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Seed Germination of Pummelo (*Citrus Grandis L. Osbeck*) as Affected by Storage Period and Presowing Treatments

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Abstract

The field investigation entitled "Seed Germination of Pummelo (*Citrus grandis* L. Osbeck) as affected by storage period and presowing treatments" was conducted at experimental farm, department of Horticulture, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during the year 2012-2013. From the investigation, it could be concluded that freshly harvested pummelo seeds had shown better results in per cent seed germination and growth parameters of pummelo seedlings up to six month of sowing. Among different pre-sowing seed treatments studied; soaking of seeds in GA_3 50 ppm for 24 hrs recorded better effect on per cent seed germination and most of the growth parameters and it was followed by scalding at 50^0C for 24 hrs. In interaction effect, soaking of freshly harvested pummelo seeds in GA_3 50 ppm for 24 hrs had shown better results in terms of per cent seed germination as well as most of the growth parameters to achieve vigour of pummelo seedlings up to 6 months after sowing and was followed by scalding of freshly harvested pummelo seeds at 50^0C for 24 hrs.

Keywords: Pummelo, Absolute growth rate, Gibberellic acid, Relative growth rate.

Introduction

Pummelo (Citrus grandis L. Osbeck) mainly known as the principal ancestor of grapefruit. It is an underexploited fruit crop with a future potential for the commercialization in warm and humid climate. Pummelo is usually grafted on other citrus rootstocks, but can be grown from sowing of fresh seeds. To carryout successful breeding programme and also for rootstock studies, it is essential to have a high percentage of seed germination and uniform size of the seedlings. Pummelo seeds are classified as recalcitrant seeds, which do not tolerate low moisture level, low temperature storage or strong light. The germination of fresh citrus seeds is not rapid and that of dried seeds even slower (Khan, Waseem and Ali Soetisna, 1985). In view of less percentage of germination and poor seedling growth of pummelo, the present investigation was carried out to find out optimum storage period as well as presowing seed treatment to improve the per cent seed germination with better vigour of seedling.

Materials and Methods

The investigation was carried out at the experimental farm of the Department of Horticulture, College of Agriculture Dapoli, Dist. Ratnagiri (M.S.) during the period 2012-13. There were two factors to be studied *viz*., three levels of storage period and seven pre-sowing seed treatments. Thus, 21 treatment combinations were replicated thrice in Factorial Randomized Block Design. The storage periods were S_1- fresh seeds, S_2- 15 days stored seeds and S_3- 30 days stored seeds at ambient temperature. Different pre-sowing seed treatments were T_1- control (i.e. no seed treatment), T_2- water soaking for 24 hrs, T_3- scalding at 50^0C for 24 hrs, T_4- soaking of seeds in 50 ppm GA_3, T_5- soaking of seeds in 100 ppm GA_3, T_6- soaking of seeds in 150 ppm GA_3, T_7- soaking of seeds in 200 ppm GA_3 for 24 hours. Seeds were extracted from uniform sized, fully ripe fruits from healthy pummelo trees. The seeds were immediately stored as well as sown after extraction from fruits as per the treatments detailed above. Fifty seeds were sown per treatment per replication. Other intercultural practices were followed to get healthy growth of pummelo seedlings. Observations on various parameters *viz.* percent seed

germination, plant height (cm), number of leaves, leaf area (cm^2), root volume (ml), dry weight of leaves and roots (g), AGR (Absolute growth rate of plant height; cm/day) and RGR (Relative growth rate in plant height; cm/cm/day) were recorded from randomly selected five pummelo seedlings in each treatment combinations. Data obtained were analyzed as per the statistical methods prescribed by Panse and Sukhatme (1995).

Results and Discussion

Data pertaining to the effect of seed storage period and pre- sowing seed treatment and their interaction on per cent seed germination, different growth parameters of pummelo are presented in Table 1and 2. The results obtained during investigation are discussed below.

Effect of Storage Period

Per cent seed germination was significantly differed from 21.10 to 77.43 per cent among all storage period treatments. The highest (77.43%) seed germination was observed in S_1, which was significantly superior over all other storage periods. The lowest (21.10%) seed germination was observed in S_3. Seed storage treatment showing per cent seed germination in descending order was $S_1 > S_2 > S_3$.Thus, it indicated that per cent seed germination was significantly decreased with increased in storage period at ambient temperature. Further, height of pummelo seedlings was also significantly varied from 26.50 to 36.14cm among all the storage period treatments. The highest (36.14cm) height of pummelo seedlings was observed in S_1, which was significantly superior over all other storage periods. However, the lowest (26.50cm) height of pummelo seedlings was observed in S_3. Seed storage treatment showing height of pummelo seedlings in descending order was $S_1 > S_2 > S_3$. The, number of leaves of pummelo seedlings was significantly varied from 26.16 to 33.01. The highest (33.01) number of leaves of pummelo seedlings was observed in S_1, which was significantly superior over all other storage period treatments. The lowest (26.16) number of leaves of pummelo seedlings was observed in S_3. Seed storage treatment showing number of leaves of pummelo seedlings in descending order is as $S_1 > S_2 > S_3$. The highest (546.83cm^2) leaf area was observed in S_1, which was significantly superior over all storage period treatments. The lowest (340.64cm^2) leaf area was observed in S_3 treatment. Seed storage treatment showing leaf areas in descending order is $S_1 > S_2 > S_3$. The highest root volume was (16.52ml) was observed in S_1, and was significantly superior over all except S_2. Root volumes in descending order are $S_1 > S_2 > S_3$. Dry weight of leaves was also significantly varied from 1.63g to 2.92g among all the storage period treatments. Significantly the highest (2.92g) dry weight of leaves was observed in S_1 treatment and was at par with S_2. Dry weight of roots was in the range of 1.64g (S_3) to 3.48g (S_1).

Data in relation to Absolute Growth Rate (cm/day) and Relative Growth Rate (cm/cm/day) of pummelo seedlings as influenced periodically by storage period, pre-sowing seed treatments and interaction effect are presented in Table 2. At 120-150 days, AGR of pummelo seedlings was significantly varied from 0.098 to 0.224 cm/day among all the storage period treatments. The highest (0.224 cm/day) AGR was observed in S_1 treatment, which was significantly superior over all other treatments. At 150-180 days, AGR of pummelo seedlings was significantly varied from 0.085 to 0.199 cm/day among all the storage period treatments. The highest (0.199 cm/day) AGR of pummelo seedlings was observed in S_1 treatment, which was significantly superior over all other storage period treatments. At 150-180 days, seed storage treatment showing AGR of pummelo seedlings in descending order is $S_1 > S_2 > S_3$.

The RGR is the rate of increase in plant height in number of days. At 120-150 days, RGR of pummelo seedlings was significantly varied from 0.034 to 0.062 cm/cm/day among all the storage period treatments. The highest RGR (0.062 cm/cm/day) was observed in S_1, which was significantly superior over all. At 150-180 days, RGR of pummelo seedlings was significantly varied from 0.030 to 0.058 cm/cm/day among all the storage period treatments. Significantly the highest RGR (0.058 cm/cm/day) of pummelo seedlings was observed in S_1 treatment and was significantly superior over all the storage period treatments. The magnitudes of AGR and RGR were higher during 120-150 days as compared to 150-180 days.

Effect of Pre-Sowing Seed Treatments

Per cent seed germination of pummelo was significantly varied among all the pre-sowing seed treatments. The highest (57.56%) seed germination was observed in T_4 treatment, which was at par with T_2, T_5 and T_6 treatments. The lowest (47.78%) seed germination was observed in T_1 i.e. control (no seed treatment) and was at par with T_2, T_3, T_5 and T_7. From the data present in Table1 revealed that pre-sowing seed treatment with GA_3 at 50 ppm showed significantly highest per cent seed germination than control i.e. (no seed treatment). Pummelo seeds are classified as recalcitrant seeds do not tolerate low moisture level, low temperature storage or strong light. The germination of fresh citrus seeds is not rapid and that of dried seeds even slower (Khan, Waseem Ali Soetisna 1985). Similarly height of pummelo seedlings was significantly varied among all the pre-sowing seed treatments. The highest (35.14cm) height of pummelo seedlings was observed in T_3, which was significantly superior over all other pre-sowing seed treatments. The lowest (29.97cm) height of pummelo seedlings was observed in T_1 i.e. control and at par with T_4, T_6 and T_7.

Among all the pre-sowing seed treatments, significantly the highest (31.77) number of leaves of pummelo seedlings was observed in T_4, which was at par with T_2 and T_3. Significantly the lowest (28.48) number of leaves of pummelo seedlings was observed in T_1 and was at par with T_2, T_5, T_6 and T_7. Among pre-sowing seed treatments, the highest (518.78cm^2) leaf area was observed in T_4, which was at par with T_2 and T_3. Dry weight of leaves; it was non significantly varied. However, it was in the range of 2.03g (T_1) to 3.15g (T_2). The treatments T_2, T_3, showed dry weight of leaves more than mean 2.32g. It was observed that dry weight of leaves of pummelo seedlings was proportionately decreased with

increase in GA_3 concentration. Dry weight of roots; it was significantly varied from 2.17g (T_1) to 3.26g (T_2) among all pre-sowing seed treatments. However, it was highest (3.26g) dry weight of roots was observed in T_2, which was at par with T_3 and T_4. The lowest (2.17g) dry weight of roots was observed in T_1 i.e. control and was at par with T_5, T_6 and T_7.

AGR of pummelo seedlings was non-significantly varied from 0.130 to 0.197 cm/day among the all pre-sowing seed treatments. However, at 150-180 days, AGR of pummelo seedlings was significantly varied from 0.109 to 0.163 cm/day among all the pre-sowing seed treatments. The highest (0.163 cm/day) AGR of pummelo seedlings was observed in T_7 treatment. RGR of pummelo seedlings was significantly varied from 0.041 to 0.056 cm/cm/day among the all pre-sowing seed treatments at 120-150 days. The highest RGR (0.056cm/cm/day) of pummelo seedlings was observed in T_3. At 150-180 days, RGR of pummelo seedlings was significantly varied from 0.035 to 0.050 cm/cm/day among all the pre-sowing seed treatments. The highest RGR (0.050 cm/cm/day) of pummelo seedlings was observed in T3.

Interaction Effect

Interaction effect between seed storage period and pre-sowing seed treatment was found to be significant (Table 1). The highest (88.00%) seed germination was recorded in the S_1T_3, which was at par with S_1T_4, S_1T_5 and S_1T_7. The lowest (10.00%) seed germination was observed in S_3T_3 and was at par with S_3T_1 and S_3T_7. Thus, freshly harvested (S_1) seed from ripe fruits of the pummelo with pre-sowing seed treatment of scalding at 50^0C showed highest per cent seed germination than all other treatment combination. When seeds treated with hot water before sowing might help in softening of seed coat leads to more imbibition of water and improve gaseous exchange, thus helps to increase seed germination.

The highest (35.54) number of leaves of pummelo seedlings was observed in S_1T_4, which was at par with S_1T_1, S_1T_2, S_1T_3 and S_2T_4. However, the lowest (22.83) number of leaves of pummelo seedlings was observed in S_3T_1 and at par with S_3T_2, S_3T_5 and S_3T_7. Non-significant variation in leaf area was in the range of 215.87cm^2 (S_3T_5) to 661.33cm^2 (S_1T_3), wehere as non-significant variation in root volume was in the range of 11.55ml (S_3T_7) to 17.33ml (S_1T_5). Dry weight of leaves of pummelo seedlings at 6 months age was adversely affected with increasing seed storage period and concentration of GA application. Dry weight of roots of pummelo seedlings at 6 months age was in the range of 1.08 g (S_3T_6) to 4.64 g (S_1T_4). The results was in confirmative with Jadhav (2003) in rangpur lime, Kalabandi *et al*. (2003) in kagzi lime.

At 120-150 days, AGR was significantly varied from 0.087 to 0.273 cm/day of pummelo seedlings. The highest AGR (0.273 cm/day) was observed in S_1T_5. At 150-180 days, AGR was significantly varied from 0.072 to 0.290 cm/day of pummelo seedlings. y The highest (0.290 cm/day) AGR of pummelo seedlings was observed in S_1T_7, which was significantly superior over all other treatment combinations. > S_3T_7 > S_3T_2 > S_3T_1 > S_3T_6.

At 120-150 days, RGR of pummelo seedlings was significantly varied from 0.031 to 0.069 cm/cm/day. Significantly the highest RGR (0.069 cm/cm/day) was observed in S_1T_5, which was at par with S_1T_1, S_1T_2, S_1T_3, S_1T_4, S_1T_6, S_1T_7, S_2T_1, S_2T_3 and S_2T_4. However, the lowest RGR (0.031 cm/cm/day) of pummelo seedlings was observed in S_2T_6 and S_3T_5. At 150-180 days, RGR was significantly varied from 0.025 to 0.069 cm/cm/day RGR of pummelo seedlings. Significantly the highest RGR (0.069 cm/cm/day) of pummelo seedlings was observed in S_1T_7 treatment combination, which was at par with S_1T_2, S_1T_3, S_1T_5 and S_1T_7. However, the lowest (0.025 cm/cm/day) RGR of pummelo seedlings was observed in S_3T_6, which was at par with S_2T_5, S_2T_6, S_3T_1, S_3T_2, S_3T_3, S_3T_4, S_3T_5 and S_3T_7.

Thus freshly harvested pummelo seeds had shown better results in per cent seed germination and all the growth parameters of pummelo seedlings up to six month from date of sowing. Among different pre-sowing seed treatments studied; soaking of seeds in GA_3 50 ppm for 24 hrs recorded better effect on seed germination and most of the growth parameters and it was followed by scalding at 50^0C for 24 hrs. In interaction effect, soaking of freshly harvested pummelo seeds in GA_3 50 ppm for 24 hrs had shown better results in terms of per cent seed germination as well as most of the growth parameters to achieve vigour of pummelo seedlings up to 6 months after sowing and was followed by scalding of freshly harvested pummelo seeds at 50^0C for 24 hrs.

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Table 1.

Effect of storage period and pre-sowing seed treatments on per cent seed germination and growth parameters of pummelo seedlings (at 6 months age)

Treatment	Per cent seed germination				Plant height (cm)				No of leaves				Leaf area (cm^2)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1	72.00 (58.91)	50.67 (45.39)	20.67 (26.83)	47.78 (43.71)	34.49	30.63	24.79	29.97	33.75	28.87	22.83	28.48	483.42	354.71	287.30	375.14
T_2	74.67 (59.85)	64.67 (53.55)	22.67 (28.41)	50.00 (47.27)	37.71	34.87	25.29	32.62	35.40	29.40	24.93	29.91	625.34	522.76	389.92	512.67
T_3	88.00 (69.91)	46.00 (42.70)	10.00 (18.80)	48.22 (43.80)	42.50	34.83	28.08	35.14	34.67	30.20	29.77	31.55	661.33	476.77	371.65	503.25
T_4	76.67 (61.52)	67.67 (55.55)	28.33 (32.13)	57.56 (49.74)	36.42	32.59	26.51	31.84	35.54	32.91	26.87	31.77	639.59	521.83	394.92	518.78
T_5	81.33 (64.97)	58.67 (50.01)	25.33 (30.15)	55.11 (48.38)	35.34	33.01	28.64	32.33	30.85	29.54	25.89	28.76	423.23	488.98	215.87	376.02
T_6	74.00 (59.44)	72.33 (58.37)	24.67 (29.29)	57.00 (49.03)	32.95	31.60	25.75	30.10	29.50	28.75	27.49	28.58	488.02	383.61	386.14	419.26
T_7	80.00 (63.51)	49.33 (44.62)	16.00 (23.29)	48.44 (43.81)	33.54	31.65	26.42	30.54	31.37	29.64	25.36	28.79	506.92	392.76	338.66	412.78
Mean	77.43 (62.59)	57.43 (50.03)	21.10 (26.93)		36.14	32.74	26.50		33.01	29.90	26.16		546.83	448.77	340.64	
	'F' test	SEm±	CD at 5%		'F' test	SEm±	CD at 5%		'F' test	SEm ±	CD at 5%		'F' test	SEm±	CD at 5%	
S	SIG	1.66	3.30		SIG	0.49	1.41		SIG	0.46	1.31		SIG	22.54	64.42	
T	SIG	1.76	5.04		SIG	0.75	2.15		SIG	0.70	1.99		SIG	34.43	98.40	
S×T	SIG	3.06	8.74		NS	1.30	-		SIG	1.21	3.45		NS	59.63	-	

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Table 1 (contd.).

Effect of storage period and pre-sowing seed treatments on per cent seed germination and growth parameters of pummelo seedlings (at 6 months age)

Treatment	Root Volume				Dry Weight of Leaves (g)				Dry Weight of Roots (g)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1	15.94	15.80	11.66	14.47	2.36	2.31	1.43	2.03	2.87	2.39	1.26	2.17
T_2	16.05	16.33	13.11	15.16	5.18	2.85	1.43	3.15	4.28	3.74	1.76	3.26
T_3	16.87	16.20	12.17	15.08	2.98	2.53	1.76	2.42	4.10	2.84	2.11	3.01
T_4	17.00	16.87	13.47	15.78	2.58	2.47	1.75	2.26	4.64	3.14	1.80	3.19
T_5	17.33	16.07	13.78	15.73	2.61	2.45	1.22	2.09	2.93	2.69	1.25	2.29
T_6	16.46	16.80	12.22	15.16	2.45	2.26	1.89	2.20	2.83	2.71	1.08	2.21
T_7	16.00	16.60	11.55	14.72	2.26	2.16	1.91	2.11	2.70	2.67	2.22	2.53
Mean	16.52	16.38	12.57		2.92	2.43	1.63		3.48	2.88	1.64	
	'F' test	SEm ±	CD at 5%		'F' test	SEm±	CD at 5%		'F' test	SEm ±	CD at 5%	
S	SIG	0.22	0.62		SIG	0.20	0.57		SIG	0.14	0.39	
T	NS	0.33	-		NS	0.30	-		SIG	0.21	0.59	
S×T	NS	0.57	-		NS	0.52	-		NS	0.36	-	

Table 2

Effect of storage period and pre-sowing seed treatment on absolute growth rate (cm/day) and relative growth rate (cm/cm/day) pummelo seedlings

Treatment	absolute growth rate (cm/day)								relative growth rate (cm/cm/day)							
	120-150 Days				150-180 Days				120-150 Days				150-180 Days			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1	0.179	0.223	0.093	**0.165**	0.154	0.143	0.074	**0.124**	0.055	0.062	0.034	**0.050**	0.050	0.047	0.026	**0.041**
T_2	0.229	0.174	0.096	**0.167**	0.182	0.151	0.077	**0.137**	0.064	0.053	0.033	**0.050**	0.056	0.049	0.026	**0.044**
T_3	0.243	0.231	0.118	**0.197**	0.204	0.166	0.107	**0.159**	0.065	0.064	0.040	**0.056**	0.059	0.053	0.038	**0.050**
T_4	0.213	0.187	0.108	**0.169**	0.178	0.161	0.089	**0.143**	0.061	0.056	0.038	**0.052**	0.054	0.051	0.031	**0.046**
T_5	0.273	0.118	0.087	**0.159**	0.227	0.100	0.090	**0.139**	0.069	0.041	0.031	**0.047**	0.063	0.036	0.033	**0.044**
T_6	0.209	0.092	0.091	**0.130**	0.158	0.097	0.072	**0.109**	0.061	0.031	0.033	**0.041**	0.051	0.030	0.025	**0.035**
T_7	0.223	0.122	0.092	**0.146**	0.290	0.111	0.088	**0.163**	0.061	0.043	0.032	**0.046**	0.069	0.040	0.030	**0.046**
Mean	**0.224**	**0.164**	**0.098**		**0.199**	**0.133**	**0.085**		**0.062**	**0.050**	**0.034**		**0.058**	**0.044**	**0.030**	
	'F' test	**SEm±**	**CD at 5%**		**'F' test**	**SEm±**	**CD at 5%**		**'F' test**	**SEm±**	**CD at 5%**	**'F' test**	**SEm±**	**CD at 5%**		
S	SIG	0.0095	0.027		SIG	0.0082	0.023		SIG	0.0019	0.0055	SIG	0.0018	0.005		
T	NS	0.014	-		SIG	0.012	0.035		SIG	0.0029	0.0085	SIG	0.0028	0.0081		
S×T	SIG	0.025	0.072		SIG	0.021	0.062		SIG	0.005	0.014	SIG	0.004	0.014		