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Effect of Sulfuric Acid Scarification followed by Organic Mulching for Papaya Seedling Growth and Development, in Pot Culture

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Abstract

A major obstacle to the development of papaya seeds is the aril, or sarcotesta, which is present in papaya and results in low and sluggish germination. Hence sulfuric acid was applied in order to evaluate its scarifying effect and materials like rice bran, wood chips and saw dust were used as organic mulching material for further facilitating the process of seed germination. The experiment was consisted of seven treatments and each treatment had 3 replications. The treatments were T_1 (sulphuric acid scarification for 1 min + Saw dust mulching), T_2 (sulphuric acid scarification for 1 min + Wood chips), T_3 (sulphuric acid scarification for 1 min + Rice bran mulching), T_4 (sulphuric acid scarification for 30 sec + Saw dust), T_5 (sulphuric acid scarification for 30 sec + Wood chips), T_6 (scarification for 30 sec + Rice bran) and T_7 control (water). Experiment was carried on completely randomized design. Total leaf count and their length, number of rootlets, plant height, length of roots, germination percentage and chlorophyll content were the parameters which were observed in periodic intervals of seedling growth. From the entire experiment it can be stated that, acid scarification and use of organic mulches proved good for the papaya seedling development. However, amongst the various treatments, sulphuric acid scarification for one minute with use of wood chips as an organic mulch material was best, documenting proper results for the different attributes.

Keywords: Acid, Mulch, Organic, Papaya, Seeds, Study

Introduction

The plant of papaya (*Carica papaya* L.), belongs to the family of Caricaceae, is indigenous to tropical parts of America and was brought to India from Malacca in the sixteenth century (Bhadarka Chandni *et al.*, 2022). This plant has minimal calories and plenty of nutrients due to its inherent mineral and vitamin content (Alara *et al*., 2020). The cosmetics and pharmaceutical industries make good use of the papaya plant's medical qualities. Throughout the last 50 years, the area in India dedicated to papaya farming and its yield increased at compound annual growth rates (CAGRs) of around 6.2 and 7.1%, respectively. At a CAGR of 6.8%, the papaya yield grew five times, between 7.7 tons per hectare in 1985 and reaching to 40.1 tons per hectare, during 2013 (Sharma *et al*., 2016). Adequate seed establishment and developing seedlings are the most crucial factors in effective generation of seedlings under papaya cultivation nursery techniques because of the rising demand for high-quality seeds of well-established varieties due to the globalization of papaya cultivation. Fertilization behavior of seeds is crucial for both agriculture and horticulture. The two most important crop growth phases that affect the ultimate yield are seed development and homogeneous growth position in the field (Li *et al*., 2022).

There are many ways to accelerate seed germination or to break dormancy and scarification is one such technique. Scarification methods for seeds have been modified and refined throughout time to become more effective and beneficial. Kimura and Islam (2012) stated that employment of heat, freeze-thaw, mechanical measures and use of acidic substances are important techniques for seed scarification. Mulching is also an important practice in horticulture which

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has shown tremendous benefits in assuring the well-being of a crop. Furthermore, organic mulching if is used then it is ecofriendly and has its own advantages over environment and soil which should be considered, as soil is viewed as a vital natural resource in natural farming (De, 2022). Thus, considering the importance scarification for breaking seed dormancy and mulching for soil moisture conservations, the present experiment was undertaken where acid scarification followed by organic mulching was employed to test and improve germination and vigour of papaya seedlings.

Materials and Methods

The research was conducted in pot cultivation from March to May of 2023 at the University of Calcutta's Department of Horticulture, Institute of Agricultural Science. To collect the seeds for the experiment, fresh, organic, mature papayas (*Carica papaya* L.) were bought from offline retailers. The removed seeds were then rinsed under running water and submerged in a water-filled container. After 1 hour, the seeds which get submerged down were taken for the study.

Seven treatments were used in the CRD (Completely Randomized Design) approach of conducting the study. The treatments were: Treatment 1 (T_1): sulfuric acid scarification for 1 min + saw dust mulching, Treatment 2 (T_2): sulfuric acid scarification for 1 min + wood chips mulching, Treatment 3 (T_3): sulfuric acid scarification for 1 min + rice bran mulching, Treatment 4 (T_4): sulfuric acid scarification for 30 sec + saw dust mulching, Treatment 5 (T_5): sulfuric acid scarification for 30 sec + wood chips mulching, Treatment 6 (T_6): sulfuric acid scarification for 30 sec + rice bran mulching, Treatment 7 (T_7): water (control). Every treatment was replicated three times. Precaution was taken that after applying sulfuric acid, immediately the seeds were washed properly. Thereafter the treated seeds were transferred in the pots which were filled with 33% cocopeat, 33% garden soil and 33% compost. Observations for parameters like germination percentage of seed (Bakhshandeh *et al*., 2017), number of leaves (Damalas *et al.*, 2019), length of leaves (Tania *et al.*, 2019), length of roots (Eisvand *et al.*, 2011), number of rootlets (Singh, 2017), and chlorophyll content (Latifa *et al*., 2019) were recorded at multiple intervals of seedling development. Online software was used to assist with the statistical assessment of the data (Sheoran *et al.*, 1998).

Results and Discussion

Total Number of Leaves

It had been revealed from the experiment results from 40 DAS (Table 1) that the highest quantity of leaves was 18.33 which was in T_3 (sulfuric acid scarification for 1 min + Rice bran) and the lowest count was for T_7 (control) with 16 leaves. Next leave counting was done on 50 DAS according to which the highest number of leave was 19.00 which was in T_2 (sulfuric acid scarification for 1 min + wood chips) followed by T_1 (sulfuric acid scarification for 1 min + saw dust), T_3 (sulfuric acid scarification for 1 min + Rice bran), T_4 (sulfuric acid scarification for 30 sec + saw dust), T_5 (sulfuric acid scarification for 30 sec + wood chips), T_6 (sulfuric acid scarification for 30 sec + rice bran) and T_7 control (water) which showed 18.67, 18.33, 17.33, 18.33, 17.33, 16.67 number of leaves, respectively. Last reading was recorded on 60 DAS, where the maximum number of leaves were observed in T_2 (apply H_2SO_4 for 1 min + wood chips) which was 22.33.

Table 1: Total number of leaves of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	17.33	18.67	18.34
T_2	18.00	19.00	22.33
T_3	18.33	18.33	19.67
T_4	16.67	17.33	18.67
T_5	17.33	18.33	21.67
T_6	16.67	17.33	18.33
T_7	16.00	16.67	19.33
CD at 5%	1.444	1.337	1.021
SEm ±	0.417	0.436	0.333

Length of Leaves

As usual the first reading (Table 2) was taken on 40 DAS which showed a highest leaf length of 7.40 cm in the treatment of T_1 (apply H_2SO_4 for 1 min + saw dust) and the lowest leaf length was 6.73 cm in T_4 (sulfuric acid scarification for 30 sec + saw dust). In the next observation on 50 DAS, the maximum leaf length was 9.60 cm in the treatment of T_5 (sulfuric acid scarification for 30 sec + wood chips) and lowest value was 8.03 for T_6 (sulfuric acid scarification for 30 sec + Rice bran). Next observation was taken in 60 DAS in which the greatest figure was seen for T_2 (sulfuric acid scarification for 1 min + wood chips) with 12.87 cm and lowest number for the said parameter was reported in T_3 (sulfuric acid scarification for 1 min + Rice bran) with 9.57 cm.

Table 2: Length of leaves (cm) of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	7.40	9.13	10.10
T_2	6.88	9.23	12.87
T_3	6.83	8.17	9.57
T_4	6.73	7.87	10.50
T_5	6.80	9.60	12.33
T_6	7.07	8.03	11.07
T_7	7.30	8.27	11.20
CD at 5%	N.S.	0.876	0.708
SEm ±	0.198	0286	0.231

Plant Height

It is noticeable from table 3 that the maximum value of this attribute was observed in T_2 (sulfuric acid scarification for 1 min + wood chips) on 40 DAS which was 18.77 cm and the

least data was obtained for T_7 control (water) which was 16.93 cm. Next observation was done on 50 DAS where the superior most plant height value was 20.80 cm in T_2 (sulfuric acid scarification for 1 min + wood chips) and the lowest value was 19.00 cm in T_7 control (water), however other treatments closely followed. The last observation was taken in 60 DAS where the plant height increased rapidly. The highest plant height was observed in T_2 (sulfuric acid scarification for 1 min + wood chips) which was 23.93 cm and the parameter value was observed in T_7 control (water) which was 22.53 cm. On 60 DAS other treatments *viz*., T_1 (sulfuric acid scarification for 1 min + saw dust), T_3 (sulfuric acid scarification for 1 min + Rice bran), T_4 (sulfuric acid scarification for 30 sec + saw dust), T_5 (sulfuric acid scarification for 30 sec + wood chips), T_6 (sulfuric acid scarification for 30 sec + rice bran) readings were 22.54, 22.57, 23.03, 23.73, 22.93, 22.53 respectively.

Table 3: Plant height (cm) of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	17.90	19.43	22.54
T_2	18.77	20.80	23.93
T_3	18.23	19.53	22.57
T_4	17.07	19.10	23.03
T_5	17.90	19.67	23.73
T_6	17.10	19.17	22.93
T_7	16.93	19.00	22.53
CD at 5%	0.519	1.087	0.590
SEm ±	0.170	0.355	0.193

Number of Rootlets

It is noticeable from table 4 that the maximum quantity of rootlets was observed in T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) on 40 DAS which was 18.67 and T_1 (sulfuric acid scarification for 1 min + saw dust mulching), T_2 (sulfuric acid scarification for 1 min + wood chips mulching), T_3 (sulfuric acid scarification for 1 min + Rice bran mulching), T_4 (sulfuric acid scarification for 30 sec + saw dust mulching), T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching), T_7 water (control) were seen with the data of 16.00, 18.00, 16.67, 17.00, 16.33, 17.33 respectively. Next observation was done on 50 DAS where the total amount of rootlets increased in comparison to initial day. The greatest value was 19.33 in T_2 (sulfuric acid scarification for 1 min + wood chips mulching) which was closely followed by T_4 (sulfuric acid scarification for 30 sec + saw dust mulching) and T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) both with 19.00 number of rootlets and the lowest number of rootlets observed in T_7 (control) which was 16.67. In the last observation of 60 DAS trend in increase number of rootlets continued and the highest number of rootlets observed in T_2 (sulfuric acid scarification for 1 min + wood chips mulching) with 20.67.

Table 4: Number of rootlets of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	16.00	17.33	18.00
T_2	18.00	19.33	20.67
T_3	16.67	18.33	17.33
T_4	17.00	19.00	18.33
T_5	18.67	19.00	20.33
T_6	16.33	17.33	18.00
T_7	17.33	16.67	18.67
CD at 5%	N.S	N.S	1.230
SEm ±	0.735	0.777	0.418

Length of Roots

From table 5 it is seen that the root length of maximum value of 13.70 cm was for T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) and lowest root length of 12.33 cm in T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching) on 40 DAS. In the next observation the maximum root length of 15.93 cm was observed for T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) and minimum root length of 14.30 cm in T_7 (control). Thereafter in last observation the maximum root length of 18.17 cm in T_2 (sulfuric acid scarification for 1 min + wood chips mulching) and T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) and minimum root length of 16.47 cm was recorded in T_1 (sulfuric acid scarification for 1 min + saw dust mulching).

Table 5: Length of roots (cm) of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	12.90	14.50	16.47
T_2	13.50	15.37	18.17
T_3	12.77	14.47	16.70
T_4	12.43	15.00	16.77
T_5	13.70	15.93	18.17
T_6	12.33	14.67	17.07
T_7	12.37	14.30	17.53
CD at 5%	0.474	0.591	0.535
SEm ±	0.155	0.193	0.175

Germination Percentage

In 40 DAS the highest germination percentage (Table 6) was 40.00% observed in T_2 (sulfuric acid scarification for 1 min + wood chips mulching) and T_3 (sulfuric acid scarification for 1 min + Rice bran mulching) both and the lowest was 20.00% observed in T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching). The following observation was made on 50 DAS, where the maximum germination percentage was 100.00% in T_3 (sulfuric acid scarification for 1 min + Rice bran mulching) and T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) both. The final observation

on germination percentage was done on 60 DAS where the highest germination percentage was 100.00% in T_2 (sulfuric acid scarification for 1 min + wood chips mulching) and T_5 (sulfuric acid scarification for 30 sec + wood chips mulching), however the lowest germination percentage was 60.00% in T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching).

Table 6: Germination percentage of papaya seedlings under different treatments and combinations

Treatment	40 DAS	50 DAS	60 DAS
T_1	33.3	66.67	66.67
T_2	40.0	53.33	100.00
T_3	40.0	100.00	66.67
T_4	20.0	66.67	73.33
T_5	33.3	100.00	100.00
T_6	20.0	73.33	60.00
T_7	33.3	73.33	80.00
CD at 5%	13.366	15.434	24.403
SEm ±	4.364	5.040	7.968

Total Chlorophyll Content

The highest total chlorophyll content (Figure 1) for 40 DAS was 3.24 mg ml^{-1} in T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching) while the lowest chlorophyll content was 3.12 in T_7 (control). Next the highest chlorophyll content for 50 DAS was measured as 3.34 mg ml^{-1} in T_6 (sulfuric acid scarification for 30 sec + Rice bran mulching) and the least chlorophyll content was measured on T_4 (sulfuric acid scarification for 30 sec + saw dust mulching). Lastly for 60 DAS maximum total chlorophyll content was measured 3.26 mg ml^{-1} in T_3 (sulfuric acid scarification for 30 sec + saw dust mulching) and T_5 (sulfuric acid scarification for 30 sec + wood chips mulching) showing the next best treatment with chlorophyll accumulation of 3.18 mg ml^{-1}. The lowest total chlorophyll content was 3.10 in T_4 (sulfuric acid scarification for 30 sec + saw dust mulching).

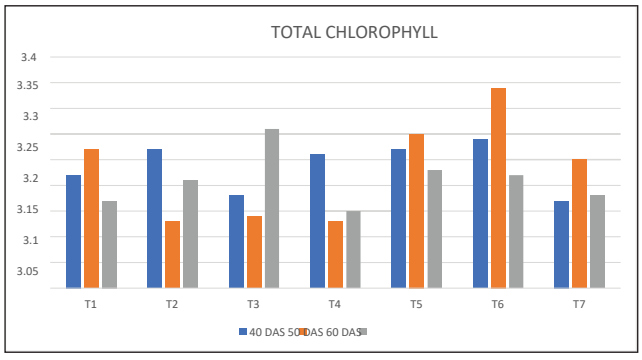

Figure 1: Total chlorophyll content (mg ml^{-1}) of papaya seedlings under different treatments and combinations

The results of this study demonstrate that scarification of seeds is a successful and effective strategy for promoting germination. In an earlier study carried out by Pipinis *et al*. (2011) on *Cercis siliquastrum* L. seeds, use of sulphuric acid as a chemical agent for scarification of seeds also found to be helpful in increasing the percentage of germination. Wood chips play a major role here as a mulching material and influenced the growth related parameters. A study conducted by Abragan and Hambre (2019) examined the effects of organic mulching on the growth performance of papaya crops (*Carica papaya* L.), using dry leaves as mulch. The results showed a similar pattern. In an another experiment, where organic mulching material was used on different cultivars of pea (*Pisum sativum* L.), for determining its effect on various yield related attributes, it was obtained that organic mulch materials significantly influenced the germination and plant length in a positive way (Sajid *et al*., 2013). Use of coco-peat and compost as an intergradient for the potting media also facilitated the germination and development process in the papaya seeds, as a similar type of media for the pot culture of papaya seedlings were used earlier in the experiments conducted by Roy and Das (2022) and Sarkar and Das (2021). Scarification had a noticeable impact on the overall height of the plants, the amount of rootlets, and the total length of the roots in papaya seedlings as well. The result shows the increase in seedling length. An analogous outcome was noted by Utami *et al*. (2021) in their investigation concerning the application of mechanical and chemical scarification to rouse sunan candlenut seed from dormancy, resulting in an increase in both rootlet length and number. We can also say that the combination of sulfuric acid as a chemical scarification agent and wood chips as organic mulching material shows a fruitful result in case of different parameters. A comparable outcome was noted in an experiment conducted by Rodríguez *et al.* (2013) to ascertain the effects of seed scarification by the use of sodium hydroxide.

Conclusion

Scarification of seeds by sulfuric acid can be employed to increase the germination rate. In the major observations the results came as such which was evident to justify the above statement. Therefore, based on the results of the complete experiment, it can be said that every therapy given to the seedling was safe to use during the entire trial. And among seven treatment scarifications with sulfuric acid for one minute and use of wood chips as an organic mulching material gives good response in terms of germination and growth.

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