken from sowing to emergence is much reduced (Hegarty, 1970). The improvement in field emergence due to invigouration could also be ascribed to activation of cells, which results in the enhancement of mitochondrial activity leading to the formation of more high energy compounds and vital biomolecules, which are made available during the early phase of germination (Dharmalingam, 1982).

From this study, it could be concluded that soaking the sesame seeds in 0.5 % $MnSO_4$ for 12 h followed by humid invigouration for 9 h can be used as a low cost technology to improve the seed germination and vigour of seedlings which ultimately leads to better crop establishment.

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