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INFLUENCE OF SEED INVIGORATION ON GERMINATION AND SEEDLING VIGOUR IN CHILLI (CAPSICUM ANNUM) L. CV. PMK-1

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Abstract:

The experiments were conducted to ascertain the efficacy of seed treatments on chilli seed during storage in the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamilnadu. The seeds were treated with Arappu leaf extract (10 %), Neem leaf extract (10 %), $CaCl_2$ (1%), Pongamia leaf extract (10 %), Panchagavya, KH_2PO_4 (1%) and KNO_3 (1%) along with control. After treatment, seeds were stored in polythene bag container for ten months and evaluated for seed quality parameters. The results revealed that, seed treated with KNO_3 @ 1% recorded highest germination percentage, root length, shoot length, dry matter production and vigour index over all other seed treatments after storage period of ten months in polythene bag.

Key Words: Chilli, Seed Invigoration, KNO_3 & $CaCl_2$

Introduction:

Chilli (*Capsicum annuum* L.) is one of the important spice crops of the world and is widely cultivated throughout the world. It belongs to family Solanaceae and native of tropical South America and introduced to India during 17th century by Portuguese (Raju and Luckrose 1991). Chilli is popular for its pleasant aromatic flavor, pungency and high colouring substance. It is used in culinary, pharmaceutical and beverage industries. Chilli is a rich source of minerals and vitamins A, B and C. The major chilli growing countries are India, China, Indonesia, Korea, Pakistan, Turkey and Sri Lanka. In India it is cultivated in states of Andhra Pradesh, Karnataka, Maharashtra, Orissa and Tamilnadu.

Seed is considered as one of the important basic agricultural inputs for obtaining higher yields. Good quality seed acts as a catalyst for realizing the potential of all other inputs in agriculture. Without good seed, the investment on fertilizers, water, pesticides and other inputs will not pay the desired dividends. Therefore production of quality seed and maintenance of high germination is of at most importance in a seed programme, where seed quality is a multiple concept comprising several physical, chemical and biological components.

Chilli seed has non-starchy endosperm and this offered a mechanical barrier to the growing embryo resulting in poor germination (Andreoli and Khan, 1999). High germination and uniform stand establishment for chili production is essential to maintaining profitable yields. Improvement in stand establishment can be obtained by advancements in seed quality and seed enhancements. Seed invigoration is a technique of seed enhancement which includes pre-soaking of seeds that improves seed performance by rapid and uniform germination, normal and vigorous seedlings, which resulted in faster and higher rate of germination and emergence in different crops (Farooq et al., 2007), which also helps seedlings to grow in biotic or abiotic stress conditions (Ashraf and Foolad, 2005; Khan et al., 2009a and 2009b). Such seed treatments result in synchronized emergence and uniform stand establishment leading to improved yield. Various seed priming techniques have beendeveloped, including hydropriming (soaking in water), halopriming (soaking in inorganic salt solutions), osmopriming (soaking in solutions of different organic osmotica), thermopriming (treatment of seed with low or high temperatures), solid matrix priming (treatment of seed with solid matrices) and biopriming (hydration using biological compounds) (Ashraf and Foolad, 2005). Keeping in view of the above facts an experiment was designed to evaluate the impact of different chemicals and botanicals on storability for seed germination and vigour in chilli.

Materials and Methods:

The experiment was conducted to study the influence of different seed invigoration techniques on germination and vigor attributes of the Chilli cultivar PMK-1in the PG laboratory, Department of Genetics and Plant breeding, Faculty of Agricultuire, Annamalai University, Tamil Nadu, India , during the year 2014. Seeds of Chilli cv. PMK-1 were collected from vegetable Research Station, Palur, Tamilnadu which was used as a basic material for this study. The experiment consisted of eight treatments involving three botanicals, three chemicals, one organic material, and a control and stored for ten months. The details of the experiments are

T_1 - Control
T_2 - Arappu leaf extract (10 %)
T_3 - Neem leaf extract (10 %)
T_4 - $CaCl_2$ (1%)
T_5 - Pongamia leaf extract (10 %)

T_6 - Panchagavya
T_7 - KH_2PO_4 (1%)
T_8 - KNO_3 (1%)

The seeds were first soaked in chemical solution at seed to solution ratio of 1:05 with periodical stirring of seeds for 12 h (Joseph and Nair, 1989). The treated seeds were shade dried to reduce the moisture content to ten per cent. The seeds were stored in polythene bags (300 gauge) and Aluminium foil pouches and stored for ten months under ambient conditions of Annamalai nagar and subjected to laboratory evaluation. The seeds were evaluated for the quality parameters for a period of 10 months at monthly interval.

Germination (%):

Germination test was conducted in three replications each of 100 seeds by adopting between paper method as described by (ISTA, 1999).A temperature of 25 ± 10^0C and relative humidity of 95 per cent was maintained during germination test. The first and final germination counts were made on seven and fourteenth days of germination test, respectively for normal seedlings and the germination was expressed in percentage.

Root Length (cm):

The normal seedlings were taken at random at the end of the germination test and the length between collar region to tip of the primary root were measured in centimeter. The mean value was recorded as root length in centimeter.

Shoot Length (cm):

Ten normal seedlings taken for measuring root length were used for shoot length measurement. The length between the collar region to tip of the primary shoot was measured in centimeter of the mean value recorded as shoot length in centimeter.

Vigour Index:

Vigour Index (VI) was computed from the germination percentage and the total seedling length (root length + shoot length) as suggested by Abdul - Baki and Anderson (1973) and expressed as whole number.

Vigour Index = Germination (%) x Seedling length (cm).

Seedling Dry Weight:

Ten seedlings after measurement of root and shoot length were kept in a butter paper packet and dried in hot air oven maintained at $70°\pm10^0$C for 24 h. Later they were cooled in a desiccator for 30 minutes and then the dry weight of seedling was recorded in an electronic balance and average weight was computed and expressed in milligram per ten seedling.

Field Emergence (%):

One hundred seeds in three replications were taken randomly from each treatment and hand dibbled in well prepared raised seed bed. Seeds were sown equidistantly and watered to maintain the optimum soil moisture for emergence. The number of seedlings emerged three centimeters above the soil surface on 15^{th} day after sowing were counted and expressed as field emergence in percentage.

Electrical Conductivity of Seed Leachate (dSm^{-1}):

Five grams of seeds were taken at random from each treatment and were soaked in $HgCl_2$ (0.10 per cent) solution for a minute and washed with distilled water for five times. Then the seeds were soaked in 25.00 ml of distilled water for 24 h at room temperature. The seed leachate was collected by decanting and the volume was made up to 25.00 ml by adding distilled water and then the electrical conductivity of seed leachate was measured in an electrical conductivity bridge (ELICO) with cell constant of 1.00. The estimations were done in four replications and mean value was expressed in dsm^{-1} (Presley, 1958).

Speed of Germination:

Seeds were germinated in sand medium with three replications of hundred seeds each. The number of seeds germinated was recorded daily up to the day of final count. The speed of germination was calculated by adopting the fallowing formula and expressed in number (Maguire, 1962).

$$\text{Rate of germination} = \frac{X_1}{Y_1} + \frac{(X_2-X_1)}{Y_2} + \frac{X_n-(X_n-1)}{Y_n}$$

Where, X_n – Number of seeds germinated at n^{th} count
Y_n – Number of days from sowing to n^{th} count

Moisture Content (%):

Three replicates of five gram of seed material were taken for determining the moisture content using low constant temperature method. The powdered seed material was placed in a weighed moisture aluminium cup and after removing the lid, placed in hot air oven maintained at 103 ± 2°C for 17 ± 1 h and the content were allowed to dry. Then, the contents were weighed in an electronic balance along with bottle and lid. The moisture content was worked out using the following formula and expressed as percentage (ISTA, 1999).

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where, M_1 = weight of the aluminium cup alone
M_2 = weight of the aluminium cup + sample before drying
M_3 = weight of the aluminium cup + sample after drying

Statistical Analysis:

The data collected from the experiment were analyzed statistically by the procedure described by Sundarajan *et al*., (1972).

Results and Discussion:

Germination test conducted immediately after the treatment, treated seeds did not show any significant beneficial effect on germination percentage, root length, shoot length, vigour index over control. But, after natural ageing at room temperature for 10 months, germination percentage, root length and shoot length of treated seeds showed significant improvement over untreated control. The data on germination percentage as affected by seed invigoration at different months of storage are presented in (Table.1). With the advancement of storage period, germination per cent declined irrespective of invigoration. All the invigoration treatments maintained significantly higher germination compared to control throughout the storage period. At the end of storage period, highest germination was recorded with T_8 (KNO_3 @ 1% (74.42%) followed by T_4 $CaCl_2$ @ 1% (72.14%) and the lowest germination was recorded with untreated control (64.99%). The increase in germination of the invigorated seeds is due to repair of cell organelles, enzymatic reactions, activation of metabolic process of food reserves and rejuvenation of embryo viability (Sudarshan, 2004). The decrease in germination and seedling vigour was very slow in KNO_3 invigorated seeds compared to rapid decrease in control and it is due to repairing of damaged membrane system.

With the advancement of storage period, root length declined irrespective of treatment. All the invigoration treatments maintained significantly higher root length throughout the storage period. At the end of storage period, higher root length was recorded with KNO_3 @ 1% treated seeds (7.17 cm) followed by $CaCl_2$ (7.01 cm) and the lowest root length was noticed with untreated control (6.67 cm) (Table 2).Significant differences for shoot length was noticed among the invigoration seeds and control. Among the invigorated seeds, T_8, KNO_3 (1%) recorded higher shoot length from 6.56 cm at the beginning to 4.52 cm at the end of storage period followed by seeds invigoration with $CaCl_2$ (1 %) (T_4) from 6.30 cm to 4.40 cm while the lowest shoot length was recorded in control (T_1) from 5.76 to 4.35 cm (Table 3). Seed invigoration with KNO_3 activated the metabolic activity in the first phase of germination favouring better emergence and more seedling length (Vanangamudi and Kulandaivelu, 1989).

Throughout the storage period, the seedling vigour index differed significantly due to invigoration seed treatments. At the end of storage period, highest seedling vigour index was recorded with T_8 (KNO_3 @ 1%) treated seeds (871) followed by T_4 ($CaCl_2$ @ 1%) (824) and the lowest seedling vigour index was observed with untreated control (702) (Table 4).

The significant differences on seedling dry weight was noticed among the seeds invigoration with organic and inorganic materials and untreated seeds in all the months of period. From the first month of storage period to at the end of the experiment significantly higher seedling dry weight was noticed in T_8, was followed by T_4 and lower dry weight recorded in T_1. The seeds invigoration using KNO_3 (1%) material (T_8) recorded the higher dry weight of 0.159 g followed by seeds invigoration with $CaCl_2$ (1%) (T_4) recorded 0.164 g and the lowest dry weight of 0.142 g was recorded in control. The significance differences on field emergence was noticed among the seeds invigoration with organic and inorganic materials and control in all the months of storage period. The seeds invigoration using KNO_3 @ 1 per cent material (T_8) maintained the higher field emergence of 70.44 per cent fallowed by seeds invigoration with $CaCl_2$ @ 1% (T_4) 67.79 per cent and the lowest field emergence (60.34%) was recorded in control.

Significantly lower electrical conductivity of seed leachate was recorded with KNO_3 (1%) material (T_8) 0.848 dSm^{-1} followed by seeds invigoration with $CaCl_2$ (1%) (T_4) 0.920 dsm^{-1} and the higher electrical conductivity of 1.698 dSm^{-1} was noticed in (T_1) untreated seeds. The low electrical conductivity value is due to repairing of damaged membrane system and protection against membrane damage. Significantly higher speed of germination was noticed in T_8, (KNO_3 @ 1% (30.19) was followed by T_4 ($CaCl_2$) 29.26 and lower speed of germination recorded in T_1. 26.10 (Table 5).

Significantly the lower moisture content 7.49 per cent was recorded with KNO_3 @ 1% (T_8) followed by seeds invigoration with $CaCl_2$ @1% (T_4) 7.50 per cent and the highest moisture content 7.63 per cent was recorded in control (table 6).

Increase in seed quality parameters may be due to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growing points and higher activity of enzymes. The superiority of KNO_3 @ 1% ascribed to its role in making less oxygen available for the citric acid cycle and thereby enhancing the ambient oxygen level. (Bewley and Black, 1982). The increase in seedling vigour index and seedling dry weight was due to increased germination percentage, root length and shoot length of seedlings.

The beneficial effects of KNO_3 (1%) were attributed to ionic strength and increase in cytochrome oxidase activity. The presence of nitrate in KNO_3 provides additional substrate for accelerated ageing and protein synthesis for enhancement of germination during priming and it also helps in membrane repair mechanism (Khan *et al*., 1978). Similar results of higher quality parameters of seeds treated with KNO_3 (1 per cent) were reported by Bradford *et al*. (1990) in chilli, Van Pijlen *et al*. (1995) in tomato, Jagadesh *et al*. (1994) in tomato, chilli and onion; Gayathri (2001) in tomato, Renukadevi *et al*. (1994) in bitter gourd, Yogananda *et al*. (2004) in bell pepper.

Conclusion:

The present study suggested that seed invigoration with KNO_3 (1%) maintains the quality of chilli seed up to ten months of storage period and improved rapid and uniform seedling germination, emergence and plant development.

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Table 1: Effect of seed invigoration on germination (%) of chilli cv. PMK 1 during storage

Treatments	Period of storage										MEAN
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	
T_1	89.35 (70.95)	88.85 (70.49)	85.18 (67.35)	83.54 (66.06)	80.79 (64.00)	75.03 (60.01)	73.80 (59.21)	69.69 (56.59)	66.94 (54.90)	64.99 (53.72)	77.81 (63.45)
T_2	91.63 (73.18)	91.13 (72.67)	84.96 (67.18)	85.79 (67.85)	81.94 (64.85)	79.01 (62.73)	78.02 (62.04)	74.29 (59.53)	70.64 (57.19)	68.94 (56.12)	80.63 (64.33)
T_3	92.60 (74.21)	93.35 (75.22)	89.53 (71.12)	87.14 (68.98)	83.99 (66.41)	80.51 (63.80)	79.43 (63.02)	75.34 (60.22)	72.24 (58.20)	69.89 (56.72)	82.40 (65.79)
T_4	93.35 (75.05)	93.53 (75.26)	90.73 (72.27)	87.94 (69.67)	85.24 (67.40)	82.53 (65.29)	80.30 (63.65)	76.75 (61.17)	74.29 (59.53)	72.14 (58.14)	83.68 (66.74)
T_5	90.15 (71.70)	90.44 (71.98)	86.43 (68.38)	84.49 (66.96)	81.26 (64.34)	76.15 (60.76)	75.04 (60.02)	71.64 (57.82)	68.66 (55.95)	65.83 (54.22)	79.00 (63.18)
T_6	93.00 (74.65)	92.93 (74.57)	89.66 (71.24)	86.78 (68.67)	84.71 (66.98)	80.81 (64.01)	79.88 (63.34)	76.09 (60.72)	71.29 (57.60)	68.81 (56.04)	82.39 (65.78)
T_7	92.36 (73.95)	90.66 (72.20)	88.25 (69.95)	84.79 (67.04)	81.79 (64.73)	78.82 (62.59)	77.44 (61.64)	74.29 (59.53)	69.50 (56.47)	68.29 (55.72)	80.61 (64.38)
T_8	93.96 (75.77)	94.28 (76.16)	93.08 (74.74)	90.29 (71.84)	88.54 (70.17)	85.00 (67.21)	83.29 (65.87)	80.14 (63.53)	76.94 (61.30)	74.42 (68.24)	85.99 (69.48)
MEAN	73.64 (58.94)	73.51 (58.85)	70.78 (50.22)	69.07 (54.70)	68.77 (66.11)	79.73 (63.30)	78.40 (62.34)	74.77 (59.88)	71.31 (57.64)	69.16 (57.36)	81.56 (65.39)
SEd	0.25	0.78	0.34	1.27	1.23	1.41	1.18	1.08	1.31	0.86	-
CD at 5%	0.52	1.59	0.69	2.59	2.51	2.88	2.40	2.22	3.79	1.76	-

Table 2: Effect of seed invigoration on root length (cm) of chilli cv. PMK 1 during storage

Treatments	Period of storage										MEAN
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	

T_1	8.75	8.55	8.70	8.18	7.85	7.57	7.30	7.05	6.67	6.49	7.71
T_2	9.05	8.80	8.65	8.32	8.07	7.87	7.69	7.35	7.02	6.67	7.94
T_3	9.15	9.13	8.85	8.53	8.26	7.99	7.74	7.47	7.22	6.59	8.09
T_4	9.25	9.26	9.36	8.82	8.52	8.21	7.90	7.64	7.33	7.01	8.33
T_5	8.85	8.70	8.75	8.31	8.06	8.27	7.50	7.18	6.82	6.54	7.89
T_6	9.16	9.20	9.65	8.73	8.42	8.04	7.69	7.47	7.20	6.93	8.24
T_7	9.16	9.06	9.01	8.64	8.32	8.09	7.65	7.44	7.33	6.77	8.14
T_8	9.35	9.04	9.50	8.92	8.67	8.40	8.62	7.74	7.47	7.17	8.48
MEAN	9.09	8.96	9.05	8.55	8.27	8.05	7.76	7.41	7.13	6.77	8.10
SEd	0.19	0.14	0.13	0.13	0.12	0.10	0.11	0.10	0.10	0.04	-
CD at 5%	0.39	0.29	0.28	0.28	0.26	0.22	0.23	0.21	0.20	0.09	-

Table 3: Effect of seed invigoration on shoot length (cm) of chilli cv. PMK1 in storage

Treatments	**Period of storage**										**MEAN**
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	
T_1	5.76	5.50	4.73	5.24	4.93	4.69	4.48	4.31	4.14	4.35	4.81
T_2	6.11	5.95	4.80	5.60	5.32	5.09	4.87	4.61	4.38	4.13	5.08
T_3	6.15	6.01	5.06	5.66	5.24	5.20	4.96	4.69	4.49	4.23	5.16
T_4	6.30	6.13	5.25	5.82	5.62	5.39	5.12	4.85	4.63	4.40	5.35
T_5	6.20	6.06	5.11	5.57	5.27	4.99	4.76	4.53	4.32	4.08	5.08
T_6	6.40	6.18	5.41	5.84	5.57	5.34	5.00	4.76	4.54	4.32	5.33
T_7	6.21	6.13	5.28	5.62	5.49	5.21	4.94	4.68	4.42	4.27	5.22
T_8	6.56	6.25	5.75	5.89	5.73	5.53	5.22	5.01	4.52	4.52	5.49
MEAN	6.21	6.02	5.17	6.65	5.39	5.18	4.91	4.68	4.43	4.28	5.19
SEd	0.04	0.05	0.15	0.10	0.07	0.08	0.07	0.07	0.07	0.07	-
CD at 5%	0.08	0.11	0.30	0.21	0.15	0.16	0.15	0.15	0.14	0.16	-

Table 4: Effect of seed invigoration on vigour index of chilli cv. PMK 1 in storage

Treatments	**Period of Storage**										**MEAN**
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	
T_1	1397	1248	1144	1121	1033	920	870	792	724	702	995
T_2	1389	1344	1143	1195	1098	1025	980	889	807	745	1061
T_3	1416	1414	1245	1237	1149	1062	1010	917	846	758	1105
T_4	1451	1440	1327	1288	1207	1123	1047	959	890	824	1155
T_5	1356	1335	1198	1173	1084	1011	920	840	766	700	1038
T_6	1447	1429	1351	7262	1186	1081	1014	931	838	776	1731
T_7	1420	1378	1263	1209	1130	1048	976	901	817	756	1089
T_8	1495	1475	1419	1338	1276	1185	1155	1022	924	871	1216
MEAN	1421	1382	1261	1977	1145	1056	996	906	826	766	1173
SE d	18.90	20.48	22.81	23.86	22.30	30.31	21.11	15.11	15.19	11.51	-
CD at 5%	38.57	41.79	46.54	48.68	45.50	61.84	43.06	30.83	30.99	23.48	-

Table 5: Effect of seed invigoration on electrical conductivity (dSm^{-1}) of chilli cv.PMK 1

Treatments	**Period of storage**										**MEAN**
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	
T_1	0.491	0.598	0.670	0.707	0.766	0.826	0.893	0.949	1.209	1.698	0.636
T_2	0.442	0.526	0.587	0.632	0.679	0.750	0.814	0.878	0.942	0.986	0.502
T_3	0.406	0.507	0.545	0.588	0.648	0.711	0.758	0.815	0.900	0.991	0.479
T_4	0.364	0.437	0.478	0.539	0.588	0.658	0.726	0.764	0.831	0.920	0.440
T_5	0.473	0.576	0.659	0.704	0.759	0.819	0.872	0.931	1.131	1.440	0.595
T_6	0.409	0.558	0.602	0.657	0.707	0.771	0.814	0.860	0.927	1.065	0.513
T_7	0.444	0.565	0.642	0.690	0.713	0.797	0.863	0.917	1.102	1.022	0.539
T_8	0.349	0.370	0.566	0.474	0.524	0.578	0.623	0.669	0.767	0.848	0.395
MEAN	0.422	0.517	0.593	0.623	0.673	0.738	0.795	0.848	0.976	1.121	0.512
SEd	0.0005	0.0006	0.0089	0.0087	0.0110	0.0134	0.0109	0.0122	0.0149	0.0799	-
CD at 5%	0.0009	0.0013	0.0183	0.0177	0.0224	0.0274	0.0222	0.0249	0.0304	0.1630	-

Table 6: Effect of seed invigoration on speed of germination of chilli cv.PMK 1

Treatments	**Period of storage**										**MEAN**
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	
T_1	36.11	35.92	34.59	33.78	32.72	30.73	29.19	27.49	26.14	26.10	27.81
T_2	36.92	36.92	35.86	34.72	33.09	32.00	31.19	29.98	28.31	27.42	29.05
T_3	37.45	37.72	36.12	35.25	33.99	32.66	31.66	30.45	28.20	27.81	29.51
T_4	37.72	37.92	36.72	35.59	35.02	33.20	32.05	31.10	29.66	29.26	30.15
T_5	36.95	36.28	34.72	33.98	32.92	30.66	29.99	28.40	26.08	25.89	28.11
T_6	37.58	37.66	36.12	35.12	34.32	32.79	31.92	30.52	27.96	27.56	29.54
T_7	37.31	36.79	35.97	34.32	33.12	31.79	30.86	29.92	27.17	26.83	28.81
T_8	36.83	37.98	37.02	36.52	35.84	34.39	33.35	32.24	31.19	30.19	30.85
MEAN	37.10	37.14	35.89	34.91	33.87	32.27	31.27	30.01	28.08	27.72	29.22
SEd	0.16	0.06	0.67	0.57	0.62	0.47	0.42	0.48	0.44	0.49	-
CD at 5%	0.34	0.01	1.36	1.17	1.27	0.96	0.86	0.98	0.90	1.09	-