International Journal of Agricultural Research and Food Production
ISSN: 2536-7331 (Print): 2536-734x (Online)
Volume 3, Number 1, March 2018
http://www.casirmediapublishing.com

Germination Potential and Seedling Establishment of Pigeon Pea (*Cajanus cajan*) as Influenced by Different Pre-treatment Techniques

Ekwugha Ugochi Eucharia
Department of Forestry and Wildlife Technology
Federal University of Technology, Owerri, Imo State
Email: uggold2005@yahoo.com

ABSTRACT

The research on germination potential and seedling establishment of pigeon pea (cajanus cajan) as influenced by different pre-treatment techniques was carried out to determine the best pre-germination treatment technology for pigeon pea seeds. The treatments were Hot Water, Cold water, Diluted Tetraoxo sulphate (vi) acid, and moderate scarification with sand paper. The seeds of pigeon pea were sown in poly bags filled with topsoil, poultry manure and fine river sand in the ratio of 1:2:3: respectively. The treatment were laid out in a Randomized Complete Block Design (RCBD) and replicated four times using poly bags giving a total of 36 bags for each germination medium respectively. Data were collected at 4,8,12 weeks after planting on the following parameters; germination count, plant height, stem girth, and number of leaves. All the data collected were analyzed using analysis of variance and mean separation carried out using least significant difference (LSD) at 5% level of probability. Results show that while treatment with tethraoxo sulphate (vi) inhibited germination of pigeon pea, scarification treatment at 8 WAP for 9min recorded 100% germination. Similarly, seeds scarified for 9mins at 4, 6 and 8 WAP recorded mean plant height of 19.07cm, 24.87cm and 30.00cm respectively. The results of stem girth and number of leaves per plant followed the same trend with scarification treatment recording the best stem girth and highest mean number of leaves. Hence, to attain higher percentage germination, reduced dormancy period, and better seedling establishment, the seeds of pigeon pea should be pre-treated with scarification or hot water soaking.

INTRODUCTION

Pigeon pea (*Cajanus cajan*), plant is a perennial shrub in the family of Fabaceae grown for its edible pods and seeds (Sheahan, 2012). It has slender stems, trifoliate leaves, usually highly branched with a woody base. The plant leaflets are oblong or elliptical in shape and the leaves are alternate and arranged spirally on the stems. The plant also produces yellow flowers, but they can be yellow with streaks of purple or red. The flowers are produced on recemes of 5 – 10 flowers. The seed pods are flat and either straight or sickle shaped and measure 5-9cm (2-3.5 in) in length. Each pod can contain between 2 to 9 seeds which can be white, cream, brown, yellow, purple or black or mottled with any combination of these colors. Pigeon pea can reach 0.5-4.0m (1.6-13.1ft) in height and is usually grown as an annual, harvested after one season. It may also be referred to as red gram or Congo pea and originates from India. (Sheahan,2012). Planting of pigeon pea is done using matured seeds.

Incorporating pigeon pea as a nitrogen fixing legume into the cropping systems has the potential to improve soil fertility and mitigate the nutrient mining impact of maize (Snapp and Silim, 2002; Bezner – Kerr *et al*., 2007). A number of studies revealed the benefits of pigeon pea for sol fertility its green manure can contribute N (and other recycled nutrients) by 20 – 90 kg/ha in small holder farming systems. (Zingore *et al*.,2003). In addition to providing much needed nitrogen, leguminous crops are high in protein making them valuable nutritionally. Pigeon pea provides a range of bi-products including leaves and stems used for folder and the dried stems for fuelwood (Simtowe et al., 2010). Despite these benefits, pigeon pea plants are hardly seen within the study area either as sole crop or crop combination in agroforestry.

In combination with cereals, pigeon pea makes a well-balanced human food. The dried peas are sprouted briefly and then cooked, for a flavor different from the green or dried peas. Sprouting also enhances the digestibility of dried pigeon peas via the reduction of indigestible sugars that would otherwise remain in the cooked dried peas (Heuze *et al*., 2017). Owing to the fact that seed phase is one of the most important stage in the life cycle of pigeon pea plant in terms of germination and seedling survival. Development of the most appropriate pre-germination treatment measures becomes necessary. According to (Malcolm *et al*., 2003) for successful seed germination of plants, the protoplasm must be saturated with water as water enhances the vital activity of the embryo, a suitable temperature which helps in rapid germination and Oxygen which is necessary for respiration of the matured seed. The success of seed germination of pigeon pea largely depends on the quality of its seed.

However, fear of success in the germination of seeds of pigeon pea may account for its absence in the study area, as the farmers within this area lack appropriate knowledge of the various techniques to achieve good seed pre-germination treatment. Therefore there is the need to carry out this research on different pre-germination treatment techniques especially on agro forestry species like pigeon pea amongst others. This will help in achieving an effective germination and seedling establishment of pigeon pea thereby boosting income generation and employment in agro forestry especially amongst the rural farmers.

MATERIALS AND METHODS

Study Area: This study was carried out in the Agro forestry garden of the Forestry and Wild life Technology Department of the Federal University of Technology Owerri (FUTO), located in the South-Eastern part of Nigeria. This is the major part of the Rain forest zone of the country made up of deciduous forests. The study area is situated between Latitude $5^0 10$ N and $6^0 0$ N and Longitude $6^0 35$ E and $7^0 0$ E within the South Eastern Rain Forest Agricultural zone of

Nigeria. The average annual rainfall, temperature and humidity are 2500mm, 27^{0}C and 75% respectively.

Field Studies: The seeds of pigeon pea were collected from mature plants of the perennial shrubs, planted at the research farm of the school of Agriculture and Agricultural Technology (SAAT) FUTO. The seed were extracted from the matured pod, two days after harvest and sun dried for two to four days to reduce the moisture content, hence healthy seeds were used for the experiment, the seeds were sown in poly bags (4am-6am) depth. The media used for sowing of seeds were top soil, coarse and fine river sands at the ratio of 1:2:3. There were four treatments in the experiment, i.e. immersion in the diluted H2S04 at (8%) concentration for intervals of 30, 60 and 90 minutes, immersion in the hot water at 20^{0}C, 40^{0}C and 60^{0}C for ten minutes, moderate (intensity) scarification with sand paper for 3, 6, and 9 minutes and immersion in cold water for intervals of 3, 6, and 9 hours respective. Two seeds of pigeon pea was sown in each poly bag with the poly bags kept in shade throughout the experiment, seeds of pigeon pea were sown at the depth of 0.5 – 1.5cm and were watered daily using watering can. Thirty six (36) poly bags were used for each treatment and the total number of poly bags used for the study was one hundred and forty four (144).

DATA ANALYSIS

A randomized complete Block design (RCBD) with four replicates were used for the experiment; which involved four treatments. Data that was collected for analysis includes:

- Germination count: - This was obtained by counting the number of seedlings that germinated at the 4th, 8th and 12th weeks after planting (WAP).
- Stem girth (cm): Was obtained by using measuring tap to measure round the stem of each of the seedlings at the 4th, 8th and 12th weeks after planting (WAP)
- Plant height (cm): This was obtained by taking measurement using a meter rule from the base of the soil to the terminal bud of the seedling at the 4th, 8th and 12th weeks after planting.

- Number of leaves per plant: This was measured quantitatively by counting the number of leaves that emerged at the 4th, 8th and 12th weeks after planting. The data collected were subjected to analysis of variance (ANOVA). The treatment means were separated using least significant difference (LSD) at 5% probability.

RESULTS AND DISCUSSION

Results of the study shows that at 14 days after (DAP) seeds soaked in Tetraoxo sulphate (vi) (H_2 $S0_4$) for 30 minutes recorded 8% germination while those soaked for 60min and 90min did not germinate at 14 DAP. Similarly at 16 DAP and 18 DAP only seeds treated with H_2 $S0_4$ at 30min showed 5% and 6% germination respectively. Table 1 Seeds treated with moderate scarification at 6mins gave recorded 33% germination at 14 DAP while seeds scarified at 3mins recorded the lowest germination percentage, (20%). At 16 DAP, seeds scarified for 9min recorded the highest (69%) percentage germination, but did not show significant difference ($p<0.05$) from the 47% germination recorded from the seeds scarified for 6min. At 18 DAP, seeds scarified for 9min recorded 100% germination which showed significant difference at (P 0.05) from the percentages (67% and 53%) recorded from the seeds scarified from 3min and 6min. Table 1. Results of this study have revealed that H_2S0_4 inhibited germination of the pigeon pea seeds. However, the observation was not similar with other treatments as hot water at various degree of boiling influenced germination of the pigeon pea seeds although the difference in germination as influenced by the degree of boiling was not significant. On the other hand, scarification treatment of the seeds for 9 mines was able to cause 100% germination of the seed at 8 WAP. The observation of poor germination as under the H_2SO_4 could be as a result of the acid causing injury to the seeds (Amusa, 2010) reported that seed treatment methods could inhibit the germination of viable seeds. While works done by (Owunbi *et al*., 2005), reported that Sulphuric acid (H_2SO_4) have shown success breaking seed dormancy and germination enhancement.

Table 1: Effect of pre-treatment on the germination of pigeon pea

		Germination Percentage (%)		
Treatment Sources	**Treatment Levels**	**14 DAP**	**16 DAP**	**18 DAP**
H_2SO_4	30min	8.00	5.00	6.00
	60min			
	90min			
LSD	-	-	-	-
	20^{oc}	20.0	23.0	40.0
Hot water	40^{oc}	0.0	40.0	53.0
	60^{oc}	0.0	27.0	53.0
LSD	-	18.0	37.0	40.0
	3min	20.0	53.0	67.0
Scarification	6min	33.0	47.0	53.0
	9min	27.0	67.0	100.0
LSD	-	29	49	29
	3hrs	53.0	67.0	7.0
Cold water	6hrs	67.0	47.0	0.0
	9hrs	53.0	67.0	0.0
LSD	-	59	37	11

At 4 WAP, seeds soaked in hot water of 40°C recorded mean height of 8.40cm, which showed significant difference ($p<0.05$) from the 6.20cm and 5.33cm plant heights recorded from the seeds soaked at 20°C and 60°C respectively. At 6 WAP, 12.07cm was the tallest plant height recorded from seeds soaked at 40°C and this did not show significant difference ($p<0.05$) from the 9.07cm recorded from seeds soaked at 60°C and 20°C respectively. Similarly, at 8 WAP, seeds soaked at 40°C recorded the tallest plant height of 17.07cm which was statistically at par with the plant heights recorded from seeds soaked at 20°C and 60°C (Table 2).

Seeds scarified for 9min recorded 19.07cm mean height at 4 WAP, which showed significant difference from the shortest plant with 7.13cm height recorded from the seeds scarified for 3min. at 6 WAP, seeds scarified for 9min also recorded mean heights of 24.87cm. This was significantly different ($p<0.05$) from the shortest plant height of 10.47cm recorded from plant scarified for 3min. At 8 WAP, the seeds scarified for 9min also recorded the tallest plants with mean heights of 30.00cm which showed significant difference ($p<0.05$) from the shortest plants with 13.33cm heights. (Table2).

Seeds soaked in cold water for 3hours recorded plant with mean heights of 12.33cm at 4 WAP which did not show significant difference ($p<0.05$) from the 9.67cm and 9.47cm plant heights recorded from the seeds soaked for 6 and 9 hours respectively. At 6 and 8 WAP, the seeds soaked in cold water for 3 hours recorded the tall plants with mean heights of 18.47cm and 22.13cm respectively; however, these did not show significant difference from the plant heights recorded from the seeds soaked for 6 and 9 hours (Table 2). Taller stands of pigeon pea were observed from seeds soaked in water boiled at 40 °C and seeds scarified for 9 mines. It was also observed that scarifying the seeds for several minutes influenced the seedling development of pigeon pea as much as soaking in varying degree of hot water did. The significant influence of scarification duration could be associated with the fact that scarification softens the seed coat. This hastens the process of hydrolysis which releases simple sugar that could be readily utilized in protein synthesis, thereby encouraging germination (Amusa, 2011).

Table 2: Effect of pre-treatment on the plant height of pigeon pea

Treatment sources	Treatment Levels	4 WAP	6 WAP	8 WAP
			Plant Height (cm)	
H_2SO_4	30 min	1.53	1.80	2.13
	60min	0.00	0.00	0.00
	90min	0.00	0.00	0.00
LSD	-	2.65	3.16	3.69
Hot water	20°C	6.20	9.07	11.67
	40°C	8.40	12.07	17.07
	60°C	5.53	8.47	11.13
LSD	-	3.79	5.29	7.68
	3min	7.13	10.47	13.33
	6min	9.53	12.73	17.40
	9min	19.07	24.87	30.00
LSD	-	7.35	10.09	12.69
	3hrs	12.33	18.47	22.13
Scarification	6min	9.53	12.73	17.40
(moderate intensity)	9min	19.07	24.87	30.00
LSD		7.35	10.09	12.69
	3 hrs	12.33	18.47	22.13
Cold Water	6 hrs	9.47	15.00	17.07
	9 hrs	9.67	14.93	18.47
LSD		8.64	13.09	16.12

WAP: Weeks after planting

Stem Girth

Soaking with hot water at 40 °C gave the stem girth of 0.30 cm at 4 WAP, but this did not show significant difference ($p<0.05$) from the smallest stem girth of 0.19 cm recorded from seeds soaked with 60 °C hot water. At 6 WAP, seed soaked at 40 °C recorded the stem girth of 0.53 cm which showed significant difference from the stem girth of 0.55 cm which was recorded from the 60 °C (Table 3).

Seeds scarified for 9 min recorded the stem girth of 0.73 cm at 4 WAP and this showed significant difference ($p<0.05$) from the 0.35 cm stem girth recorded from seeds scarified for 6 min. AT 6 WAP, the stem girth of 0.99 cm was also recorded from the seeds scarified for 9 min which showed significant difference ($p<0.05$) from the 0.39 cm which was recorded from seeds scarified for 3 min. Similarly, at 8 WAP, the largest stem girth of 1.34 cm was recorded from the seeds scarified for 9 min which showed significant difference ($p<0.05$) from the 0.57 cm which was recorded from seeds scarified for 3 min (Table 3). The significant difference observed in the Stem Girth of pigeon pea as influenced by scarification could also be attributed to the softening of the seed coat. The longer the duration of scarification, the softer the coat and this leads to faster development of the seedling (Owunbi *et al.,* 2015). Compared to seeds Soaked in cold and hot water, the scarified seeds showed significant influence at various stages of growth. These points to the efficacy of the scarification method for the treatment of pigeon pea seeds.

Table 3: Effect of pre-treatment on the plant height of pigeon pea

			Stem Girth (cm)	
Treatment sources	**Treatment Levels**	**4 WAP**	**6 WAP**	**8 WAP**
	30 min	0.05	0.07	0.09
H_2SO_4	60 min	0.00	0.00	0.00
	90 min	0.00	0.00	0.00
LSD	-	0.08	0.12	0.16
Hot water	20^{o}c	0.28	0.46	0.59
	40^{o}C	0.30	0.53	0.76
	60^{o}C	0.19	0.34	0.55
LSD		0.19	0.34	0.55
	3min	0.16	0.18	0.21
Scarification	6 min	0.35	0.51	0.67
	9 min	0.73	0.99	1.34
LSD		0.26	0.38	.051
	3 hrs	0.45	0.70	0.94
Cold Water	6 hrs	0.38	0.57	0.85
	9 hrs	0.37	0.51	0.79
LSD		0.26	0.42	0.61

Number of Leaves/Plant

Soaking seeds in hot water did not show significant difference ($p<0.05$) in number of leaves at 4 WAP among the levels of hot water used. But at 6 WAP, seeds soaked in hot water at 40 ^{0}C recorded mean number of leaves of 3.13 which showed significant difference ($p<0.05$) from the lowest number of leaves of 1.20 which was recorded from seeds soaked in hot water at 60 ^{0}C. AT 8 WAP, seeds soaked in hot water at 40 ^{0}C was also significantly different ($p<0.05$) from the lowest (2.27) mean number of leaves recorded number of leaves of 4.60 which was also recorded from seeds soaked with 60 ^{0}C hot water.

AT 4 WAP, seeds scarified for 9 min recorded mean number of leaves of 3.80 which showed significant difference ($p<0.05$) from the lowest (1.53) mean number of leaves recorded from seeds scarified for 6 min. At 6 WAP, the seeds scarified for 9 min also recorded the mean number of leaves of 5.33 which was significantly different from mean number of leaves (2.93 and 2.87) recorded from seeds scarified for 3 and 6 min respectively. At 8 WAP, 7.60 was the highest mean number of leaves recorded from the seeds scarified for 9 min. and it was significantly different from the lowest number of leaves of 4.27 which was recorded from seeds scarified for 3 and 6 min (Table 4).

Leaf production was observed to be significantly influenced by scarification at all stages of growth. This was not so in the Soaking treatments. Soaking with hot water showed significant influence on the leaf production as the plants advanced in stage while soaking in cold water have no observable influence on the leaf production of the plant. This observation further confirms the scarification method as best suited for the pre-treating of pigeon pea seeds as observed by earlier proponents of pre-seed treatment (Heuze *et al,* 2017; Simtowe *et al.,* 2010).

Table 4: Effect of pre-treatment on the leaf of pigeon pea

		Number of Leaves		
Treatment sources	**Treatment Levels**	**4 WAP**	**6 WAP**	**8 WAP**
	30 min	0.27	0.40	0.60
H_2SO_4	60 min	0.00	0.00	0.00
	90 min	0.00	0.00	0.00
LSD		0.46	0.69	1.04
Hot water	20°c	1.20	2.20	3.20
	40°C	1.60	3.13	4.60
	60°C	1.40	1.20	2.27
LSD		1.06	0.1.34	1.97
	3min	1.80	2.93	4.27
Scarification	6 min	1.53	2.87	4.27
	9 min	3.80	5.33	7.60
LSD		1.39	1.41	2.37
	3 hrs	2.73	4.20	5.80
Cold Water	6 hrs	1.87	3.53	5.07
	9 hrs	1.73	2.53	4.13
LSD		1.58	2.87	4.08

CONCLUSION

The nature and dimension of hard seed coat dormancy varies according to plants. However, Pre-germination treatments are needed to break physical dormancy caused by hard seed coat or pericarps. The result of the study therefore shows that although seeds of pigeon pea may germinate with or without pre-germination treatment. The results which recorded significant difference on scarification in all the parameters observed, suggests that for optimum germination, growth and development of pigeon pea, scarification method of pre germination treatments is most suited for pigeon pea.

REFERENCES

Amusa, T.O. (2011), Effects of three pre-treatment techniques on dormancy and germination of seeds of *Afzelia Africana* (sm. Expers). Journal of Horticulture and forestry. Vol. 3 (4). 96 -103).

Heuze, V., Thiollet, H., Tran, Delagards, R., Bstianelli, D and Lebas, F., (2017). Pigeon pea (*Cajanus cajan)* seeds. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO, pp 561-570.

Malcolm, P.J., Holford, P., Mc Glasson, W. B. and Newman, S. (2003). Temperature and Seed weight affect the germination peach root stock seeds and the growth of root stock *Scientia Horticuture.* 98(3): pp 247 – 256.

Nwoboshi, F.D. (1983). Seed dormancy as an obstacle to success of a nursery to obtain a possible number of seed. Pp. 56-67. Agroforestry System, 57, pp 199-211.

Owunbi, J.J. and Otegbey, G.O. (2004). Disappearing forest: A Review of the Challenges for Conservation of Genetic Resources and Environmental Management, Journal for Resources Management 1:1-11.

Simtowe, F.B., Shiferaw, M., Kassie, T., Abate, S., Silim, M and Siambi, G. (2010). Assessment of the current situation and future outlooks for the pigeon pea sub-sector in Malawi ICRISAT. Pp 45-52.

Snapp, S.S and Silim, S.N. (2002). Farmer preferences and legume intensification for low nutrient environments J.J. Adu-Gi (Ed.), Food Security in Nutrient-stressed Environments: Exploiting Plant's Genetic Capabilities, pp. 289-300.

Zingore, S., Mafongoya P., Nyamugafata, P and Giller, K. (2003). Nitrogen mineralization and maize yield following application of tree prunnings in sandy soil in Zimbabwe. *Agroforestry System,* 57, pp 199-211.