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Effect of Storage Container, Temperature and Period on Seed Germination of *Acacia nilotica* (L.)

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ABSTRACT

Acacia nilotica (L.) commonly known as babul is a multipurpose nitrogen fixing tree which provides timber, fuel, shade, food, fodder, dye and gum. Seed maturity indices were studied and seeds collected during 2^{nd} week of June (5^{th} collection) resulted maximum germination (85.2+0.46 %). At this stage, the colour of pod and seed was yellowish white and brownish black, respectively. In ordinary storage conditions, seeds get damaged due to insect pest attacks. Hence, a study was conducted to standardize the optimum seed storage conditions for getting maximum germination. The seeds were stored up to 600days in different containers at different temperatures viz. poly bag at room temperature 15-40^{0}C (B_1T_1), poly bag at BOD25^{0}C (B_1T_2), poly bag at refrigerator 5^{0}C (B_1T_3), paper bag at room temperature 15-40^{0}C (B_2T_1), paper bag at BOD 25^{0}C (B_2T_2), paper bag at refrigerator 5^{0}C (B_2T_3), cloth bag at room temperature 15-40^{0}C (B_3T_1), cloth bag at BOD 25^{0}C (B_3T_2) and cloth bag at refrigerator 5^{0}C (B_3T_3). The results revealed that seeds stored for 15 days in poly bag at refrigerator 5^{0}C(B_1T_3) recorded the maximum germination of 85.2 % and 81.12 % in laboratory and field conditions, respectively. The seed germination decreased with advancement of storage period in all the storage treatments. However, after 600 days of storage period, the maximum seed germination (59.1%) was recorded in B_1T_3in laboratory conditions. The seeds stored in poly bags as well as in cloth bags and stored in refrigerator gave maximum germination in laboratory and field conditions. Hence, it may be concluded that the seeds of A. nilotica can be stored either in poly bag or in cloth bag in refrigerator at 5^{0}C for long term storage to get maximum germination.

KEYWORDS

Acacia nilotica, maturity indices, germination, storage periods, temperature and container

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INTRODUCTION

Ac*acia nilotica* (L.) belongs to family Fabaceae, is medium-sized tree with spreading crown and feathery foliage. It is commonly called as babul or kikar and is found in tropical and subtropical countries. It's indigenous to the Indian Sub-continent, tropical Africa, Burma, Sri Lanka, Saudi Arabia, Egypt, and West and East Sudan. In India, natural babul forests are generally found in Maharashtra, Gujarat, Andhra Pradesh, Rajasthan, Haryana and Karnataka (Raj *et al*, 2015). It can grow on a diversified soils and climatic conditions, from the sea level to an altitude of 2000 m. It can tolerate high temperature ranging (>50 ^{0}C) and drought conditions, but adequate moisture is needed for its optimum growth. It can be grown as agro-forestry tree species in different landscapes. It is, also, used for reclamation of degraded, erosion prone mining areas and ravines like Chambal ravines in India Its leaves are uses as fodder, particularly in dry regions and constitute the chief diet for goat and sheep in semi and arid region in India. It's foliage and also the pods functions as vital source of nutrients during feed scarcity period. Its wood is suitable for timber, furniture and veneer. Its wood is also used for making charcoal of excellent quality, having calorific value 4800 - 4950 K-Cal/kg. It is a good source of gum known as 'Indian gum Arabic' which exudes during March-May and also having ethno-medicinal importance. Thus, it can be an important source of livelihoods, employment and foreign exchange earnings.

The pressure on our existing forests and agriculture fodder resources are constantly increasing with the ever-increasing human and cattle population (Kumar *et al*, 2014). This situation has reached at alarming proportion in several parts of the country and massive efforts are afoot to not only rehabilitate the degraded forests but also to bring more area under forest cover. Availability of mature and viable seeds may be a pre-requisite for raising the good quality of seedlings at massive scale. Germinability of seeds is strongly influenced by the stage of harvesting and maturity of seeds. The knowledge of stage and time of maturity of seeds are essential for collection of abundant quantity of healthy and vigorous seeds.

To raise large scale seedlings for plantations, a huge quantity of seeds is required and a full-grown tree of A. nilotica can produce 2000-3000 pods in very good fruiting season, each with usually between 8 and 16 seeds. Its seeds also exhibit seed dormancy because of the presence of hard seed coat. In ordinary storage conditions, its seeds get damaged due to insect pest attacks and effect the seed germination adversely.

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The information on effect of seed storage on germination of babul is scarce. Keeping in view, the importance of the A. nilotica, this present study was carried out to determine the effect of storage temperature, period and container on seed germination.

MATERIALS AND METHODS

To carry out the present investigation during 2017-18, the seeds were collected from Agra and adjoin areas viz., Mathura and Hathras. The study area (Western Uttar Pradesh) lies between 27^o 10′ N to 26^o '4 N' latitude and 78^o 02′ E to 79^{o}7′E longitude between elevation 165 and 179.8 m amsl.

To study the maturity indices the pods of Acacia nilotica were collected from all three sites at different periods i.e., 2nd week of April (D_1), 4th week of April (D_2), 2nd week of May (D_3), 4th week of May (D_4) and 2nd week of June (D_5). The seeds collected from different sites were mixed together as per the collection schedule and used for study.

Collected pods were placed in plastic bags and brought to the laboratory. Before the seed extraction and cleaning, pod parameters like length, width, moisture content (%), weight of 100 pods, number of pods per 100g were measure for each collection period. Moisture content (%) was determined on fresh weight and moisture content was calculated as:

$$Moisture\ Content\ (\%) = \frac{Fresh\ weight - Dry\ weight}{Fresh\ weight} \times 100$$

The pods were dried for 4-5 days and thereafter beaten with a stick and cleaned by winnowing to release seeds. After the process of seed extraction and cleaning, 3 replicates of 10 seeds were measured for seed length, width and size. The seeds were surface sterilized with 0.1 $HgCl_2$. Seeds were rinsed thoroughly to remove traces of mercuric chloride before putting for germination. For germination, 3 replicates of 100 seeds each were used. The germination was carried out in Petri dish at laboratory (room temperature) for each collection date. Germination was counted when visible radicle develops. Germination percent was calculated as follow:

$$Germination\ (\%)\ = \frac{No.\ of\ germinated\ seeds}{Total\ no.\ of\ seeds\ put\ in\ petridish} \times 100$$

Data recorded for different characters on different sites have been tested for their significance by using statistical technique of analysis of variance with Randomized block design (Chandel, 1998) .

The seeds were treated with Thiram 75 DS before putting the seed in different storage containers. The detail of the storage containers and temperatures are :poly bag at room temperature 15-40^{0}C (B_1T_1), poly bag at BOD (25^{0}C(B_1T_2), poly bag at refrigerator 5^{0}C (B_1T_3), paper bag at room temperature 15-40^{0}C (B_2T_1), paper bag at BOD 25^{0}C (B_2T_2), paper bag-refrigerator 5^{0}C (B_2T_3), cloth bag at room temperature 15-40^{0}C (B_3T_1), cloth bag at BOD 25^{0}C (B_3T_2) and cloth bag-refrigerator 5^{0}C (B_3T_3).

After 15 days of seed collection, they were tested to know the germination percent and thereafter the germination tests were conducted in lab and nursery condition at the interval of 60 days up to 600 days. For lab study, three (3)replications of 50 seeds each was used to study the germination in petri dishes. Germination percent was counted when visible radicle emerged. Under Nursery conditions, three replications of 100 seeds each from different treatments were sown in lines in nursery beds. After every 15 days of seed sowing observations was recorded and germination (%) was expressed and standard error was calculated as per the method given by Chandel (1998).

RESULTS AND DISCUSSION

The change in colour of pods and seeds are primary indicator of maturity. The results presented in Table 1 showed that the pod colour changed from the green colour (2nd week of April) to yellowish white (2nd week of June). Similarly, the seed colour changed from bright green to brownish black at maturity, shown in Table 2. The change in pod colour with the advancement of maturity was also reported by other researchers, also, in various tree species (Ramakrishnan *et al*, 1990) and (Bharathi *et al*, 1996).With the advancement of maturity, the moisture content in pods also decreased. During the first collection i.e. 2ndweek of April, moisture content was found maximum and thereafter it declined with the advancement of collection period. The average pod moisture content was 42.54 %, (Table 1). Similarly, the seed moisture content also declined with the advancement of maturity. Maximum seed moisture was observed in seeds collected during 2nd week of April. The lowest seed moisture content was found within the seeds collected during2nd week of June (Table 2). Loss of water during seed maturity is more inherent phase of seed development. The decline in seed moisture content during pod/seed development is usually attributed to the continued deposition of storage material in seeds. Change in colour and decrease in moisture content were also identified as maturity indicator by many researchers (Welbaun and Bardford, 1988) (Maideen *et al*, 1990) (Phartyal *et al*, 2002). The mean pod/fruit length and width were recorded 13.82 cm and 11.66 m (Table 1)

The data on seed germination (Table 2, Figure 1) revealed that the maximum germination 85.2 % was recorded in the seeds collected during the 2nd week of June. During this collection period, the pods and seeds were having yellowish white and brownish black, respectively. (Table 1 and Table 2) At this stage the seed moisture content was 21.4%, the size of seeds was 47.6 mm2, seed weight/ 100 seeds was 11.5 g. Pandit *et al* (2002) also found the similar observation in Populus ciliata, the drop in moisture content of capsules from 80% to 60% during maturation coincided with the maximum germination in seeds.

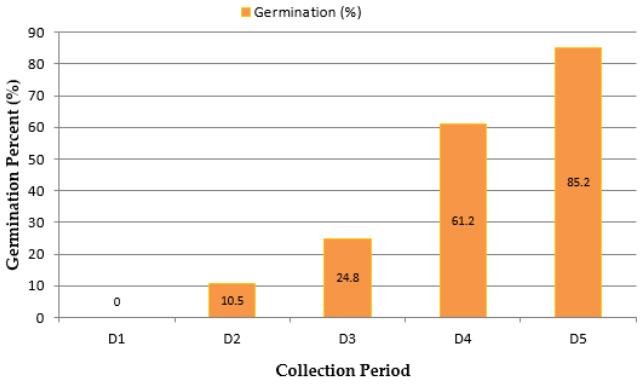

Fig. 1: Effect of collection periods on seed germination of *Acacia nilotica*

Seed germination under laboratory conditions

The data presented in Table 3, showed that maximum germination (85.2 %) in laboratory conditions was recorded when seeds were stored in poly bag at refrigerator 5^0C (B_1T_3) and sown after 15 days of collection. Although, the seeds stored in cloth bag at refrigerator 5^0C (B_3T_3) also registered 85.0 % germination which was at par with B_1T_3. The seeds were stored up to 600 days and germination tests were conducted at the interval of 60 days. The findings of those germination tests revealed that the germination percent declined with the advancement of storage period in all the treatments. After 300 days of storage in treatment B_1T_3, the germination decreased up to 69.4 % which further declined to 59.1 % after 600 days of storage, although the germination was found maximum in compared to other storage treatments.

Table 1: Physical parameters of pods of *Acacia nilotica* over the collection period from April to June

Day of collection	Week	Pod colour	Pod length (cm)	Pod width (mm)	Wt. of 100 pod (g)	No. of pod/100 gm	Pod moisture content (%)
D_1	$2^{nd}$of April	Green	12.3±0.59	6.0±0.30	620.3±1.3	16.74±0.2	52.3±0.34
D_2	$4^{th}$of April	Green	12.7±0.43	11.0±0.21	627.3±1.5	17.17±0.2	47.2±0.39
D_3	2^{nd} of May	Yellow green	13.9±0.43	13.0±0.54	595.9±1.0	16.9±1.0	42.3±0.42
D_4	$4^{th}$of April	Brown green side yellow	14.7±0.71	13.5±0.40	602.6±2.0	19.3±0.5	44.1±0.29
D_5	$2^{nd}$of June	Yellowish white	15.5±0.53	14.8±0.13	376.9±1.7	26.3±0.6	26.8±0.49
Mean			**13.82**	**11.66**	**564.6**	**19.3**	**42.54**

Table 2: Physical parameters of seeds of *Acacia nilotica* over the collection period from April to June

Day of collection	Week	Seed colour	Seed length (mm)	Seed width (mm)	Seed size (mm) ^{2}	No. of seed/ 100 g	Seed wt/100 seed(g)	Seed diameter (mm)	No. of seed/ pod	Seed moisture content (%)	Germination (%)
D_1	2^{nd} April	Bright green	6.3±0.15	5.3±0.21	33.5±1.59	294.2±0.76	32.4±0.56	2.5±0.3	11.3±0.3	42.2±0.66	0±0
D_2	4^{th} April	Bright green	6.5±0.17	5.4±0.22	34.5±1.88	344.3±1.47	27.8±0.36	2.6±0.3	11.7±0.2	40.8±0.37	10.5±0.30
D_3	2^{nd}May	Light yellowish green	6.6±0.31	5.5±0.17	38.5±1.33	398.2±2.20	29.4±0.97	3.3±0.3	12.5±0.2	45.2±0.18	24.8±0.78
D_4	4^{th}April	Greenish brown	6.7±0.26	5.7±0.15	41.2±1.22	295.5±2.19	31.95±1.22	3.4±0.2	11.7±0.3	42.1±0.22	61.2±0.56
D_5	2^{nd}June	Brownish black	7.7±0.21	6.0±0.15	47.6±1.51	875.5±2.27	11.5±0.02	3.5±0.2	11.8±0.4	21.4±0.31	85.2±0.46
Mean			**6.76**	**5.58**	**39.1**	**441.58**	**26.6**	**3.06**	**11.82**	**38.37**	**36.33**

Table 3: Germination of *Acacia nilotica* seeds under laboratory conditions

Storage days	Germination (%) in storage treatments								
	B_1T_1	B_1T_2	B_1T_3	B_2T_1	B_2T_2	B_2T_3	B_3T_1	B_3T_2	B_3T_3
15	77.0±1.76	80.2±2.53	85.2±0.97	81.0±2.12	78.0±5.6	83.00±0.76	74.0±1.76	81.0±1.22	85.0+1.96
60	75.3±0.44	75.4±2.15	84.2±1.56	79.6±0.08	74.6±0.60	80.4±0.76	72.0±2.33	77.4±3.50	83.0+1.56
120	73.7±2.05	71.2±0.31	81.6±1.10	77.2±2.57	72.6±1.72	77.6±1.03	70.4±1.15	73.6±1.04	78.4+1.91
180	71.6±1.21	69.0±0.80	77.4±1.55	76.0±1.72	71.8±1.04	76.2±1.13	69.1±0.90	70.8±1.15	76.2+2.12
240	68.0±2.27	69.1±1.94	73.4±2.19	70.0±1.15	68.4±1.13	74.1±0.84	68.1±0.42	69.0±0.36	72.3+2.18
300	65.0±0.79	66.2±1.11	69.5±1.06	66.0±0.97	67.0±0.87	72.5±1.80	66.2±1.86	68.1±2.02	71.5+2.02
360	60.0±1.01	62.5±0.87	67.0±1.33	61.2±0.60	60.0±1.22	68.2±1.17	63.4±2.51	68.3±2.90	69.0+0.98
420	57.0±0.61	60.2±1.75	64.5±1.04	58.8±1.13	59.2±1.33	64.5±1.39	62.0±0.97	67.0±1.56	68.0+0.93
480	55.0±0.72	58.0±1.17	62.0±1.23	57.2±1.83	58.2±0.42	60.2±0.87	59.0±0.29	64.2±2.18	65.0+1.04
540	47.0±0.90	53.0±0.93	59.1±2.18	55.4±2.27	56.0±1.70	57.2±0.79	55.2±0.64	62.4±1.65	61.0+1.04
600	38.0±2.15	48.0±2.86	59.1±0.7	48.0±1.33	51.0±2.06	54.0±0.87	54.0±0.29	58.0±1.69	59.0+1.39

B_1T_1- Poly bag at room temperature 15-40^{0}C, B_1T_2– Poly bag at BOD 25^{0}C, B_1T_3– Poly bag at refrigerator 5^{0}C, B_2T_1– Paper bag at room temperature 15-40^{0}C, B_2T_2– Paper bag at BOD 25^{0}C, B_2T_3-Paper bag at refrigerator 5^{0}C, B_3T_1- cloth bag at room temperature 15-40^{0}C, B_3T_2–Cloth bag at BOD 25^{0}C and B_3T_3-cloth bag at refrigerator 5^{0}C.

These results are in conformity with the findings of Sharma (1980) who reported the maximum germination in fresh seeds of Moringa oleifera. He also observed that with the progressive storage period, the germination percent declined considerably. Many researchers also got the same pattern of seed germination in different tree species like as in Azadirachta indica Singh *et al* (1997) and Grevia optiva (Nayal, 2000).

Table 4: Germination of *Acacia nilotica* seeds under nursery conditions

	Germination (%) in storage treatmentsGermination (%) in storage treatments								
Storage Day	B_1T_1	B_1T_2	B_1T_3	B_2T_1	B_2T_2	B_2T_3	B_3T_1	B_3T_2	B_3T_3
15	68.7±2.97	73.45±0.45	81.12±2.05	76.7±3.02	71.6±1.87	79.4±0.47	69.2±0.88	76.5±3.06	80.7±2.02
60	68.1±0.49	71.5±2.15	79.2±1.44	74.8±1.16	69.0±0.60	78.0±1.37	67.7±0.87	70.4±1.47	77.2±3.29
120	66.2±0.82	67.6±2.66	72.3±1.33	71.5±1.66	67.0±0.40	70.4±0.58	64.2±2.22	65.2±0.95	70.3±1.88
180	62.2±1.08	65.2±0.99	70.1±1.21	65.1±1.89	60.4±2.08	66.1±0.53	60.2±0.73	64.0±0.99	68.0±1.69
240	57.5±0.75	63.7±0.70	68.2±3.38	63.4±1.69	59.1±2.12	64.2±0.93	57.2±1.26	63.7±2.08	66.5±0.90
300	52.5±0.95	61.5±0.58	65.4±2.61	60.5±1.6	56.2±1.89	62.1±0.67	54.9±1.99	64.9±3.33	65.2±1.44
360	48.0±1.6	55.7±0.79	60.4±1.62	57.4±0.15	52.1±2.30	58.1±1.31	48.7±1.32	63.7±1.30	62.1±1.14
360	46.2±2.34	53.2±1.31	59.1±0.86	54.6±0.59	51.4±2.89	55.2±0.76	46.1±2.65	62.1±1.50	60.5±1.88
420	40.5±0.93	51.2±1.05	56.1±2.35	48.9±0.36	50.3±1.63	52.3±2.92	43.5±1.30	57.5±0.87	58.2±1.39
540	35.2±0.81	46.2±1.13	51.2±1.53	43.6±2.08	45.6±0.72	50.1±1.73	40.9±2.76	53.8±2.37	54.1±1.85
600	30.2±3.22	33.2±1.98	48.5±2.06	36.7±1.6	38.5±1.60	45.2±0.7	37.8±1.19	42.3±2.5	48.0±1.02

B_1T_1- Poly bag at roomtemperature 15-40^{0}C, B_1T_2– Poly bag at BOD 25^{0}C,B_1T_3– Poly bag at refrigerator 5^{0}C, B_2T_1–Paper bag at room temperature 15-40^0 C, B_2T_2–Paper bag at BOD 25^{0}C, B_2T_3-Paper bag atrefrigerator 5^0 C, B_3T_1- cloth bag at roomtemperature 15-40^0 C, B_3T_2–Cloth bag at BOD 25^{0}Cand B_3T_3-cloth bag at refrigerator 5^0 C.

Seed germination under nursery conditions

Almost similar trend of seed germination was recorded when seeds stored in different containers and temperatures were sown within the nursery condition (Table 4). The maximum germination (81.12 %) was recorded when seeds were sown after 15 days of harvesting in nursery conditions (B_1T_3). The seeds stored in cloth bag at refrigerator 5^0C (B_3T_3) shown almost equal (80.7 %) germination within the same treatment (Table 4).The decline in germination percent with advancement of storage period was also recorded in nursery condition, but the lesser germination was recorded in nursery as compared to laboratory conditions.

After 300 days of storage period, only 65.4 % of seed germinated which further declined to 48.5% after 600 days of storage period in B_1T_3 treatment.The seed stored in cloth bag at refrigerator 5^0C (B_3T_3) also gave almost same germination (48.0 %) after 600 days storage period. (Table 4). Almost similar findings were reported by Abdelgabar (2014) in Acacia Senegal & Acacia mellifera, and Sharma and Agrawal (2002) in Albizia lebbek and Aswathanarayan *et al* (1996) in Prosopis juliflora, Dalbergia sissoo, and Casuriana equisetifolia.

CONCLUSION

The present study revealed that the seeds of Acacia nilotica registered maximum germination when collected during 2^{nd} week of June. The fresh seeds also registered highest germination i.e. after 15 days of storage period. Although, the seed germination declined with the advancement of storage period, but better germination was recorded when seeds were stored either in poly bag or cloth bag in refrigerator at 5^0C. Hence, seed collection may be done in the 2^{nd} week of June, and poly bag or cloth bag may be used for long term seed storage of Acacia nilotica seed at 5^0C temperature.

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