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IMPACT OF THE SEED TREATMENT, PACKING MATERIALS AND STORAGE TEMPERATURE ON VIABILITY OF SOYBEAN

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Abstract

An attempt was made to know the effect of different treatments on seed viability. Experiment was conducted by using three factors like seed treatment with fungicides, storage containers and storage conditions. Among the fungicide treatment the maximum germination (88.94 %), root length (16.07 cm), shoot length (19.83 cm) and seedling dry weight (1.69 g) was observed in X_2 seeds compared to X_1 and X_0. Among the packing materials the significantly maximum germination (93.72%), root length (18.29 cm), shoot length (18.59 cm) and seedling dry weight (1.76 g) was observed in vacuum packed seeds (C_3) followed by polythene bag (C_2), gunny bag (C_4) and cloth bag (C_1). As per the storage conditions the cold storage (A_2) showed maximum germination (90.86%), root length (17.60 cm), shoot length (22.42 cm) and seedling dry weight (1.73 g) compared to the ambient storage (A_1). The interaction effects between all twenty four treatments, $X_2C_3A_2$ showed maximum germination (97.96%), root length (24.20 cm), shoot length (30.57 cm) and seedling dry weight (2.05 g) after two months of storage. Among the fungicide treatment X_2, among the packing materials vacuum packing (C_3), among the storage condition cold storage (A_2) and among the interaction $X_2C_3A_2$ showed significantly maximum germination, root length, shoot length and seedling dry weight throughout the storage period.

Key words : Seed treatment, soybean, storage temperature, packing materias.

Introduction

Seed deterioration is summation of physical, physiological and biochemical changes occurring in a seed. Deteriorative changes occurring with time that increase the seed's vulnerability to external challenges and decrease the ability of the seed to survive. The factors affects to seed deterioration are seed structure, seed chemistry, genetics, physiological seed quality, relative humidity and temperature of the storage environment and external environmental factors. Soybean [*Glycine max* (L.) Merr.] ranks first among oilseeds, oil content of the soybean is up to 20%. Oil seeds are very sensitive to the adverse environmental conditions. The oil inside the seeds will get oxidized easily and deteriorate the seed health during storage (Kausar *et al*., 2009). The storage conditions of seeds influence the germination characteristics and vigor potential of seeds. Diverse environmental conditions such as temperature, pests and diseases, seed oil and moisture content, mechanical damages, storage time and relative humidity of store may affect the viability of seeds (Marshal and Levis, 2004). The environment where the seeds are stored greatly influences the length of seed survival. Seed deterioration leads to the reduction in the quality, viability and vigor either due to aging or effect of adverse environmental factors (Seiadat *et al*., 2012 and Kapoor *et al*., 2010). Decrease in seed vigor may be due to decrease in germination indexes and also can increase the susceptibility of seeds to environmental stress. Hence, the present investigation was carried out to understand impact of seed treatment with fungicide, packing materials and storage condition on viability of soybean seed.

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Materials and Methods

Experiment was conducted in department of Crop Physiology during the year of 2014 to 2016. The experiment was laid out in a factorial CRD design with three different fungicide treatments, four packing materials and two different storage conditions. The soybean variety used for experiment was DSb-21. Seeds were subjected to three different fungicide treatments i). absolute control (X_0) ii). no fungicide treatment to the

Table 1 : Influence of Xelora fungicide seed treatment, different packing and storage conditions on germination per cent (%) in soybean seeds at different period of storage.

Treatment	2nd month	4th month	6th month	8th month	10th month	12th month
Xelora fungicide treatments						
X_0	**81.54**^{b}(64.63)	70.89^{b}(57.96)	61.49^{c}(48.82)	44.32^{b}(36.30)	25.17^{c}(22.28)	12.97^{b}(12.99)
X_1	88.87^{a}(70.84)	77.90^{b}(62.80)	77.69^{b}(62.50)	57.17^{ab}(46.26)	36.83^{b}(32.98)	39.62^{a}(34.42)
X_2	**88.94**^{a}(72.03)	84.42^{a}(63.78)	86.00^{a}(69.01)	64.41^{a}(54.48)	42.26^{a}(38.24)	42.62^{a}(37.50)
SEm±	**0.44**	**0.73**	**0.59**	**1.18**	**0.32**	**0.34**
LSD (0.01)	**1.70**	**2.75**	**2.24**	**4.48**	**1.22**	**1.27**
Storage containers						
Cloth bag (C_1)	**84.88**^{b}(67.43)	74.21^{c}(60.02)	72.75^{b}(58.61)	47.78^{b}(39.31)	26.92^{c}(21.55)	23.75^{b}(19.34)
Polythene bag (C_2)	88.29^{b}(70.44)	85.62^{ab}(65.07)	74.17^{b}(59.38)	65.60^{a}(51.77)	34.12^{b}(32.86)	28.17^{b}(23.12)
Vaccum packing (C_3)	**93.72**^{a}(76.11)	89.18^{a}(66.17)	85.83^{a}(68.43)	65.99^{a}(54.60)	49.84^{a}(44.83)	51.20^{a}(45.12)
Gunny bag (C_4)	88.38^{b}(70.28)	75.62^{bc}(61.57)	75.69^{b}(60.56)	48.35^{b}(42.09)	31.88^{b}(28.79)	26.93^{b}(28.44)
SEm±	**0.51**	**0.84**	**0.68**	**1.36**	**0.37**	**0.39**
LSD (0.01)	**1.94**	**3.18**	**2.59**	**5.17**	**1.40**	**1.47**
Storage conditions						
Room temperature (A_1)	**86.77**(69.15)	68.78(56.16)	66.37(53.40)	25.58(24.12)	20.83(9.83)	16.19(16.43)
Cold storage (A_2)	**90.86**(72.99)	87.54(70.26)	87.85(70.09)	87.17(69.77)	66.55(54.18)	48.83(41.58)
SEm±	**0.36**	**0.59**	**0.50**	**0.96**	**0.26**	**0.27**
LSD (0.01)	**1.37**	**2.25**	**1.91**	**3.66**	**0.99**	**1.04**
Interaction (X x C x A)						
$X_0C_1A_1$	**79.32**^{h}(62.93)	60.11^{hi}(50.84)	0.00^{h}(0.18)	0.00^{g}(0.18)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_1C_1A_1$	81.67^{gh}(64.68)	68.69^{f-h}(56.00)	64.00^{g}(77.37)	0.00^{g}(0.18)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_2C_1A_1$	83.85^{f-h}(66.35)	74.75^{d-g}(59.83)	73.33^{gh}(75.33)	35.83^{f}(36.71)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_0C_2A_1$	82.73^{f-h}(65.44)	66.49^{f-h}(54.62)	85.00^{d-f}(67.36)	36.88^{ef}(37.37)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_1C_2A_1$	86.26^{e-g}(68.25)	72.25^{e-h}(58.20)	0.5^{h}(2.40)	50.00^{ef}(29.99)	3.33^{h}(2.54)	0.00^{k}(0.18)
$X_2C_2A_1$	91.59^{c-e}(73.18)	91.23^{ab}(62.25)	91.66^{b-d}(73.18)	59.16^{de}(50.29)	0.00^{h}(0.18)	6.66^{j} (5.45)
$X_0C_3A_1$	87.98^{d-f}(69.69)	78.30^{de}(56.42)	69.44^{gh}(62.24)	0.00^{g}(0.18)	51.66^{e-g}(19.31)	10.99^{ij}(8.37)
$X_1C_3A_1$	91.70^{c-e}(73.23)	81.72^{c-e}(57.44)	71.08^{gh}(64.80)	56.99^{de}(41.63)	44.16^{fg}(15.69)	12.66^{ij}(10.15)
$X_2C_3A_1$	**97.28**^{ab}(80.63)	95.92^{a}(60.59)	93.32^{a-c}(75.12)	68.78^{cd}(56.04)	65.67^{c}(25.09)	18.00^{h}(15.13)
$X_0C_4A_1$	81.37^{gh}(64.41)	54.23^{i}(47.44)	0.00^{h}(0.18)	0.00^{g}(0.18)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_1C_4A_1$	90.83^{b-e}(68.31)	86.37^{a-d}(52.49)	62.77^{g-i}(72.36)	11.25^{g}(19.57)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_2C_4A_1$	91.11^{c-e}(72.67)	88.33^{a-c}(57.80)	71.41^{gh}(70.30)	13.33^{fg}(17.43)	12.93^{g}(10.06)	9.00^{g-i}(8.41)
$X_0C_1A_2$	85.00^{fg}(66.81)	84.41^{c-d}(56.78)	84.17^{e-g}(67.20)	69.89^{f-h}(66.64)	0.00^{h}(0.18)	0.00^{k}(0.18)
$X_1C_1A_2$	91.67^{c-e}(69.96)	88.20^{a-c}(66.15)	83.15^{e-g}(73.24)	82.50^{a-c}(65.59)	74.59^{b}(59.72)	59.39^{de}(54.18)
$X_2C_1A_2$	91.81^{c-e}(73.83)	88.67^{a-c}(70.53)	86.93^{c-e}(58.36)	84.16^{a-c}(66.56)	76.69^{b}(68.85)	63.51^{cd}(61.14)
$X_0C_2A_2$	87.50^{d-f}(66.39)	83.99^{bc}(65.92)	83.30^{e-g}(69.33)	71.83^{b-d}(57.94)	56.22^{e}(48.55)	0.00^{k}(0.18)
$X_1C_2A_2$	90.29^{c-e}(72.02)	85.58^{a-d}(67.68)	80.83^{ef}(64.09)	82.37^{a-c}(65.16)	79.27^{ab}(51.89)	61.93^{c-e}(57.75)
$X_2C_2A_2$	97.89^{a}(77.39)	94.87^{a}(81.77)	89.48^{b-d}(79.90)	88.17^{ab}(69.90)	83.26^{a}(65.89)	72.50^{bc} (65.75)
$X_0C_3A_2$	93.69^{b-d}(73.29)	91.76^{bc}(75.46)	91.50^{b-d}(68.78)	86.66^{c-e}(73.04)	84.67^{a}(68.52)	46.46^{h}(43.95)
$X_1C_3A_2$	95.63^{a-c}(77.94)	93.50^{ab}(76.04)	93.33^{a-c}(75.00)	86.63^{c-e}(75.64)	84.33^{a}(66.70)	65.79^{e}(52.85)
$X_2C_3A_2$	**97.96**^{a}(81.90)	97.68^{a}(71.06)	94.00^{a}(64.64)	93.83^{a}(81.22)	86.40^{a}(68.57)	**83.11**^{a}(76.91)
$X_0C_4A_2$	90.85^{c-e}(69.63)	90.00^{b-d}(75.55)	87.89^{cd}(71.54)	85.00^{a-c}(67.34)	56.16^{e}(48.52)	10.00^{ij}(8.19)
$X_1C_4A_2$	93.58^{b-d}(72.37)	90.83^{b-d}(75.87)	89.17^{b-d}(70.76)	86.22^{c-e}(72.36)	57.80^{de}(49.47)	48.89^{gh}(44.34)
$X_2C_4A_2$	95.83^{a-c}(74.31)	94.00^{ab}(76.03)	92.71^{bc}(78.22)	85.53^{a-c}(75.85)	64.37^{c}(53.35)	52.89^{fg}(46.64)
SEm±	**1.25**	**2.05**	**1.67**	**3.34**	**0.91**	**1.55**
LSD (0.01)	**4.75**	**7.78**	**6.35**	**12.67**	**3.44**	**5.89**

X_0 - No fungicide treatment to the seeds collected from control plot (Absolute control).

X_1 - No fungicide treatment to the seeds collected from xelora and opera treated plot.

X_2 - Seed treatment with xelora @ 2.5 ml/kg to the seeds collected from xelora and opera treated plot.

Means followed by the same latter (s) in the column does not differ significantly by DMRT (p = 0.01).

Table 2 : Influence of fungicides (Xelora and Opera), different packing and storage conditions on root length (cm) in soybean seeds at different period of storage.

Treatment	2nd month	4th month	6th month	8th month	10th month	12th month
Xelora fungicide treatments						
X_0	12.78	9.50^{b}	9.76^{b}	5.79^{b}	4.28^{c}	4.45^{b}
X_1	15.28	15.06^{a}	14.62^{a}	9.00^{ab}	7.06^{b}	6.42^{ab}
X_2	15.89	**16.07^{a}**	16.07^{a}	10.33^{a}	10.93^{a}	8.13^{a}
SEm±	**0.34**	**0.42**	**0.26**	**0.40**	**0.18**	**0.25**
LSD (0.01)	**NS**	**1.60**	**1.00**	**1.52**	**0.70**	**0.94**
Storage containers						
Cloth bag (C_1)	**11.90^{b}**	10.28^{b}	10.21^{b}	4.77^{b}	6.78^{b}	4.54^{b}
Polythene bag (C_2)	14.74^{ab}	14.49^{ab}	13.34^{b}	10.19^{a}	7.01^{b}	7.07^{ab}
Vaccum packing (C_3)	**18.29^{a}**	17.69^{a}	15.30^{a}	10.80^{a}	10.37^{a}	8.28^{a}
Gunny bag (C_4)	14.38^{b}	12.52^{ab}	12.01^{b}	8.60^{ab}	6.38^{b}	6.15^{ab}
SEm±	**0.40**	**0.49**	**0.31**	**0.46**	**0.21**	**0.29**
LSD (0.01)	**1.51**	**1.84**	**1.16**	**1.75**	**0.81**	**1.09**
Storage conditions						
Room temperature (A_1)	15.80	12.24	10.53	3.73	3.37	**3.87**
Cold storage (A_2)	**17.60**	15.56	13.86	13.45	11.90	9.15
SEm±	**0.28**	**0.34**	**0.22**	**0.33**	**0.15**	**0.20**
LSD (0.01)	**1.06**	**1.30**	**0.82**	**1.24**	**0.57**	**0.77**
Interaction (X x C x A)						
$X_0C_1A_1$	**8.93^{h}**	9.01^{i-k}	7.00^{m}	0.00^{g}	0.00^{o}	0.00^{j}
$X_1C_1A_1$	13.76^{d-g}	13.15^{e-j}	9.87^{kl}	0.00^{g}	0.00^{o}	0.00^{j}
$X_2C_1A_1$	17.06^{c-e}	14.79^{c-h}	13.30^{h-j}	6.03^{d-f}	0.00^{o}	0.00^{j}
$X_0C_2A_1$	16.23^{c-f}	9.93^{h-k}	4.58^{l}	1.60^{fg}	0.00^{o}	0.00^{j}
$X_1C_2A_1$	16.73^{cd}	13.66^{e-i}	11.45^{jk}	5.28^{d-f}	5.12^{j-l}	0.00^{j}
$X_2C_2A_1$	18.63^{bc}	14.79^{c-h}	15.48^{d-i}	12.27^{bc}	7.47^{hi}	2.66^{i}
$X_0C_3A_1$	18.60^{bc}	12.33^{f-k}	10.25^{h-k}	10.10^{cd}	6.13^{i-k}	3.60^{i}
$X_1C_3A_1$	20.93^{ab}	13.73^{e-i}	13.37^{g-j}	6.35^{d-f}	7.54^{h-j}	5.36^{g-i}
$X_2C_3A_1$	22.36^{a}	16.07^{b-g}	15.13^{d-i}	11.00^{cd}	9.10^{f-h}	5.96^{d-f}
$X_0C_4A_1$	14.97^{c-f}	8.05^{jk}	7.06^{l}	0.00^{g}	0.00^{o}	0.00^{j}
$X_1C_4A_1$	11.97^{f-h}	10.86^{g-k}	9.60^{kl}	4.76^{d-f}	3.50^{l-n}	1.80^{i}
$X_2C_4A_1$	15.20^{c-f}	12.58^{f-k}	11.10^{jk}	4.44^{d-f}	4.50^{k-m}	2.52^{ij}
$X_0C_1A_2$	12.65^{d-h}	11.93^{g-k}	7.69^{l}	5.26^{d-f}	0.00^{o}	0.00^{j}
$X_1C_1A_2$	18.90^{bc}	18.92^{a-e}	15.04^{d-i}	12.53^{bc}	12.27^{de}	8.17^{e-g}
$X_2C_1A_2$	21.75^{a}	16.87^{b-f}	14.83^{d-i}	14.95^{ab}	14.00^{d}	9.18^{d-f}
$X_0C_2A_2$	15.63^{c-f}	10.37^{g-k}	10.17^{h-k}	9.70^{cd}	9.40^{f-h}	0.00^{j}
$X_1C_2A_2$	18.29^{bc}	18.09^{b-d}	14.85^{e-i}	12.70^{bc}	10.47^{e-g}	0.00^{j}
$X_2C_2A_2$	23.07^{a}	20.13^{ab}	19.41^{a-c}	16.38^{a}	14.45^{cd}	13.77^{a}
$X_0C_3A_2$	20.62^{ab}	19.13^{a-c}	15.95^{d-i}	13.20^{bc}	12.64^{de}	11.27^{bc}
$X_1C_3A_2$	22.30^{a}	17.90^{a-e}	16.81^{c-g}	16.27^{a}	13.20^{cd}	5.84^{d-f}
$X_2C_3A_2$	**24.20^{a}**	22.28^{a}	18.65^{a}	16.57^{a}	15.00^{a}	**13.86^{a}**
$X_0C_4A_2$	14.25^{c-f}	13.05^{e-j}	12.26^{h-j}	11.43^{cd}	7.30^{hi}	0.00^{j}
$X_1C_4A_2$	18.97^{bc}	16.03^{b-g}	15.97^{d-i}	14.77^{ab}	10.63^{e-g}	9.30^{d-f}
$X_2C_4A_2$	19.26^{ab}	16.51^{b-g}	16.00^{d-i}	15.93^{ab}	12.32^{de}	10.53^{bc}
SEm±	**0.97**	**1.19**	**0.75**	**1.13**	**0.52**	**0.70**
LSD (0.01)	**3.69**	**4.52**	**2.84**	**4.29**	**1.97**	**2.66**

X_0 - No fungicide treatment to the seeds collected from control plot (Absolute control).
X_1 - No fungicide treatment to the seeds collected from xelora and opera treated plot.
X_2 - Seed treatment with xelora @ 2.5 ml/kg to the seeds collected from xelora and opera treated plot.
Means followed by the same latter (s) in the column does not differ significantly by DMRT (p = 0.01).

Table 3 : Influence of fungicides (Xelora and Opera), different packing and storage conditions on shoot length (cm) in soybean seeds at different period of storage.

Treatment	2nd month	4th month	6th month	8th month	10th month	12th month
Xelora fungicide treatments						
X_0	**15.09^{b}**	12.81^{b}	12.24^{b}	7.70^{b}	4.22^{b}	3.70^{b}
X_1	17.97^{ab}	16.27^{a}	15.27^{ab}	15.51^{a}	11.36^{a}	9.78^{a}
X_2	**19.83^{a}**	18.11^{a}	17.90^{a}	16.96^{a}	11.00^{a}	11.00^{a}
SEm±	**0.28**	**0.28**	**0.25**	**0.72**	**0.24**	**0.24**
LSD (0.01)	**1.05**	**1.06**	**0.96**	**2.74**	**0.92**	**0.90**
Storage containers						
Cloth bag (C_1)	**16.03**	15.42	14.58	11.55^{b}	7.05^{b}	6.19^{b}
Polythene bag (C_2)	18.58	16.13	16.19	15.07^{ab}	9.41^{a}	8.61^{ab}
Vaccum packing (C_3)	**18.59**	16.61	16.19	16.12^{a}	11.60^{a}	10.25^{a}
Gunny bag (C_4)	17.26	16.39	16.03	13.71^{ab}	9.10^{a}	7.54^{b}
SEm±	**0.32**	**0.32**	**0.29**	**0.83**	**0.28**	**0.27**
LSD (0.01)	**NS**	**NS**	**NS**	**3.16**	**1.06**	**1.04**
Storage conditions						
Room temperature (A_1)	15.42	14.24	12.83	11.81	10.16	**9.11**
Cold storage (A_2)	**22.42**	20.82	19.09	16.62	12.98	12.62
SEm±	**0.23**	**0.23**	**0.21**	**0.59**	**0.20**	**0.19**
LSD (0.01)	**0.86**	**0.86**	**0.79**	**2.23**	**0.75**	**0.73**
Interaction (X x C x A)						
$X_0C_1A_1$	**12.60^{ijk}**	11.85^{j}	11.20^{j}	0.00^{k}	0.00^{i}	0.00^{j}
$X_1C_1A_1$	17.90^{e-g}	14.27^{d-i}	13.17^{ij}	0.00^{i}	0.00^{i}	0.00^{j}
$X_2C_1A_1$	20.77^{c-e}	17.73^{b-e}	15.60^{g-j}	15.25^{e-g}	0.00^{i}	0.00^{j}
$X_0C_2A_1$	14.22^{g-k}	13.23^{g-j}	12.74^{ij}	7.12^{g-i}	0.00^{i}	0.00^{j}
$X_1C_2A_1$	17.77^{e-g}	13.87^{f-j}	10.70^{j}	6.83^{g-i}	5.00^{hi}	0.00^{j}
$X_2C_2A_1$	20.24^{c-e}	20.67^{b}	16.03^{e-i}	12.05^{f-h}	7.57^{h}	0.00^{j}
$X_0C_3A_1$	13.27^{i-k}	13.57^{g-j}	13.20^{ij}	7.94^{g-i}	7.44^{h}	0.00^{j}
$X_1C_3A_1$	20.09^{c-e}	16.47^{b-h}	16.37^{e-i}	14.82^{e-g}	12.17^{ef}	6.13^{i}
$X_2C_3A_1$	19.78^{c-e}	18.27^{bc}	16.17^{e-i}	12.16^{f-h}	10.80^{fg}	8.18f^{i}
$X_0C_4A_1$	12.48^{jk}	11.30^{ij}	10.79^{j}	0.00^{i}	0.00^{i}	0.00^{j}
$X_1C_4A_1$	15.43^{g-j}	13.40^{g-j}	13.67^{ij}	7.37^{g-i}	3.50^{hi}	0.00^{j}
$X_2C_4A_1$	18.90^{e-g}	15.01^{d-i}	14.73^{h-j}	9.75^{e-g}	8.13^{gh}	4.00^{hi}
$X_0C_1A_2$	14.76^{g-k}	14.48^{d-i}	12.97^{ij}	7.59^{g-i}	0.00^{i}	0.00^{j}
$X_1C_1A_2$	18.67^{e-g}	17.30^{b-f}	16.47^{e-i}	14.68^{e-g}	12.36^{ef}	12.06^{c}
$X_2C_1A_2$	26.23^{a}	24.75^{a}	20.73^{bc}	19.91^{b-f}	19.48^{b}	17.27^{a}
$X_0C_2A_2$	19.79^{c-e}	16.67^{b-g}	16.20^{e-i}	16.88^{de}	0.00^{i}	0.00^{j}
$X_1C_2A_2$	23.70^{ab}	21.66^{ab}	21.01^{b}	17.58^{d-f}	16.60^{cd}	8.38^{f-i}
$X_2C_2A_2$	28.19^{a}	25.26^{a}	25.68^{a}	25.01^{a}	22.90^{a}	17.40^{a}
$X_0C_3A_2$	27.60^{a}	21.23^{ab}	16.93^{e-i}	16.23^{d-f}	15.50^{c-h}	15.47^{b}
$X_1C_3A_2$	27.65^{a}	22.06^{ab}	21.33^{b}	20.90^{b}	17.57^{c}	17.70^{a}
$X_2C_3A_2$	**30.57^{a}**	25.57^{a}	24.83^{a}	23.57^{a}	18.00^{a}	**18.07^{a}**
$X_0C_4A_2$	19.89^{c-e}	18.52^{bc}	14.32^{h-j}	14.13^{e-g}	11.52^{f}	0.00^{j}
$X_1C_4A_2$	26.72^{ab}	20.58^{bc}	15.72^{g-j}	14.90^{e-g}	13.13^{ef}	11.87^{de}
$X_2C_4A_2$	29.52^{a}	22.93^{ab}	19.23^{b-d}	17.67^{d-f}	14.45^{de}	14.38^{cd}
SEm±	**0.78**	**0.79**	**0.72**	**2.04**	**0.68**	**0.67**
LSD (0.01)	**2.97**	**3.00**	**2.72**	**7.74**	**2.59**	**2.55**

X_0 - No fungicide treatment to the seeds collected from control plot (Absolute control).
X_1 - No fungicide treatment to the seeds collected from xelora and opera treated plot.
X_2 - Seed treatment with xelora @ 2.5 ml/kg to the seeds collected from xelora and opera treated plot.
Means followed by the same latter (s) in the column does not differ significantly by DMRT (p=0.01).

Table 4 : Influence of fungicides (Xelora and Opera), different packing and storage conditions on seedling dry weight (g) in soybean seeds at different period of storage.

Treatment	2nd month	4th month	6th month	8th month	10th month	12th month
Xelora fungicide treatments						
X_0	**1.37^{b}**	1.33^{b}	1.28^{b}	1.27^{b}	1.16^{b}	0.98^{b}
X_1	1.56^{a}	1.51^{a}	1.46^{ab}	1.37^{b}	1.30^{ab}	1.25^{ab}
X_2	**1.69^{a}**	1.63^{a}	1.58^{a}	1.50^{a}	1.45^{a}	1.38^{a}
SEm±	**0.04**	**0.04**	**0.03**	**0.06**	**0.03**	**0.03**
LSD (0.01)	**0.14**	**0.13**	**0.13**	**0.21**	**0.12**	**0.11**
Storage containers						
Cloth bag (C_1)	**1.40^{b}**	1.35^{b}	1.29^{b}	1.20^{b}	1.13^{b}	1.07^{b}
Polythene bag (C_2)	1.61^{a}	1.57^{ab}	1.51^{ab}	1.42^{ab}	1.37^{ab}	1.29^{a}
Vaccum packing (C_3)	**1.76^{a}**	1.70^{a}	1.65^{a}	1.60^{a}	1.54^{a}	1.32^{a}
Gunny bag (C_4)	1.56^{ab}	1.52^{ab}	1.47^{ab}	1.39^{ab}	1.32^{ab}	1.26^{ab}
SEm±	**0.04**	**0.04**	**0.04**	**0.06**	**0.04**	**0.03**
LSD (0.01)	**0.16**	**0.15**	**0.15**	**0.24**	**0.14**	**0.13**
Storage conditions						
Room temperature (A_1)	1.43	1.39	1.33	1.97	1.17	**1.02**
Cold storage (A_2)	**1.73**	1.68	1.63	1.56	1.51	1.45
SEm±	**0.03**	**0.03**	**0.03**	**0.05**	**0.03**	**0.02**
LSD (0.01)	**0.11**	**0.11**	**0.11**	**0.17**	**0.10**	**0.09**
Interaction (X x C x A)						
$X_0C_1A_1$	**1.16^{h}**	1.11^{h}	1.01^{f}	0.98^{f}	0.00^{h}	0.00^{e}
$X_1C_1A_1$	1.28^{f-h}	1.23^{f-h}	1.15^{d-f}	1.05^{de}	0.00^{h}	0.00^{e}
$X_2C_1A_1$	1.41^{d-h}	1.37^{d-h}	1.27^{b-f}	1.13^{c-e}	1.04^{d-g}	0.00^{e}
$X_0C_2A_1$	1.32^{e-h}	1.30^{d-h}	1.25^{b-f}	1.14^{b-e}	1.05^{d-g}	0.00^{e}
$X_1C_2A_1$	1.41^{d-h}	1.38^{c-h}	1.31^{b-f}	1.11^{c-e}	1.08^{c-g}	0.00^{e}
$X_2C_2A_1$	1.57^{b-h}	1.53^{a-h}	1.48^{a-e}	1.42^{b-e}	1.37^{b-d}	0.00^{e}
$X_0C_3A_1$	1.49^{c-h}	1.45^{b-h}	1.41^{a-f}	1.37^{b-e}	1.32^{b-e}	0.28^{f}
$X_1C_3A_1$	1.63^{a-g}	1.59^{a-g}	1.53^{a-e}	1.48^{b-e}	1.41^{a-c}	1.38^{ab}
$X_2C_3A_1$	1.77^{a-d}	1.71^{a-d}	1.68^{ab}	1.61^{b-e}	1.58^{ab}	1.46^{ab}
$X_0C_4A_1$	1.20^{gh}	1.17^{gh}	1.11^{ef}	1.02^{e}	0.97^{fg}	0.91^{de}
$X_1C_4A_1$	1.32^{e-h}	1.26^{e-h}	1.21^{c-f}	1.15^{b-e}	1.01^{e-g}	0.00^{e}
$X_2C_4A_1$	1.64^{a-g}	1.60^{a-g}	1.57^{a-d}	1.41^{b-e}	1.34^{b-e}	0.28^{de}
$X_0C_1A_2$	1.24^{f-h}	1.21^{gh}	1.18^{d-f}	1.02^{e}	0.95^{g}	0.00^{e}
$X_1C_1A_2$	1.52^{c-h}	1.47^{b-h}	1.43^{a-f}	1.37^{b-e}	1.31^{b-f}	1.29^{bc}
$X_2C_1A_2$	1.77^{a-d}	1.73^{a-d}	1.69^{ab}	1.63^{b-e}	1.58^{ab}	1.51^{ab}
$X_0C_2A_2$	1.67^{a-f}	1.61^{a-g}	1.56^{a-d}	1.51^{b-e}	1.48^{ab}	0.58^{d}
$X_1C_2A_2$	1.73^{a-e}	1.67^{a-f}	1.63^{a-c}	1.56^{b-e}	1.51^{ab}	1.46^{ab}
$X_2C_2A_2$	1.98^{ab}	1.92^{a}	1.85^{a}	1.79^{a}	1.75^{a}	1.68^{a}
$X_0C_3A_2$	1.75^{a-e}	1.70^{a-e}	1.64^{a-c}	1.60^{b}	1.56^{ab}	1.50^{ab}
$X_1C_3A_2$	1.87^{a-c}	1.82^{a-c}	1.77^{a}	1.68^{ab}	1.62^{ab}	1.58^{ab}
$X_2C_3A_2$	**2.05^{a}**	1.93^{a}	1.86^{a}	1.83^{a}	1.77^{a}	**1.71^{a}**
$X_0C_4A_2$	1.61^{a-g}	1.57^{a-g}	1.51^{a-e}	1.47^{bc}	1.42^{a-c}	0.38^{d}
$X_1C_4A_2$	1.73^{a-e}	1.69^{a-e}	1.65^{a-c}	1.58^{b-e}	1.52^{ab}	1.43^{ab}
$X_2C_4A_2$	1.88^{a-c}	1.83^{ab}	1.78^{a}	1.72^{b-e}	1.67^{ab}	1.60^{ab}
SEm±	**0.10**	**0.10**	**0.10**	**0.16**	**0.09**	**0.08**
LSD (0.01)	**0.39**	**0.38**	**0.37**	**0.60**	**0.33**	**0.31**

X_0. - No fungicide treatment to the seeds collected from control plot (Absolute control).
X_1. - No fungicide treatment to the seeds collected from xelora and opera treated plot.
X_2. - Seed treatment with xelora @ 2.5 ml/kg to the seeds collected from xelora and opera treated plot.
Means followed by the same latter (s) in the column does not differ significantly by DMRT (p = 0.01).

seeds collected from fungicide (Xelora and Opera) treated plot (X_1) and iii). Seed treatment with Xelora @ 2.5 ml kg^{-1} to the seeds collected from fungicide (Xelora and Opera) treated plot (X_2). These seeds were packed in four different packaging materials i). Cloth bags (C_1) ii). Polythene bags (C_2) iii). Vaccum packing bags (C_3) and iv). Gunny bags (C_4). After packing seeds were stored in two different storage conditions i). Ambient storage (A_1) and ii). Cold storage (A_2). For ambient storage bags were stored in the laboratory of Crop Physiology at room temperature (25 ± 2°C) and for cold storage seeds were stored in cold storage unit facilitated by Pesticide Laboratory in Department of Environmental Science. The temperature in the cold storage was around 5±2°C and relative humidity was 85-90 per cent. The required quantity of seeds was drawn at bimonthly interval from each treatment for determination the effect of fungicide, packing materials and storage condition on seed viability for twelve months. Randomly selected soybean seeds of each treatment were subjected to germination test by using between paper method. Germination count was taken at the end of 10th day and expressed in per cent. After germination count five seedlings were selected from each treatment and measured root length, shoot length and seedling dry weight.

Results and Discussion

An attempt was made to know the effect of different treatments on seed viability. Germination test was used as index of seed viability. Results presented in the tables 1-4, differed significantly with respect to the fungicide treatment, packing materials, storage conditions and their interactions. Among the fungicide treatment the maximum germination (88.94%), root length (16.07 cm), shoot length (19.83 cm) and seedling dry weight (1.69 g) was observed in X_2 seeds compared to X_1 and X_0. Among the packing materials the significantly maximum germination (93.72%), root length (18.29 cm), shoot length (18.59 cm) and seedling dry weight (1.76 g) was observed in vacuum packed seeds (C_3) followed by polythene bag (C_2), gunny bag (C_4) and cloth bag (C_1). As per the storage conditions the cold storage (A_2) showed maximum germination (90.86%), root length (17.60 cm), shoot length (22.42 cm) and seedling dry weight (1.73 g) compared to the ambient storage (A_1). The interaction effects between all twenty four treatments, $X_2C_3A_2$ showed maximum germination (97.96%), root length (24.20 cm), shoot length (30.57 cm) and seedling dry weight (2.05 g) after two months of storage. Among the fungicide treatment X_2, among the packing materials vacuum packing (C_3), among the storage condition cold storage (A_2) and among the interaction $X_2C_3A_2$ showed significantly maximum germination, root length, shoot length and seedling dry weight throughout the storage period (twelve months).

The seed germination and other parameters decreased with increased storage period but at the end of 12th months also, same combination showed higher values because fungicides prevent the fungal diseases in the storage and reduces rate of seed respiration in seeds by electron transfer in the II complex (Cytochrom bc_1 complex) and helps to increase the viability of the seeds under storage (Raikar *et al*., 2011). With respect to packing materials, the good quality seeds with higher vigour and viability was seen in seeds stored in vacuum packaging method irrespective of storage conditions throughout the storage period because of the less moisture content and lesser rate of respiration of the seeds because of less availability of oxygen in container (Vasudevan *et al*., 2014). With respect to storage conditions the seeds stored in cold storage had higher germination, root and shoot growth and seedling dry weight which may be due to lower respiration rate, metabolic activity at lower temperature and lower temperature inhibits enzymatic activity in seeds, reduces fungal infection and reduces damage to the seeds (Mbofung, 2012). The results are in agreement with findings of Sunkad and Hosamani (2013) in chickpea and Meena (2014) in soybean.

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