EFFECTS OF WASHING AND MEDIA ON THE GERMINATION OF PAPAYA (*C. PAPAYA)* SEEDS

OKEYO A., OUMA G.

Abstract

Studies were carried out at Maseno University, Kenya to investigate the effect of media and seed washing on the germination and subsequent growth of Papaya (C. papaya) seedlings. Seed extraction was carried out from the fruit then flotation test was carried out to determine the viability of the seeds followed by application of the treatment which were washing half the seeds to remove the gelatinous material and leaving the other half unwashed. Two types of media were used namely sand and topsoil and were placed separately in pots and planting the seeds commenced with the washing and non-washing of the seeds on 17th February 2007. The pots were then placed in the shade house, which allowed 70% light. The treatments were, T1 (unwashed seeds planted in sand), T_2 (washed seeds planted in Sand) T_3 (unwashed seeds planted in topsoil) T_4 (washed seeds planted in topsoil.
The experimental design was completely randomized (CRD) replicated four times. Data taken were the number of germinated seeds after four weeks from the first emergence, root length, leaf number, leaf area, stem diameter and plant height. Data was subjected to analysis of variance (ANOVA) and mean separation using L.S.D at 5% significance level. The results showed that washing affected or increased germination in sand only but it also increased the growth of the seedlings in topsoil. It is concluded that Papaya seeds should be washed and soaked before sowing to enhance germination.

Key words: papaya, germination, media, washing, inhibitor

INTRODUCTION

Seed germination is affected by many factors, which include type of substrate used, environmental factors such as oxygen, water, temperature and for some plant species, light (Hortmann et al, 2001). The germination of seeds of C. papaya is frequently reported to be slow, erratic and is incomplete (Chako and Singh,1966; Lange, 1961). For example, in one study freshly harvested seeds gave only 6% germination. (Koyama, 1951). The seed is endosed within a gelatinous sarcotesta (aril, or outer seed coat which is formed from the outer integument). Whilst this sarcotesta can prevent germination (Lange, 1961; Yahiro, 1979) dormancy is also observed in seeds from which the sarcotesta has been removed (Lange, 1961; Yahiro, 1979). Removal of seed covering structures: arils then presoak arils then pre wash improves germination (Lange, 1961; Perez et al, 1980; Yahiro, 1979). The flesh of Papaya fruit contains inhibitors, which can prevent germination (Lange, 1961; Perez et al, 1980; Yahiro, 1979). But drying freshly extracted seeds results in increased germination (Yahiro, 1979). Consequently, it is suggested as a general practice that at harvest the freshly extracted seeds are rubbed to remove the gelatinous sarcotesta and thoroughly washed in running water before the seeds are dried for storage. Pre soaking the seeds in water for 24 hours is reported to promote germination of Carica spp. (Riley, 1981). Water-soluble endogenous inhibitors have been reported for other plants (Koyamu, 1951).

The strong germination inhibitors in the fruit flesh may act as a barrier to the movement of the inhibitor between the ovary flesh and seed coat. Past studies have not investigated how other factors can interact with washing to affect germination and how they can affect subsequent seedling growth. The objectives of the present study were to investigate the effect of washing of papaya seeds and type of substrate on the germination of and subsequent growth of C. Papaya seedlings.

MATERIALS AND METHODS

The research was carried out at Maseno University, Kenya in a shade house which allowed 70% light, from 17th February 2007 to 22nd April 2007. Maseno university is situated at latitude of 0^0 1'N-0^0 12'S and a longitude of 34^0 12'S 25'E-47'E, It is at 1500 meters above the sea level with mean temperatures of 28.7°C with a relative humidity of 40%. The average annual precipitation is1750 mm with a bimodal distribution. The soil is classified as Acrisol, according to Netondo (1999) and also well-drained acidic, with high extractable Ca and K. Soil organic Carbon and Phosphorus content are 1.8% and 4.5mg/kg respectively. The pH of the soil ranges between 4.6 and 5.4 the shade net allowed 70% sunlight. The papaya fruits 'solo variety' was obtained from the local market in Kisumu city. Sand and top soils as the two media were provided by the university.

Sand was placed in (8) 1.5 liter pots and topsoil placed in the other remaining 8 (1.5) liter pots.
The fruits were then cut longitudinally by knife and seeds extracted by scooping out of the fruit with a spoon. The seeds were then placed in a beaker containing tap water and floatation test done to determining the seed viability. Those that floated were discarded as they were considered not viable. Water was reduced in the beaker and the separation of the seeds that had earlier sank into two seed lots was done to produce a working sample. In one of the seed lots washing was done by rubbing the seed coating remove the gelatinous cover. In the other seed lot seed coat the gelatinous material was not interfered with.
Planting was then done by planting the washed seeds in 4 pots containing sand and other 4 pots containing top soils totalling to eight pots in total.
Planting of the unwashed seed lot was also done on 4 pots containing sand and other 4 pots containing top soil. 30 seeds were planted on each pot.
Watering was done and the planted pots with the treatments placed in a shade house.
The four treatments that were replicated four times were T1 (having sand and unwashed seeds), T2 (having sand and washed seeds), T3 (having topsoil as the media and unwashed seed), T4 (having washed seeds and top soil.
Growth parameters were used to determine seedling emergence and growth rate. Days and number of seedling emergence were determined by data collection by physical counting the emerged seedlings. Three weeks from the first emergence, thinning of the seedlings to five seedlings per pot was done at a spacing of 5 cm to reduce competition among them.
Watering was done with care not to flood the pots and cause favourable conditions for damping off to occur. Thinning of the emerged seedlings was done on 14th March 2007 at a spacing of 4cm leaving four plants per pot.
Finally, a destructive measurement method was taken on 21st April 2007 whereby the final plant height, were determined and so was the root length with the aid of a 30 cm ruler. Leaves were traced on to graph paper in order to determine the leaf area. A Venier caliper was used to measure the stem diameter. Four seedlings per pot were used in the destructive measurement.

Experimental design and analysis and data collected

The design was completely randomized design in factorial arrangement with four treatments and four replicates. The results were subjected to the analysis of variance and means were separated using the LSD method at 5% significance.
Germination percentage: Final count of the emerged seedlings was done doing the fourth week from the beginning of the first emergence with respect to each pot when germination stopped and a calculation done in relation to the number of planted seeds and a percentage was obtained by the use of the formula below. The number of germinated seedlings was divided by the number of seeds planted per pot multiplied by100%.
Number of leaves: This was done at the end when the true leaves had emerged.
Plant height: This was taken at the end of the experiment using the destructive method using a ruler.
Root length was measured by destructive method of uprooting the plant and taking measurements with the use of a 30 cm ruler.
Leaf area: Leaves from the plants that were used in the destructive measurements were taken and traced onto a graph paper to determine leaf area.
Stem diameter: A venier calliper was used to measure the stem diameter of the sampled plants.
Data analysis: Data obtained was subjected to analysis of variance and least significance difference (LSD) at 5% was used to separate the means.

RESULTS AND DISCUSSION

Treatments T_1, T_2 and T_4 were not significantly ($P \leq 0.05$) different but had significantly higher percent germination than T_3 (Table 1).
The growth parameters of the Papaya seedlings were also significantly affected by the treatments. T_4 had taller seedlings than all others but T_3 and T_1 were not significantly different from each other in plant height (Table 3). Conversely, T_4 had significantly longer roots than all the other treatments, which were not significantly different. T_3 and T1 were not significantly different in leaf number and so was T_2 and T_4 but the latter had greater number of leaves than the former (Table 4). With stem diameter T_1,T_3 were not significantly different but T4 had a significantly bigger stem diameter than all other treatments (Table5). In leaf area T_1,T_2, T_3 and T_4 were all significantly different and the trend in decreasing order was T_4,T_2,T_1, T_3 (Table 6)
Percent germination was similar for washed and unwashed for topsoil but for sand it was 70% germination for washed and 40% germination for unwashed (Figure 1). Similar results were obtained for plant height (Figure 2) For stem diameter both washed and unwashed seeds had very small values in sand, which were not significantly different, but in topsoil, unwashed seeds had far higher values than washed seeds (Figure 3). Similar results were observed for leaf area (Figure 4).
Both media and washing significantly ($P, < 0.05$) affected the germination of Papaya seeds. There was no significant difference between washed and washed seeds in topsoil while in sand, washed seeds were superior to unwashed seeds in terms of germination percent. Washing seeds before sowing improved germination in sand but not in topsoil. The presence of the gelatinous material (sarcotesta) reduced the average percent germination. Washing the seeds resulted in increased germination. There is a possible inhibiting effect of the sarcotesta in relation to the oxygen

available during germination resulting from continuous washing (Black and Wareing, 1959). It appears that the differences between the physical properties of sand and topsoil in terms frequency of watering needed i.e. topsoil needs frequent watering. It is likely that the washed seeds also need soaking to promote more germination as was carried out in the sand. Sand also has more aeration permitting more oxygen, which promoted more germination. The higher germination resulting from soaking (as in the sand) and washing in the absence of sarcotesta may indicate that the sarcotesta acts as a barrier to the movement of the water-soluble inhibitor out of the seed coat. These results suggest the presence in the seed coat of a leachable inhibitor, which is held against leaching by the sarcotesta in sufficient concentration to reduce germination at any concentration. Several workers have also reported that removal of the sarcotesta and then presoaking as carried out in the frequent watering in sand and washing promotes germination of Papaya. (Lange, 1961; Perez et al, 1980; Yahiro 1979). The strong germination – inhibitor in the fruit flesh, may act as barrier to the movement of the inhibitor between the ovary flesh and seed coat (Koyamu, 1951). It is apparent that washing removes the inhibitor the same way scarification does in some species to break dormancy (Katherine et al, 1970; Amen, 1965). The improved growth of Papaya seedlings after the removal of the inhibitor by washing is mostly probably due to the interaction between promoters and inhibitors (Galston and Davies, 1969; Van overbeck, 1966). ABA in the inhibitor interacts with GA3 which is increased after the inhibitor is removed, to increase growth (Lipe and Crane, 1960, Sandheimer and Galson, 1966). Further the nutrients in the topsoil may have also contributed to this increased growth.

Table 1: Effects of Treatments on Germinatio
LSD = 11.834

T3	43.3 a
T4	69.175 b
T2	70.82 b
T1	70.84 b

Figure 1: Effect of washing and media on the germination and growth of papaya *(C. papaya*) seedlings grown at Maseno, Kenya

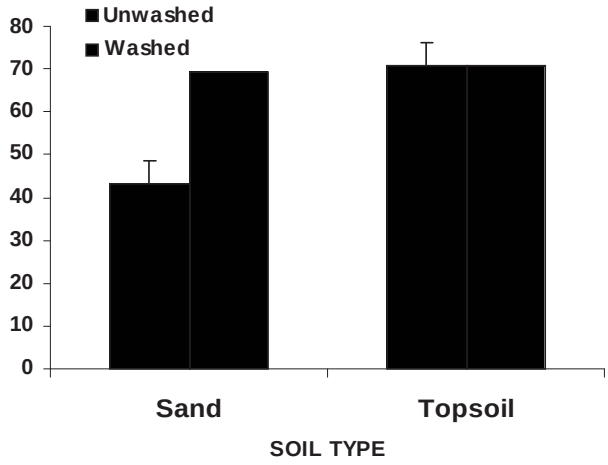
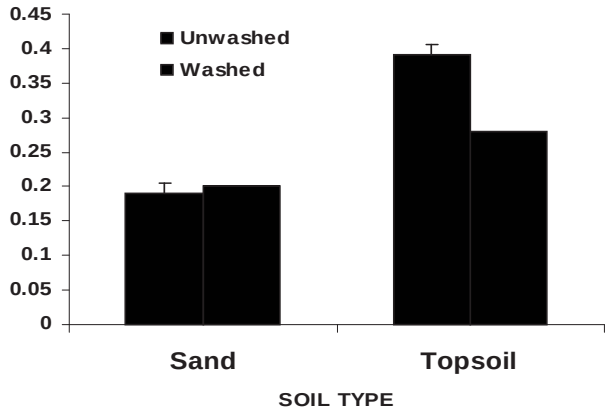


Figure 2: Effect of washing and media on the plant height of papaya (*C. papaya*) papaya seedlings grown at Maseno, Kenya in 2007



Means followed by the same letter in the same column are not significantly different at L.S.D at 5% significance level.

Table 2: Effects of Treatments on plant height papaya seedlings
L.S.D= 0.939

T2	5.6 a
T1	5.8375 a
T3	7.9625 b
T4	11.61 c

Means followed by the same letter in the same column are not significantly different at L.S.D at 5% significance level (Table 3).

Table 3: Effects of Treatments on the root length of papaya seedlings
L.S.D ($P < 0.05$) = 3.51

T3	5.1663 a
T1	5.795 a
T2	8.95 a
T4	12.1188 b

Means followed by the same letter in the same column are not significantly different at L.S.D at 5% significance level.

Figure 3: Effect of washing and media on the stem diameter of papaya (*C. papaya*) seedlings grown at Maseno, Kenya.

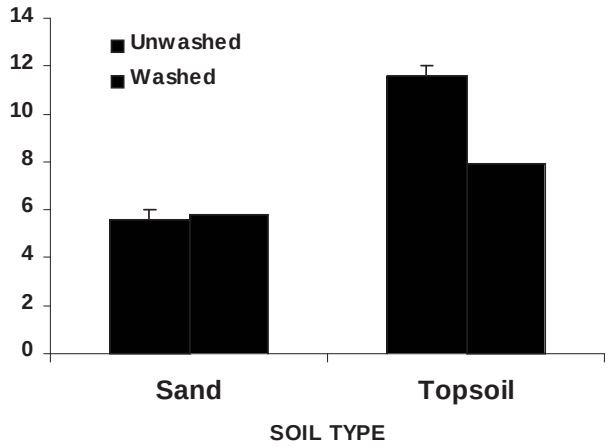


Figure 4: Effect of washing and media on the leaf area of papaya (*C. papaya*) seedlings grown at Maseno, Kenya

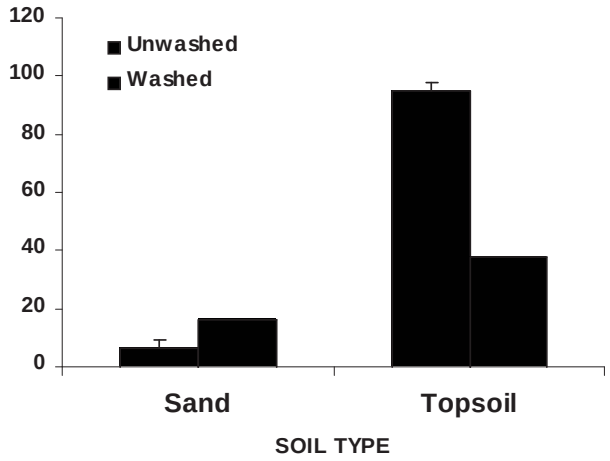


Table 4. Effects of Treatments on the leaf number of papaya seedlings grown at Maseno, Kenya, in 2007
L.S.D (P< 0.05) = 0.66

T3	3.25 a
T1	3.75a
T2	5.25 b
T4	6.5 b

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Means followed by the same letter in the same column are not significantly different at L.S.D at 5% significance level.

Table 5: Effects of treatments on the stem diameter of papaya seedlings grown at Maseno, Kenya in 2007
L.S.D ($P < 0.05$) = 0.04

T3	0.1925 a
T1	0.201 a
T2	0.281 b
T4	0.389 c

Means followed by the same letter in the same column are not significantly different at L.S.D 5% significance level.

Table 6: Effects of treatment on the leaf area of Papaya seedlings grown at Maseno, Kenya in 2007
L.S.D ($P < 0.05$) = 6.6

T3	6.625 a
T1	14.625 b
T2	38.105 c
T4	94.75 d

Means followed by the same letter in the same column are not significantly different at at L.S.D at 5% significance level.

CONCLUSION

Washing improves germination and it is therefore recommended that freshly extracted seeds be washed before sowing.

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Corresponding author:

Dr. George Ouma
Department of Botany and Horticulture
Maseno University
P.O.BOX 333, Maseno, Kenya
e-mail: goumaoindo@ yahoo.com