Seed Priming Studies for Improvement of Seed Quality and Field Performance in Sunflower (Helianthus annuus L.)

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Abstract

Studies conducted to assess the effect of seed priming treatments on seed quality, storability and field performance of two sunflower (Cv. Morden) seed lots having initial germination of 78 and 85 per cent respectively indicated that, seed priming with $Na_2H_2PO_4$ (0.5%), $N_2S_2O_3.5H_2O$ (1%), $CoCl_2$ (0.5%), Mixtelol (5 ppm), GA_3 (50 ppm) and hydration-dehydration, significantly improved the germination seedling vigour, storability of seeds and field performance in terms of field emergence, establishment and speed of emergence in both the seed lots over their control both under normal and moisture stress conditions. The effects were more conspicuous under stressed than normal condition. The low germinable seed lot showed greater response to seed priming treatments. Considering the comparative performance, seed priming with NaH_2PO_4, $CoCl_2$, Mixtelol, $Na_2S_2O_3.5H_2O$ and GA_3 were found to be most promising.

Key words : Seed Priming, Seedling Vigour, Storability, Field Performance.

Introduction

The success of crop production depends on the use of good quality seeds. Seed deterioration during storage under tropical and subtropical climate is considered as a serious limitation for supply of quality seed. Seed deterioration is defined as irreversible degenerative changes in the seed (ABDUL-BAKI and ANDERSON, 1972) which is accompanied by several biochemical phenomena such as degradation of various compounds, loss of membrane integrity, accumulation of inhibitors,

production of the fatty acids etc., leading to loss in vigour and viability of seed which inturn result in low field emergence, poor field stand and performance. Several studies indicate that pre-sowing or mid-storage seed treatment can improve the seed storability even under less than ideal condition (BASU, 1976) and also the germination performance of stored seed (BROCKLEHURST and DEARMAN, 1984). Relatively short duration hydration and dehydration treatments 12-24 hours of imbibition) have been reported to increase the vigour of the stored seed and/or extend the longevity both under normal and adverse conditions in rice, jute, sunflower, pulses and vegetable seeds (BASU, 1976) and wheat (RUDRAPAL and BASU, 1982).

The beneficial effect of treatments have been attributed to reduced lipase activity, lowered fatty acid (DAY and MUKHERJEE, 1986), lowered lipid peroxidation in treated seeds as compared to untreated. Sunflower being a second most important edible oil seed crop, there has been a increasing demand for quality seed. Being an oil seed crop, the seeds get deteriorated at faster rate because of free radical formation on lipid peroxidation which impairs the membrane stability. Thus a study was conducted to improve the seed quality and storability by seed priming/invigouration treatments which is a technique accomplished by imbibing the seed in an osmotic/salt solution that allows the seed to imbibe water to a level that permits some of the initial steps of germination to proceed but prevents radical emergence (HEYDEKAR, 1975).

Material and Methods

Two seed lots of sunflower (Cv. Morden) (L_1 and L_2) having a initial seed germination of 85 and 78 per cent were used for the study. The low germinable seed lot (L_2) seven months old (8% moisture) was first subjected to several seed priming treatments comprising of 24 inorganic salts and 12 growth regulators, compared with control and hydration-

dehydration treatments with standardised volume of water and time of soaking (1:1 for 12 hrs) for initial screening. The seeds were then dried under shade to the original moisture content (8%) for three days. The seeds were then subjected to laboratory test to record the various seed quality parameters like germination vigour index, mobilization efficiency using standard procedures. Based on the results, ten promising priming treatments were selected along with control and hydration-dehydration to study the storability and field performance of high and low germinable seed lots. The seeds were stored after priming treatment in cloth bags under ambient condition for 4 months. Seeds were tested bimonthly for seed quality parameters to evaluate storability. Another set of primed seed of the same lots were sown in field during rainy season (1991) in 3 m x 1.5 m plots using Factorial RCBD with three replications under normal (irrigated) and stressed condition. Observations on germination, vigour index, field emergence and speed of emergence (MAGUIRE, 1962) were recorded as per the standard procedure. The data was subjected to statistical analysis adopting "Fishers Analysis of Variance technique". Data in per cent were transformed into Arc Sin root transformation before analysis.

Results and Discussion

The data on the storability of primed seed on germination (%) and vigour index is presented in Table 1 and 2. The results infer that, all the selected priming treatments improved the germination percentage (15.05-4.48%) over their control in the initial stage with NaH_2PO_4 (0.5%), showing highest improvement. With increase in storage period there was a decrease in germination in both the seed lots. Seeds primed with NaH_2PO_4 and hydration-dehydration treatments maintained their superiority over control, even after four months storage. While the other treatments responded negatively in both the seed lots. Similar improved germination during subsequent storage with NaH_2PO_4 in sunflower was

reported by BASU and DEY (1983) and DHARMALINGAM and BASU (1990).

Decline in vigour index was observed over the period of storage in both the seed lots. The treatments with Mixtelol, NaH_2PO_4, hydration-dehydration and $Na_2S_2O_3.5H_2O$ were found to retain their superiority over untreated control. Substantial improvement in seed quality was observed with low germinable seed lot. The increased vigour index was due to increased mobilization efficiency from the cotyledon to embryonic axis (data not presented) which was also observed by KATHIRESAN et al. (1984a).

The data on the field performance of primed seed in terms of field emergence and speed of emergence is presented in Table 3 and 4. The results of field germination followed the same trend as that of laboratory germination with NaH_2PO_4, $CoCl_2$, Mixtelol, hydration-dehydration, $Na_2S_2O_3.5H_2O$ showing better performance in terms of field emergence and establishment. However, no consistency in response with different priming treatments was observed for different parameters under both normal and moisture stress conditions, although $Na_2S_2O_3.5_2O$ and NaH_2PO_4 recorded highest field establishment (84.2%) under normal condition while GA_3, KH_2PO_4 and $CoCl_2$ recorded highest field establishment (77%) under stressed condition. Similar better field emergence and establishment were reported in okra with GA_3 (OMRAN et al., 1980), in sunflower with NaH_2PO_4 (BASU and DEY, 1983), in carrot with $Na_2S_2O_3.5H_2O$ (KUNDU and BASU, 1981).

Thus it can be concluded from the study that, all the seed priming treatments were found beneficial to improve the initial germination and seedling vigour of sunflowe,r although some priming treatments [$(NH_4)_2$ MoO_4, $MgSO_4$, KH_2PO_4, $ZnSO_4$, proline] could not maintain the same during subsequent storage. Hydration-dehydration alone improved the germination over the control, but the additional beneficial effect of chemicals such as NaH_2PO_4, $CoCl_2$, Mixtelol, GA_3 and $Na_2S_2O_3.5H_2O$ was

also observed on storability of seeds and improved field performance in both the seed lots. However, it was evident that seed priming was more beneficial with low germinable seed lot. The effects were more conspicuous under stressed than normal condition.

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Table 1: Germination percentage as influenced by seed lots and seed priming treatments during storage.

Seed priming treatments (T)		MONTHS AFTER STORAGE: Initial (0 month) L_1	L_2	Mean	2 months L_1	L_2	Mean	4 months L_1	L_2	Mean
T_1 Untreated control		66.98 (84.70)	60.22 (75.30)	63.60 (80.20)	65.91 (83.30)	58.91 (73.30)	62.41 (78.60)	63.45 (80.00)	57.21 (70.70)	60.33 (75.50)
T_2 Hydration-dehydration		71.56 (90.00)	64.43 (81.40)	67.99 (85.99)	69.16 (87.30)	62.04 (78.00)	65.60 (82.90)	66.95 (84.70)	58.91 (73.30)	62.93 (79.30)
T_3 Ammonium molybdate	(0.1%)	75.07 (93.40)	64.43 (81.40)	69.75 (88.00)	50.38 (59.30)	48.83 (56.70)	49.60 (58.00)	38.83 (39.30)	33.20 (30.00)	36.01 (34.60)
T_4 Cobalt chloride	(0.05%)	73.65 (92.10)	69.20 (87.40)	71.42 (89.90)	70.95 (89.30)	66.95 (84.70)	68.95 (87.10)	66.95 (84.70)	61.12 (76.70)	64.03 (80.80)
T_5 GA_3	(50ppm)	73.57 (92.00)	65.40 (82.70)	69.48 (87.70)	69.20 (87.40)	63.92 (80.70)	66.56 (84.20)	66.40 (82.70)	53.93 (65.30)	59.67 (74.50)
T_6 Magnesium sulphate	(0.05%)	69.16 (87.30)	63.43 (80.00)	66.29 (83.80)	54.74 (66.70)	46.52 (52.70)	50.63 (59.80)	48.83 (56.70)	29.76 (24.70)	39.29 (40.10)
T_7 Mixtelal	(5ppm)	72.90 (91.40)	68.06 (86.00)	70.48 (88.80)	64.43 (81.40)	65.40 (82.70)	64.91 (82.00)	63.45 (80.00)	48.45 (56.00)	55.95 (68.70)
T_8 Potassium dihydrogen phosphate	(0.5%)	71.62 (90.10)	63.92 (80.70)	67.77 (85.70)	58.48 (72.70)	49.99 (58.70)	54.23 (65.80)	41.93 (44.70)	32.36 (28.70)	37.15 (36.50)
T_9 Sodium dihydrogen phosphate.	(0.5%)	76.70 (94.70)	71.01 (89.40)	73.85 (92.30)	74.40 (92.80)	69.16 (87.40)	71.78 (90.20)	68.59 (86.70)	62.04 (78.00)	65.31 (82.60)
T_{10} Sodium thiosulphate	(1.0%)	75.82 (94.00)	69.20 (87.50)	72.51 (91.00)	71.62 (90.10)	66.95 (84.70)	69.28 (87.50)	63.94 (80.70)	55.55 (68.00)	59.74 (74.60)
T_{11} Zinc sulphate	(0.01%)	69.73 (88.00)	63.92 (80.70)	66.82 (84.51)	54.33 (66.00)	48.06 (55.30)	51.20 (60.70)	48.06 (55.30)	31.08 (26.70)	39.57 (40.60)
T_{12} Proline	(0.01M)	70.34 (88.70)	63.45 (80.00)	66.89 (84.60)	67.49 (85.30)	61.12 (76.70)	64.30 (81.20)	54.33 (66.00)	44.61 (49.30)	49.47 (57.80)
Mean		72.26 (90.70)	65.55 (82.90)	68.91 (87.10)	64.26 (76.90)	58.99 (73.40)	61.62 (77.40)	57.56 (71.20)	47.35 (54.10)	52.46 (62.90)

Per cent increase in germination over control									
	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean
T_1	-	-	-	-	-	-	-	-	-
T_2	6.25	8.10	7.22	4.80	6.40	5.47	5.87	3.68	5.03
T_3	10.27	8.10	9.72	-28.81	-22.64	-26.21	-50.87	-57.57	-54.17
T_4	8.73	16.06	12.09	7.20	15.55	10.81	5.87	8.48	7.01
T_5	8.61	9.82	9.35	4.92	10.09	7.12	3.37	-7.63	-1.32
T_6	3.06	6.24	4.48	-19.92	-28.10	-23.92	-29.12	-65.06	-46.88
T_7	7.91	14.20	10.72	-2.28	12.82	4.33	0.00	-20.79	-9.00
T_8	6.37	7.17	6.86	-12.72	-19.92	-16.28	-44.12	-59.40	-51.65
T_9	11.80	18.72	15.08	11.40	19.24	14.76	8.37	10.32	9.40
T_{10}	10.97	16.20	13.46	8.16	15.55	11.32	0.87	-3.81	-1.19
T_{11}	3.89	7.17	5.36	-20.76	-24.56	-22.17	-30.87	-62.23	-46.22
T_{12}	4.72	6.24	5.48	2.40	4.64	3.30	-17.50	-30.26	-23.44

For comparing means of	Initial (0 month) SEm +	CD at 5%	2 months SEm +	CD at 5%	4 months SEm +	CD at 5%
Seed lots (L)	0.325	0.637	0.302	0.592	0.292	0.572
Seed priming treatment (T)	0.797	1.561 CV (%) 2.00	0.740	1.450 CV (%) = 2.08	0.715	1.401 CV (%) = 2.36
Interaction (LXT)	1.127	2.208	1.046	2.050	1.011	1.982

Note : Figures in the parantheses indicate original values and without parantheses are Arc sin root transformed values

L_1 = Lot 1 (High germinable seed lot)
L_2 = Lot 2 (Low germinable seed lot)

Table. 2. Vigour. index (Germination (%) x seedling length (cm)) as influenced by seed lots and seed priming treatments during storage

Seed priming treatments (T)		MONTHS AFTER STORAGE								
		Initial (0 months)			2 months			4 months		
		L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	Mean
T_1	Untreated control	1627.62	1068.16	1347.89	1502.93	913.64	1208.28	1154.50	806.86	980.68
T_2	Hydration-dehydration	1917.90	1316.76	1617.33	1706.78	1205.02	1455.90	1328.84	971.09	1149.96
T_3	Ammonium molybdate (0.1%)	2055.40	1744.82	1900.11	1014.48	885.71	950.10	506.30	308.10	407.20
T_4	Cobalt chloride (0.05%)	2276.26	1940.96	2108.61	1920.73	1676.33	1798.53	1398.70	1009.60	1204.15
T_5	GA_3 (50ppm)	2303.06	1889.68	2096.37	2002.53	1738.36	1870.45	1472.29	893.42	1177.86
T_6	Magnesium sulphate (0.05%)	1849.18	1706.66	1777.92	1332.00	837.16	1084.58	800.40	294.53	547.47
T_7	Mixtelal (5ppm)	2363.56	2044.56	2204.06	1862.33	1808.63	1835.48	1363.16	770.60	1066.88
T_8	Potassium dihydrogen phosphate (0.5%)	1964.85	1744.73	1854.79	1474.90	1099.86	1287.38	611.62	335.42	473.52
T_9	Sodium dihydrogen phosphate (0.5%)	2362.21	2187.26	2274.74	1993.33	1785.46	1889.40	982.40	1036.87	1009.63
T_{10}	Sodium thiosulphate (1.0%)	2210.88	1892.15	2051.51	1915.50	1700.80	1808.15	1243.88	867.20	1055.54
T_{11}	Zinc sulphate (0.01%)	1970.02	1629.11	1799.57	1246.36	978.71	1112.54	781.37	281.45	531.41
T_{12}	Proline (0.01M)	1958.00	1687.78	1822.89	1694.13	1461.63	1577.88	1065.06	613.86	839.46
	Mean	2071.58	1737.72	1904.65	1638.83	1340.94	1489.89	1059.04	681.58	870.31
For comparing means of		S.Em + CD at 5%			S.Em + CD at 5%			S.Em + CD at 5%		
Seed lots (L)		17.262	33.834		16.446	32.234		38.060	74.598	
			C.V(%) 3.84			C.V(%) 4.68			C.V.(%)	18.55
Seed priming treatment (T)		42.284	82.876		40.285	78.958		93.228	182.726	
Interaction (LXT)		59.798	117.204		56.971	11.663		-	NS	

Note: L_1 = Lot 1 (High germinable seed lot). L_2 = Lot 2 (Low germinable seed lot), NS = Non significant

Table 3 : Field emergence (%) as influenced by field conditions, seed lots and seed priming treatments

Seed priming treatments (T)		Field condition/seed lots (CXLXT)				Mean (T)	Mean (LXT)		Mean (CXT)	
		C_1		C_2						
		L_1	L_2	L_1	L_2		L_1	L_2	C_1	C_2
T_1 Untreated control		64.43 (81.40)	57.21 (70.70)	57.63 (71.30)	49.60 (58.00)	57.21 (70.70)	61.03 (76.50)	53.40 (64.50)	60.82 (76.20)	53.61 (64.80)
T_2 Hydration-dehydration		66.95 (84.70)	60.67 (76.00)	55.55 (68.00)	53.13 (64.00)	59.08 (73.60)	61.25 (76.90)	56.90 (70.20)	63.81 (80.50)	54.34 (66.00)
T_3 Ammonium molybdate	(0.1%)	53.54 (64.70)	47.29 (54.00)	49.99 (58.60)	47.68 (54.70)	49.63 (58.00)	51.76 (61.70)	47.49 (54.30)	50.42 (59.40)	48.84 (56.70)
T_4 Cobalt chloride	(0.05%)	71.01 (89.40)	60.23 (75.30)	61.58 (77.30)	56.39 (69.40)	62.30 (78.40)	66.30 (83.80)	58.31 (72.40)	65.62 (83.00)	58.99 (73.40)
T_5 GA_3	(50ppm)	58.08 (72.00)	66.95 (84.70)	62.04 (78.00)	59.79 (74.70)	61.71 (77.50)	60.06 (75.10)	63.37 (79.90)	62.51 (78.70)	60.91 (76.40)
T_6 Magnesium sulphate	(0.05%)	61.12 (76.70)	51.16 (60.70)	56.81 (70.00)	46.14 (52.00)	53.81 (65.10)	58.96 (73.40)	48.65 (56.30)	56.14 (68.90)	51.48 (61.20)
T_7 Mixtelal	(5ppm)	60.24 (75.30)	62.49 (78.70)	62.49 (78.70)	51.94 (62.00)	59.29 (73.90)	61.37 (77.00)	57.22 (70.70)	61.37 (77 00)	57.22 (70.70)
T_8 Potassium dihydrogen phosphate	(0.5%)	63.45 (80.00)	52.73 (63.30)	59.35 (74.00)	49.61 (58.00)	56.28 (69.20)	61.40 (77.10)	51.17 (60.70)	58.09 (72.00)	54.48 (66.30)
T_9 Sodium dihydrogen phosphate	(0.5%)	71.72 (90.20)	55.15 (67.40)	64.96 (82.10)	55.97 (68.70)	61.95 (77.90)	68.34 (86.40)	55.56 (68.00)	63.43 (80.00)	60.46 (75.70)
T_{10} Sodium thiosulphate	(1.0%)	69.24 (87.40)	63.50 (80.10)	58.95 (73.40)	56.79 (70.00)	62.12 (78.10)	64.09 (80.90)	60.15 (75.20)	66.37 (83.90)	57.87 (71.70)
T_{11} Zinc sulphate	(0.01%)	68.67 (86.80)	52.74 (63.30)	56.39 (69.40)	47.67 (54.70)	56.37 (69.30)	62.53 (78.70)	50.21 (59.00)	60.70 (76.10)	52.03 (62.10)
T_{12} Proline	(0.01M)	58.50 (72.70)	54.74 (66.70)	55.96 (68.70)	53.13 (64.00)	55.58 (68.00)	57.23 (70.70)	53.93 (65.30)	56.62 (69.70)	54.54 (66.40)
Mean		63.91 (80.70)	57.07 (70.50)	58.48 (72.70)	52.32 (62.60)		61.19 (76.80)	54.70 (66.60)	60.49 (75.70)	55.40 (67.80)

For comparing means of	S.Em ±	C.D. at 5%
Field conditions (C)	0.208	0.576
Seed lots (L)	0.208	0.576
Seed priming treatment (T)	0.509	1.410
CXL	-	NS
CXT	0.720	1.994 CV (%) = 3.04
LXT	0.720	1.994
CXLXT	1.018	2.820

Figure in parantheses indicate original values and without parantheses are Arc sin root transformed values.

Note: NS = Non significant
C_1 = Normal field condition
C_2 = Stress field condition
L_1 = Lot 1 (High germinable seed lot)
L_2 = Lot 2 (Low germinable seed lot)

Table 4.3: Speed of emergence as influenced by field conditions, seed lots and seed priming treatments

Seed priming treatments (T)		Field condition/seed lots (CXLXT)				Mean (T)	Mean (LXT)		Mean (CXT)	
		C_1 L_1	C_1 L_2	C_2 L_1	C_2 L_2		L_1	L_2	C_1	C_2
T_1 Untreated control		55.33	51.33	43.00	22:33	43.00	49.16	36.83	53.33	32.66
T_2 Hydration-dehydration		50.00	32.66	27.66	23.66	33.50	38.83	28.16	41.33	25.66
T_3 Ammonium molybdate	(0.1%)	44.66	33.66	35.00	27.66	35.25	39.83	30.66	39.16	31.33
T_4 Cobalt chloride	(0.05%)	67.66	52.00	49.66	39.66	52.25	58.66	45.83	59.83	44.66
T_5 GA_3	(50ppm)	64.00	66.66	52.33	36.33	54.83	58.16	51.50	65.33	44.33
T_6 Magnesium sulphate	(0.05%)	57.07	25.66	43.33	25.33	37.83	50.16	25.50	41.33	34.33
T_7 Mixtelal	(5ppm)	53.66	55.33	49.33	32.33	47.66	51.50	43.83	54.50	40.83
T_8 Potassium dihydrogen phosphate	(0.5%)	53.33	44.33	47.00	28.33	43.25	50.16	36.33	48.83	37.66
T_9 Sodium dihydrogen phosphate	(0.5%)	76.66	45.33	53.66	37.66	53.33	65.16	41.50	61.00	45.66
T_{10} Sodium thiosulphate	(1.0%)	65.00	53.66	48.00	43.00	52.41	56.50	48.33	59.33	45.50
T_{11} Zinc sulphate	(0.01%)	63.66	39.66	44.33	24.00	42.91	54.00	31.83	51.66	34.16
T_{12} Proline	(0.01M)	60.33	46.00	49.33	40.66	49.08	54.83	43.33	53.16	45.00
Mean		59.27	45.52	45.22	31.75		52.25	38.63	52.40	38.48

For comparing means of	S.Em ±	C.D. at 5%
Field conditions (C)	0.344	0.953
Seed lots (L)	0.344	0.953
Seed priming treatment (T)	0.842	2.334
CXL	- -	NS
CXT	1.191	3.301 CV (%) = 6.42
LXT	1.191	3.301
CXLXT	1.685	4.669

Note: NS = Non significant
C_1 = Normal field condition
C_2 = Stress field condition
L_1 = Lot 1 (High germinable seed lot)
L_2 = Lot 2 (Low germinable seed lot)