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RESPONSE OF SEED SIZE, STORAGE CONDITION, MEDIA AND SOWING TIME ON SEED GERMINATION AND SUBSEQUENT GROWTH OF CHESTNUT (*CASTANEA SATIVA* MILL) SEEDLING

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SUMMARY

Significantly higher seed germination (48.67%), seedling height (28.83cm), seedling diameter, number of laterals, and length and diameter of laterals were recorded in extra large seed of chestnut (*Castanea sativa* Mill) Although seed stored in aluminum foil pouch exhibited maximum germination per cent (47.75%), the maximum seedling growth was registered in sand storage condition. Large seeds stored in sand and aluminum foil pouch resulted in good germination and seedling growth. Significantly maximum seed germination (33.5%) was registered in soil + sand (media), whereas other growth parameter was highest in field sown seedling. November sown seeds resulted in maximum germination (45.5%) and seedling height; however, seedling diameter, number of laterals and diameter were highest in October sown seedling. Large seed and November sowing had highest germination (52.70%). Field sowing in month of November resulted in maximum seedling height and diameter, length of laterals and their diameter.

Key words: **Chestnut, recalcitrant seed, seed germination, storage condition.**

INTRODUCTION

Chestnut, an important diet in Northern hemisphere, belongs to family *Fagaceae*. It is one of the nuts which are low in fat content, cooked by steaming in earthen pots after removing outer shells, consumed with salt and milk. The nuts are eaten roasted or used to prepare bread. Chestnut trees have ornamental value and planted as avenue trees. The trees are big in size and pose difficulty in fruit harvesting. The giant nature of trees further creates difficulty in cultural practices. The vegetatively propagated trees are dwarf sized that helps in accommodation of large number of trees and facilitates cultural operations. The chestnut seeds are recalcitrant in nature and present complex problems as they normally perish in a week's time but can survive for one to six months under suitable storage condition. The high moisture seeds are much sensitive to heat damage, biological activity, growth and multiplication of the insect, pathogen are greater at high moisture level. Chestnut seeds loose their viability with loss of moisture during storage thus it must be prevented from drying. Viewing the above problems, attempts were made to standardize germination media, sowing time, seed size and storage condition to increase seed longevity for raising of chestnut root-stocks.

MATERIALS AND METHODS

The experiment was conducted at experimental farm of Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Srinagar

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during the year 2005-06 and 2006-07. Well mature nut seeds were collected in the end of September and were categorized into four groups according to size and weight; W_1 (extra large) = 18-20g, W_2 (large) = 16-18 g, W_3 (medium) = 14-16g and W_4 (small) = 12-14 g/seed. Seeds of various size and weights were stored in different storage conditions i.e. sand (S_1), aluminum foil pouch (S_2), saw dust (S_3), and wood ash (S_4)). There were 16 treatment combinations. In other case four sowing media (field sowing, Soil+Sand, Soil+Sand+ FYM and sand +FYM) and four sowing times viz. October, November, February and March (as the temperature condition for seedling vary greatly during October to March) and their combinations were tried. The experiment was laid out in a factorial randomized block design with three replications having 10 seeds per replication. After grouping the seeds as per size, these were stored in different media. To avoid drying of seeds water at 15 days interval was sprinkled on media and the tray containing media was placed under shade to avoid direct exposure to sunlight. Individual seeds of chestnut were packed in aluminum foil pouch. Observations on per cent seed germination, seedling height and diameter, number of laterals, length and diameter of laterals were recorded at the end of the growing season (end of November). The data generated were pooled and analyzed statistically for interpretation of the results.

RESULTS AND DISCUSSION

Effect of seed size: Seed size had significant effect on the seed germination (Table 1). Highest seed germination percentage (48.67%) was obtained in extra large (W_1) seeds, followed by large (W_2) seeds (42.83%) and medium (W_3) size (32.83%) where as least number (14.75%) of seeds germinated in small (W_4) seed. Similar trend was noted in seedling height. Significantly longest seedling (28.83 cm) was observed in the W_1 seed followed by W_2 seed (22.25), which was statically at par with W_3 sized seed. Lowest height (11.67cm) was noted in W_4 sized seed. Largest number of laterals (4.67) were obtained in W_1 closely followed by W_2 (4.25), significantly lowest number of laterals were recorded in W_3, which was at par with small W_4. Significant difference was recorded in lateral length. Longest lateral (8.25cm) was noted in W_1 which was statically at par with large seed size (7.54 cm). Minimum lateral length was observed in W_4 (3.08cm). More or less similar trend was observed in lateral diameter. W_1 exhibited maximum lateral diameter (7.67 mm) followed by large seed (5.17mm) but the value was at par with medium (5.25mm) seed size. Minimum lateral diameter (3.83mm) was noted in small seed. Significantly higher seedling diameter was noted in W_1 (13.33mm), which was statistically at par with W2 (12.83mm) and W_3 (12.25mm), lowest diameter (6.92mm) was recorded in W_4. High germination potential of large seeds might be due to initial capital (Ashby, 1936) as well as quantity of nutrients available for germination (Bartee and Krieg, 1974). Increase in protein content with increase in seed size might also be attributed to high germiniability of the bold seeds (Paul and Ramaswamy, 1979). Similar results were also obtained by Kumar (1997) and Ahmad and Mohan (1985) in pineapple.

Storage condition: Significantly higher seed germination (47.75%) was obtained in aluminum pouch (S_2) storage, which was at par with sand (S_1) storage (43.83%). The germination in wood ash (S_4) storage was appreciably lower than S_2, S_1 and S_3 (saw dust) which might be due to higher moisture retention by the media thus resulting in seed rotting. The results are in conformity with those of Doijode (2002) who also recommended hermetic container such as laminated aluminum foil for effective long term storage of seeds. Since such pouches are effective in maintaining desired level of seed moisture for fairly long period, low moisture seeds retains moisture for long times in sealed pouches. This may be due to stoppage of exchange of oxygen from atmosphere resulting in ceasing of respiration. Significantly higher height was registered in sand storage (24.00cm) followed by aluminum pouch (22.58 cm) and lowest in wood ash (16.91 cm). Similarly highest seedling diameter (13.41mm) was recorded in sand storage, which, was at par with S_2 and S_3 storage conditions. In S_4 the value was significantly lowest (8.67mm). As far as number of laterals are concerned, similar trend was noted in S_1, S_2, and S_3 storage condition though statistically at par. However appreciably lower lateral numbers (2.13) were recorded in S_4 storage condition Longest lateral length (9.83 cm) was noted in S_1 condition followed by S_2 (7.91 cm) which was statistically at par with S_3 (1.25cm). Smallest lateral (3.78cm) was recorded in S_4 storage condition. No significant variation was recorded with

Table 1. Response of seed size and storage condition on seed germination and subsequent growth of chestnut seedling.

Treatment	Seed germination (%)	Seedling height (cm)	Seedling diameter (mm)	Number of lateral	Length of lateral (cm)	Diameter of lateral (mm)
Seed size						
Extra large seed (W_1)	48.67	28.83	13.33	4.67	8.25	7.67
large seed (W_2)	42.83	22.25	12.83	4.25	7.54	5.17
Medium (W_3)	32.83	22.08	12.25	2.75	4.33	5.25
Small (W_4)	14.75	11.67	6.92	1.83	3.08	3.83
Mean	34.77	21.20	11.33	3.37	5.8	5.48
L S D at 5%	3.66	1.52	3.36	0.95	0.72	1.09
S. E. (mean diff.)	1.49	6.62	1.37	0.39	0.29	0.44
Storage condition						
Sand storage (S_1)	43.83	24.00	13.41	3.83	9.83	6.91
Aluminum foil (S_2)	47.75	22.58	12.17	3.67	7.91	6.5
Saw dust (S_3)	30.42	19.33	11.13	3.17	7.25	6.08
Wood ash (S_4)	17.08	16.91	8.67	2.13	3.78	5.41
Mean	34.77	28.70	11.34	3.2	7.19	6.22
L S D at 5%	3.57	1.95	1.99	0.82	0.73	1.57
S. E. (mean diff.)	1.73	0.94	0.96	0.40	0.35	0.76
Interaction						
$W_1 \times S_1$	68.33	29.33	15.67	5.33	10.00	9.00
$W_1 \times S_2$	63.33	28.33	16.00	5.00	7.33	8.10
$W_1 \times S_3$	39.67	27.67	11.00	4.70	7.33	6.67
$W_1 \times S_4$	23.30	22.70	10.67	4.57	8.30	7.00
$W_2 \times S_1$	56.00	26.00	15.70	4.70	7.30	6.00
$W_2 \times S_2$	60.67	25.67	14.0	4.70	8.00	5.70
$W_2 \times S_3$	34.33	20.33	13.33	3.87	7.10	5.10
$W_2 \times S_4$	17.30	16.67	8.33	4.00	7.00	4.10
$W_3 \times S_1$	31.67	26.67	14.30	3.66	6.00	5.00
$W_3 \times S_2$	44.33	24.00	12.00	3.33	5.00	4.67
$W_3 \times S_3$	35.00	18.67	13.67	2.00	3.67	5.71
$W_3 \times S_4$	20.33	19.00	8.67	2.00	2.67	5.70
$W_4 \times S_1$	19.33	13.67	8.00	1.67	4.0	7.70
$W_4 \times S_2$	23.67	12.33	6.33	1.67	3.33	7.67
$W_4 \times S_3$	12.67	10.67	6.33	2.33	3.00	7.00
$W_4 \times S_4$	7.33	10.00	7.00	1.67	2.00	5.00
L S D at 5%	7.14	3.90	3.99	1.63	1.47	3.14
S. E. (mean diff.)	3.46	1.89	1.93	0.79	0.71	1.52
CV (%)	12.19	11.19	20.91	28.79	15.13	29.97

respect to diameter of laterals though maximum diameter (6.91mm) was registered with S_1 storage condition (Table 1).

Effect of seed size and storage condition: Seed size and storage condition had significant effect on seed germination and seedling growth. Highest germination percentage (68.33% and 63.67%) was recorded when extra large seed (W_1) was stored in sand (S_1) and aluminum foil (S_2), respectively whereas when large seed was stored in S_2, germination was 60.67 % which was at par with W_1S_2 treatment combination (63.33%). Least seed germination (7.33 %) was recorded when small seed was stored in S_4. Table 1 also indicate that seed packed in aluminum pouch gave better seed germination irrespective of seed size. Sealing of individual seed in aluminum foil pouch might have resulted in modification of atmosphere with high carbon dioxide and low oxygen which decreased the rate of respiration and further loss of reserve carbohydrate. The packaging also functions as a physical barrier which reduces air movement across nut surface. Chestnut seeds responded well in all the storage condition which may be due to the prevention of loss of moisture. Doijode (2002) also observed higher germination in mangosteen seeds when stored in charcoal at room temperature.

Effect of media: Significant variation was observed in the germinating media for seed germination. Highest seed germination (33.5%) was observed in M_2 (Soil +Sand) followed by M_1 (29.5%). M_1 was statistically at par with M_3 whereas significantly lower germination was noted in M_4. Maximum seedling height (35.75 cm) was noted in M_1 followed by M_3 (27.17cm). However, significantly lower growth was noted in M_4 (18.33cm) which was statistically at par with M_2 (21.75cm). Significantly higher seedling diameter was noted in M_1 (16.83 mm) closely followed by M_3 (15.17 mm) though M_1 and M_3 were statistically at par, where as minimum seedling diameter (9.91 mm) was recorded in M_2. Similarly maximum number of laterals were noted in M_1 (5.75) which was statistically at par with M_2, where as minimum laterals were noted in M_4 (3.75). Significantly maximum length of lateral (11.33 cm) was noted in M_1 followed by M_3 (10.83 cm), where as lowest (4.00 cm) in M_2. Similar trend for diameter of laterals was observed in M_1 (9.25 mm) followed by M_3 (8.58 mm), which were statistically at par, however, minimum was noted in M_2 (5.33 mm). These results are in agreement with Kaur and Malhi (2006) who reported maximum growth and sprouting of epicotyl grafts of mango in soil + sand + FYM media.

Sowing time: It is evident from Table 2 that sowing time exhibited significant variation on various growth parameters of the chestnut seedlings. Significantly highest seed germination (45.50%) was noted in T_2, followed by T_3 (28.67%). However, minimum seed germination (18.83 %) was recorded in T_4. Seedling height was significantly higher (30.33 cm) in T_2 followed by T_1 (26.67 cm) which was statistically at par with T_3 (26.25 cm) whereas, lowest height was recorded in T_4 (19.75 cm). Diameter of seedling was highest (16.83 mm) in T_1, whereas, least diameter was noted (9.67 mm) in T_4, though the value of T_1 and T_2 was statistically at par with each other. Significant variation in the laterals number was recorded among various sowing time. Lateral number was found to be maximum in T_1 (5.5) followed by T_2 (4.92) whereas least lateral was registered in the T_4 (3.33), which was statistically at par with T_3 (3.93). Unlike lateral number, length of the lateral was highest in T_2 (9.92 cm) closely followed by T_1 (9.83cm), statistically at par and minimum length (5.75cm) was noted in T_4. As far as diameter of the lateral was concerned it was maximum (9.91mm) in T_1 followed by T_2 (7.83mm) and minimum (5.17mm) in T_4 , however T_4, T_2 and T_3 as well as T_3 and T_4 values were statistically at par with each other. These results are in consonance with Tripathi *et al*. (2006) who recorded good seed germination in walnut for two consecutive years when nuts were sown in December which experienced good rainfall with low temperature thus resulted in better stratification and rapid germination.

Effect of media and sowing time: The interaction effect of media and sowing time had profound effect on germination percentage. Soil + Sand (M_2) media and November (T_2) sowing resulted in highest germination (52.70%) followed by M_3 (Soil+ Sand+ FYM) and November sowing (46.00%) ,which registered significantly highest germination than other combination. M_1T_2 combination exhibited maximum seedling height (43.67 cm) closely followed by M_2T_2 (42.33) and M_1T_1 (36.67%) whereas the other combinations were significantly lowest. Similarly M_1T_2 combination resulted

Table 2. Response of media and sowing time on seed germination and subsequent growth of chestnut seedling.

Treatment	Seed germination (%)	Seedling height (cm)	Seedling diameter (mm)	Number of lateral	Length of laterals (cm)	Diameter of lateral (mm)
Germination media						
Field sowing (M_1)	29.5	53.75	16.83	5.75	11.33	9.25
Soil + Sand (M_2)	33.5	21.75	9.91	4.25	4.00	5.33
Soil + Sand + FYM (M_3)	28.08	27.17	15.17	3.91	10.83	8.58
Sand + FYM (M_4)	23.00	18.33	12.83	3.75	7.33	6.58
Mean	28.52	25.75	13.68	4.41	8.37	7.43
L S D at 5%	3.78	5.15	2.65	1.75	1.86	1.04
S. E. (mean diff.)	1.54	2.10	1.08	0.72	0.76	0.43
Sowing time						
October (T_1)	21.08	26.67	16.83	5.5	9.83	9.91
November (T_2)	45.5	30.33	15.41	4.92	9.91	7.83
February (T_3)	28.67	26.25	12.83	3.92	8.00	6.83
March (T_4)	18.83	19.75	9.67	3.33	5.75	5.17
Mean	28.52	25.75	13.68	4.41	8.37	7.43
L S D at 5%	3.49	3.47	2.04	0.88	1.44	1.53
S. E. (mean diff.)	1.69	1.68	0.99	0.42	0.70	0.74
Interaction						
$M_1 \times T_1$	16.66	36.67	17.67	6.33	16.67	12.33
$M_1 \times T_2$	44.70	43.67	18.33	6.00	17.00	11.80
$M_1 \times T_3$	33.70	33.70	18.10	5.03	16.60	11.67
$M_1 \times T_4$	23.00	29.00	13.33	4.30	14.00	10.67
$M_2 \times T_1$	23.00	24.70	14.67	5.00	6.00	6.67
$M_2 \times T_2$	52.70	42.33	10.67	4.30	4.10	5.30
$M_2 \times T_3$	38.70	23.67	7.33	3.30	3.33	4.68
$M_2 \times T_4$	19.70	18.00	7.00	3.00	2.67	4.60
$M_3 \times T_1$	29.70	29.67	18.00	5.00	11.00	10.67
$M_3 \times T_2$	46.00	18.70	17.00	4.33	10.00	9.60
$M_3 \times T_3$	18.33	23.33	15.67	3.30	13.00	8.59
$M_3 \times T_4$	18.33	15.33	10.00	3.00	8.67	5.33
$M_4 \times T_1$	15.00	15.67	17.00	4.67	9.67	10.00
$M_4 \times T_2$	38.67	16.67	15.67	4.00	8.00	8.00
$M_4 \times T_3$	24.00	24.33	10.33	2.67	6.00	5.33
$M_4 \times T_4$	14.33	16.70	8.30	2.60	5.67	3.00
L S D at 5%	6.98	6.93	4.08	1.75	2.89	3.07
S. E. (mean diff.)	3.38	3.36	1.97	0.85	1.40	1.49
CV (%)	14.53	15.99	17.70	23.64	20.51	24.50

in highest seedling diameter (18.33 mm) closely followed by M_1T_3 (18.10 cm) and M_3T_1 combinations. Field sowing at November resulted in maximum seedling diameter, because seedlings are not confined in limited area or like in poly-bag sowing. Similarly direct field planting in October gave maximum (6.33) lateral numbers closely followed by M_1T_2 (6.00) and M_1T_3 combinations. Whereas other combinations were either statistically at par or low. Lateral length was highest (17.00 cm) in direct field sowing in November (M_1 T_2) closely followed by M_1T_1 (16.67 cm), and M_1 $T_{3.,}$ however, other combinations were appreciable low. As far as diameters of laterals was concerned, maximum (12.33 mm) diameter was registered in M_1T_1 combination closely followed by M_1T_2 (11.80 mm) and M_1T_3 (11.67 mm). The field sowing exhibited significantly more seedling growth irrespective of sowing time because the conditions might be more congenital for growth under field condition as seedlings roots are not confined in limited area as in poly-bags.

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