Journal of Animal & Plant Sciences, 2011. Vol. 11, Issue 2: 1418-1423
Publication date: 30/9/2011, http://www.biosciences.elewa.org/JAPS; **ISSN 2071 - 7024**

Effect of potassium priming on *papaya (Carica papaya* var.kamiya)

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Keywords: priming, germination, seeds, papaya, washing, potassium.

1 SUMMARY

Papaya (Carica papaya L.) is an important fruit in Kenya for fresh consumption and wine making. It can be propagated by budding, seeds, cuttings and tissue culture. Seed propagation is the simplest and cheapest method of propagation and is affected by the factors such as temperature, moisture loss and seed priming. Papaya seeds are classified as recalcitrant therefore loss of moisture through drying has an effect on seed viability. Removal of gelatinous material through washing removes the sarcostetae which causes secondary dormancy. The seeds also have a hard seed coat and a germination inhibitor below them which hinder water absorption thus preventing germination it is with this background that an experiment was conducted in the year 2008 in a greenhouse at Maseno University, Kenya. The studies involved seed extraction using standard methods and a subsequent floatation test to determine seed viability. followed by washing the whole seed to remove the gelatinous material covering it. Washed seeds were divided into six lots, with the first lot washed, second soaked in potassium chloride solution(KCL), third soaked in potassium hydroxide solution(KOH)., fourth soaked in potassium nitrate solution,(KNO_3) fifth soaked in potassium sulphate(K_2SO_4) and sixth soaked in wood ash solution(K_20) These were therefore the treatments which were randomized in a completely randomized design. The seeds were planted in plastic pots, placed in a greenhouse and watered twice daily. Data was collected on the number of seedlings emerging per pot, root length, leaf number, leaf area, stem diameter and plant height which were taken weekly. The data was analyzed using the Statistical Analysis System (SAS) where analysis's of variance and mean separation done using the Least Significant Difference (L.S.D) at five percent probability. The results showed that priming with potassium solutions improve seedling germination capacity and subsequent seedling growth .It is therefore concluded that papaya seeds should be primed with potassium solution after washing.

2 INTRODUCTION

Seed germination is affected by many factors including substrate type, environmental factors such as oxygen, water and temperature and for some plant species, light (Hartmann, et *al,* 2001). The germination of seeds of *C. papaya* is slow, erratic and incomplete (Chako and Singh, 1960, Lange, 1961). For example, in one study freshly harvested seeds gave 6% germination. (Koyama, 1951). The seed is enclosed within agelatinous 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 have been removed. (Lange, 1961, Yahiro, 1979). Removal of seed covering structures, arils then presoaking and prewashing them improves germination. (Lange, 1961., Yahiro,

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1979, Perez *et al* 1980, Ouma and Okeyo, 2008).
Priming improves germination (Tisdale, 1985, Mengel and Kirby, 1987,); other methods of priming are osmotic conditioning and addition of limited amount of water (Hartman *et al* 2001). The objectives of the present study were:

1. to find the effect of different potassium compounds on the germination of washed papaya seeds(i.e. Potassium was chosen because it does not cause so much salinity as compared to for example sodium)
2. To find the effect of different potassium compounds on subsequent growth of germinated seedlings.

3 MATERIALS AND METHODS

Ripe papaya fruit of 'Kenya' variety was obtained from Luanda market near Kisumu, Kenya in May 2008. The fruits were cut longitudinally using a knife and seeds extracted by scooping out using a spoon. The seeds were then placed in a beaker containing distilled water and flotation test carried out to determine their viability. Those that floated were removed as they had low viability (Hartmann *et al*, 2001). The seeds were then washed to remove the gelatinous materials. The washed seeds were divided into lots. In the meantime top soil was obtained from Maseno university farm, Kenya and placed in 24 pots. The first lot was planted directly on top soil; the other five lots were soaked in different solutions containing 0.04 moles of potassium ions (KCl, K_2SO_4, KNO_3, KOH, wood ash (K_2O). The treatments were therefore as follows.
T1 – washed seeds
T2- seeds soaked in KCl
T3 – soaked seeds in KOH
T4 – soaked seeds in KNO_3
T5 – soaked seeds in K_2SO_4
T6 – soaked seeds in woodash (K_2O)

After 30 minutes the seeds were obtained from soaking solutions and were sown in the pots containing top soil and each replicated four times. The treated plants were placed in the greenhouse and watered. Soaked seeds from potassium solutions were used to determine growth rate and vigor.
After six weeks from the first emergence thinning of the seedlings was done to leave 2 seedlings per pot at a spacing of approximately 4 cm to reduce competition among the seedlings. Regular watering was done and number of seedlings emerging with true leaves was determined. Parameters measured included root length leaf area, stem diameter using standard methods. The roots and shoots of the seedlings were separated and their fresh weights were determined by a weighing balance and then they were dried in an oven at 60^0 C for 48 hours and dry weights determined. Data collection was carried out for three months and the following were determined: germination percent which was determined after the seedlings emerged by the formula;
Number of germinated seedlings/Total number of seedlings per potX100 percent=Germination Percent

Number of leaves: This was determined from the top of the soil to the highest point in centimeters
Root length: This was determined by a ruler in millimeters.
Leaf area: This was determined by tracing the seedlings on a graph paper and calculating the areas covered.
Stem diameter: This was determined by a veneer caliper.
Determination of Fresh and dry weights.: The roots and shoots of the seedlings were separated and their fresh weights determined by analytical balance and then dried in an oven for 24 hours at 60^0C.
Data analysis was by the statistical analysis system (SAS) package where analysis of variance (ANOVA) and mean separation done by the Least significant difference method (L.S.D) at 5 percent.

4 RESULTS AND DISCUSSION

The treatments T3, T2 and T5 (Table 1, 2) were not significantly different ($P \leq 0.05$) from each other but had a higher germination percentage than T1.This shows that washing papaya seeds is inferior to priming by potassium salts or compounds. Similarly, T5, T4, T2 and T1 (were not significantly different in the number of days to seedling emergence but were less than T6 and T3 (Table 2).

Table 1: Effects of treatments on germination percent

Treatment	Mean
T1	66.7b
T2	83.3a
T3	80.0a
T4	86.7a
T5	86.7a
LSD (P ≤0.05)	13.14
CV	11.10

Means followed by the same letter in the same column are not significantly different.

Table 2: Effects of treatments on number of days to first seedling emergence

Treatment	Mean
T1	23.33b
T2	23.33b
T3	35.33a
T4	20.00 b
T5	20.00 b
T6	30.00 a
L.S.D	6.70
CV	25.40

This confirms the role of these compounds in promoting subsequent growth of the seedlings it seems that other potassium compounds apart from KCL promote plant growth; the latter appears to be inhibiting growth of the plants most likely due to salinity it provides. Plant heights were also affected by the treatments and T1, T4, T2 were not significantly different from each other while T5, T3, T6 and T5 had taller plants than the rest of the treatments (Table 3). Leaf area was not affected consistently by the treatments (Table 4). T1 and T6 were significantly different with T6 having more leaf area than T1, T4, T2 and T3 were not significantly different from each other but was lower than T6. Leaf fresh weight was similarly affected by the treatments with T4, T5, T1 T2 and T3 (Table 5) being insignificantly different but had less weight than T6. Stem fresh (Table 9) weights were also affected by the treatments and T6 had significantly higher stem fresh weight than T1 which was significantly less than T3, T5, T2 and T4, the latter treatments were not significantly different from each other.

Table 3: Effects of treatments on plant height

Treatment	Mean
T1	4.28 c
T2	5.38 bc
T3	5.67 b
T4	4.93 bc
T5	6.07 ab
T6	7.25 a

Means followed by the same letter in the same column are not significantly different.

With respect to root length (Table 6) T6 was higher than T1 and was significantly different while T3, T4, T2 and T5 were not significantly different from each other. Root fresh weight (Table 7) was significantly higher in T6 than T1 while T1, T2, T4, T3, T5 were not significantly different in leaf dry weight (Table 8). T3 and T6 were not significantly different from each other but were significantly higher than the rest of the treatments. With respect to stem dry weight (Table 9) T6 had significantly

bigger values than T1 which was not significantly different from T3, T5, T2, T4 and T6. It would appear that the role of potassium salts in all the measured growth parameters above is to perform its physiological function of water uptake but KCL does not play this role because of the two much salinity it provides. The other K compounds such as KOH, K_2SO_4, and K_20 appear superior.

Table 4: Effects of treatments on leaf area

Treatment	Mean
T1	18.00 c
T2	26.16 bc
T3	30.00 b
T4	24.67 b
T5	29.16 b
T6	30.17 b
L.S.D	6.83 a
CV	25.24

Means followed by the same letter in the same column are not significantly different.

Table5: Effects of treatments on leaf fresh weight

Treatment	Mean
T1	0.22 b
T2	0.24 b
T3	0.25 b
T4	0.28 ab
T5	20.15 b
T6	23.83 a
L.S.D	0.02
CV	25.63

In contrast T6 had heavier root dry weights than T1 (Table 10) which was not significantly different from T2, T3, T5 and T4. Germination of papaya was increased by the potassium salts used in the present study because they increased water uptake needed by the germinating seed (Mengel and Kirby, 1987; Tisdale et al, 1985). The first seedling emergence was delayed by the potassium hydroxide and oxide solutions. This may have been attributed to the higher solution pH than optimum that hindered the metabolic processes to activate germination. The effects on the subsequent growth of the seedlings were most likely due to the effects potassium on increased water uptake and on other metabolic reactions.

Table 6: Effects of treatments on root length

Treatment	Mean
T1	14.90 c
T2	19.36 b
T3	18.95 b
T4	19.01 b
T5	20.15 b
T6	23.83 a
L.S.D	1.61
CV	14.37

Means followed by the same letter in the same column are not significantly different.

Table 7: Effects of treatments on root fresh weight

Treatment	Mean
T1	0.17 b
T2	0.20 ab
T3	0.22 ab
T4	0.20 ab
T5	0.27 ab
T6	0.28 a
L.S.D	0.10
CV	26.95

Means followed by the same letter in the same column are not significantly different.

Table 8: Effects of treatments on leaf dry weight

Treatment	Mean
T1	0.04 b
T2	0.03 c
T3	0.06 a
T4	0.02 c
T5	0.04 b
T6	0.06 a
L.S.D	0.01
CV	0.2

Means followed by the same letter in the same column are not significantly different.

Table 9: Effects of treatments on stem dry weight

Treatment	Mean
T1	0.01 a
T2	0.02 a
T3	0.02 a
T4	0.03 a
T5	0.02 a
T6	0.03 a

Means followed by the same letter in the same column are not significantly different.

Table 10: Effects of treatments on root dry weight

Treatment	Mean
T1	0.01 c
T2	0.023 bc
T3	0.03 abc
T4	0.04 ab
T5	0.04 ab
T6	0.04 a

Means followed by the same letter in the same column are not significantly different.

5 CONCLUSION

Priming papaya seed with potassium solutions generally improves the germination of washed papaya seeds and their subsequent growth. Potassium salts such as KOH, K_2O, and K_2SO_4 appear superior in this promotion.

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