Short Communication

Effect of storage containers on germination, seedling growth and morphological parameters of satawar (Asparagus racemosus) seed

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Key words: *Asparagus racemosus*, seed germination, storage container, seedling vigour, morphological character

Asparagus racemosus can be propagated through seed as well as crowns (roots), but propagation through crowns is not recommended as roots are the economic part. Propagation through seeds is also advantageous over the crown in many ways. Seeds have longer shelf life and are less bulky, easy to handle and less expensive. If sowing is delayed one or another reason, crowns need large safe storage facility. Apart of that, considerable time, labour and equipment are required to dig, sort and transport the crowns. Also, there is little no chance to carry *Fusarium* disease from one field to another in case of propagation through seeds. (Garg and Chandra, 2005). Hexamer (1918) mentioned in his book that the maintenance of seed quality is far more important than the time for sowing. During storage, the conditions to which seed is exposed determine the longevity of the seed. The environmental conditions especially temperature and relative humidity are crucial factors in determining the viability of a seed lot. Out of these, the latter can be controlled by choosing proper storage container. Proper storage of seed is an important sequel to the production of seed. It is of no use to produce good quality seed if it becomes worthless prior to planting. Therefore, the purpose of good storage is to preserve high germination and vigour of seed from harvest to next planting season. Proper storage environment would slow down the ageing process and enhance the longevity of seeds. Fresh seeds of satawar may be recognized by its glossy black colour and uniform smooth surface, while old seed has a smutty gray colour and its surface is generally rough and wrinkled. Therefore, the present study was carried out to find suitable storage container for maintaining seed quality of Asparagus racemosus seed during storage.

Seeds of satawar (*Asparagus racemosus*) were collected from Medicinal and Aromatic Plants Research and Development Centre, Haldi (Pantnagar). It was the produce of February-March 2009. Seeds were cleaned manually and dried under the sunlight until the moisture content was reached at 10.2 %. Rough and wrinkled seeds were discarded and seeds with glossy black colour and uniform smooth surface (both spherical and hemispherical shaped) were used for observations. Storage studies were carried out with three months old seeds. After performing initial germination test in the month of June 2009, seeds were stored at 10.2% moisture content in two containers viz., cloth bag (vapour pervious) and 250-gauge polyethylene bag (vapour impervious) under ambient storage conditions from June to December,2009. Seed physical parameters like seed index, seed volume and bulk density were recorded twice, first prior to storage and second at the end of storage. Seed weight was recorded using triplicates of 100 seeds to work out seed index (g). After weighing, 100 seeds (each in three replicates) were immersed in 100 ml volumetric flask filled up to 100 ml mark. The increase in volume (ml) of water was measured with the help of 5 ml pipette after shaking well to remove air adhered to seeds. This increase in volume was taken as seed volume (ml/100 seeds). Bulk density (g/cc) was worked out by the following formula as given by Cresswell and Hamilton, 2002).

Bulk density (g/cc) = Weight of 100 seeds (g) / volume of 100 seeds (ml).

During storage, moisture content and germination test was performed bimonthly up to December, 2009. For calculating moisture content, five grams of ground and sieved (passed through 120 mesh screen) seed sample was weighed from each container in three replications and oven dried at 80±20C until constant weight was obtained. The moisture content was calculated in percentage on fresh weight basis by the formula given below:

$$\text{Moisture content (\%)} = \frac{FW - DW}{FW} \times 100$$

Where, FW is weight of ground seed material before drying and DW is oven dry weight of seed material. Germination test was carried out by using 'top of the paper' method. For this, 50 seeds in each replication were treated with thiram (tetramethyl thiram disulphide) @ 2.5 g/kg seed and placed on top of two moist filter papers, enclosed in transparent Petri dish (15 cm diameter). Daily

germination counts were made of seeds with visible radical protrusion (~1mm) through the seed coat. At the end of test period (final count), seedlings were evaluated as per standard given for *Asparagus officinalis* L. in Indian Minimum Seed Certification Standards (2013). Samples were evaluated on the basis of the classification of seedlings described by Agrawal (1996) and categorised in three categories (normal seedlings, abnormal seedlings and un-germinated seedlings). On the basis of daily counts and seedling evaluations various parameters were calculated. Per cent germination was calculated at the end of test period on the basis of normal seedlings by the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedings}}{\text{Sum of normal and abnormal seedlings and ungerminated seeds}} \times 100$$

After incubation, the day on which the first germinated seed was observed, was recorded as 'days taken to germination initiation (TI)', days taken to 50% germination (T50) was calculated at the end of test period according to the formula as used by Dezfuli *et al*. (2008).

$$T_{50} = ti + \frac{\left\{\left(\frac{N}{2}\right) - ni\right\}(ti - tj)}{(ni - nj)}$$

Where, N is final number of germinated seeds. ni and nj are cumulative number of seeds germinated by adjacent counts at times ti and tj, when $ni < (0.5 \times N) < nj$. Mean germination time (MGT) was calculated by the formula suggested by Bonner (1983) and speed of germination (SG) was computed by the formula suggested by Gupta (1993). The formula proposed by Djavanshir and Pourbeik (1976) was used for calculating Germination Value (GV). Seeding vigour parameters were calculated as per formula given by Abdul Baki and Anderson (1973). The experiments were executed using completely randomized design (CRD) with four replications. Comparison between two treatment means was made by using critical difference (CD) where 'F' test was significant (Cochron and Cox, 1959).

Effect of storage containers on seed moisture and germination

Present study revealed that seed moisture content increased with the advancement of storage but the increase was relatively lower in seed stored in polyethylene bag than that stored in cloth bag (Fig.1a). At the end of two months of storage (August, 2009) seeds stored in cloth bag and polyethylene bag recorded moisture content of 10.76% and 10.27%, respectively, which were at par with each other (Fig1a).After four months of storage, in the month of October also, seed stored in cloth bag (11.90%) showed an increase in moisture content whereas those stored in polyethylene bag (10.22%) exhibited marginal decline compared to that of August. The difference in seed moisture content between two storage containers was significant. Further increase in storage by two months caused an increase in seed moisture content in both containers. But relative increase in seed moisture content of cloth bag (12.23%) was more than polyethylene bag (10.97%) leading to significant differences in seed moisture content.

Seed germination of satawar seed declined during advancement of storage period but germination of seed stored in polyethylene bag remained almost static throughout study, whereas in case of cloth bag there was very sharp decline in germinability between August to October (Fig.1b). The fast loss of germinability in cloth bag stored seed may be due to high seed moisture content in the seeds stored in cloth bag because during the rainy season high relative humidity of the atmosphere might have resulted in high equilibrium seed moisture content in the seed stored in cloth bag compared to polyethylene bag. It is also evident from seed moisture content recorded at different storage periods wherein cloth bag stored seed showed significantly higher moisture content than seed stored in polyethylene bag (Fig. 1a).The moisture permeable container like cloth bag allows movement of water vapour between seed and atmosphere and it may be in both the direction i.e. from seed to atmosphere and from atmosphere to seed. On the other hand, moisture vapour impervious containers (like

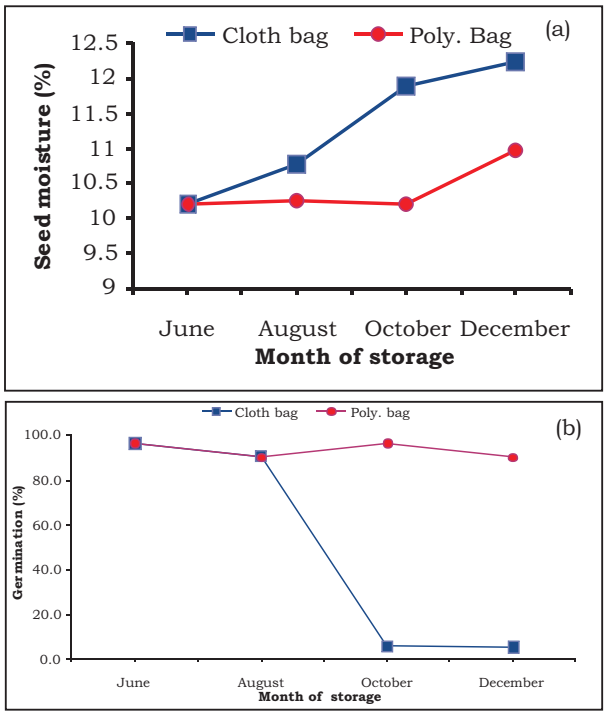

Fig.1: Effect of storage container on seed moisture content (a) and germination percentage (b) of of Asparagus racemosus during storage

polyethylene bag) inhibit the exchange of water vapour between atmosphere and seed. High temperature prevailing in the month of July and August coupled with high seed moisture content in seeds stored in cloth bag might have further accelerated the process of seed deterioration In the month of June, 2009, the germination percentage of seed lot was 96.5%. After two months of storage, germination decreased to 90.3% and 90.0% in seeds stored in cloth bag and polyethylene bag, respectively. Both the containers did not differ significantly from one another for germination percentage. Germination percentage drastically reduced to 6.0% in seeds stored in cloth bag, after four months of storage. The fast decrease in per cent germination in cloth bag stored seeds may be due to high seed moisture content in the seeds stored in cloth bag than polethylene bag. This was significantly lower than the germination recorded by seed stored in polyethylene bag (96.3%). Seed stored in polyethylene bag maintained the germination of 90.0% up to six months of storage, whereas the seeds stored in cloth bag, germination dropped down to 5.5% in the same period. The difference in germination per cent between two containers was significant after four and six months of storage period. Maintenance of higher seed germination and viability by storing the seeds in moisture impervious storage containers has also been reported by Ghimire (2003) in case of onion and okra seeds, Ankaiah *et al*. (2004) in case of sunflower, Vadivelu *et al*. (1985) in *Cicer arientinum* and Rahman (2008) in groundnut. All of them attributed this effect to the fact that the relative humidity has effect on moisture vapour of the packaging materials and thereby promotes deterioration of seeds in containers which are not moisture proof. This is also true with the present study.

Effect of storage containers on seedling vigour parameters

Seeds stored in both the containers (cloth bag and polyethylene bag) initiated germination on the same day i.e. six days after incubation at the end of two months of storage. Time taken to 50 per cent emergence (T50) was significantly lower in seeds stored in cloth bag than that of polyethylene bag (Table 1). The differences in all the vigour parameters except T50were non-significant due to storage container in the month of August (Table 1), indicating similar growth pattern of the seedling under both the storage containers. Further advancement in storage period caused such a drastic reduction in number of germinable seed that even ten seedlings were not available for recording observations on seedling length, dry matter and vigour parameters. Therefore, effect of storage period on seedling growth can not be explained in this study, but it is certain that the reduction in seed viability caused by prolonged storage in cloth bag was due to seed death because there was very high number of un-germinated decayed seeds in the samples. It is, therefore, evident that the longevity of seed is very low and the effect is through seed death not due to abnormality in seedlings. Root length, shoot length, seedling length, root dry weight, shoot dry weight and seedling dry weight recorded a decrease in their value after two months storage as compared to initial values. But non-significant differences were observed due to storage container after two months of storage for all the above mentioned growth attributes.

Effect of storage containers on morphological characters of seed

The data on seed index, seed volume (ml/100 seeds) and bulk density (BD) are presented in Table 2. Initially seed lot showed seed index (100 seed weight) of 3.46 g, seed volume (ml/100 seeds) of 2.47 ml and bulk density of 1.40 g/cc. After thirteen months of storage, seed index values were 3.31 g and 3.33 g in cloth bag and polythene bag stored seeds respectively, whereas the differences in seed index were not significant. Contrary to this, there was a significant reduction in seed volume over a period of thirteen month storage, but both the storage containers had similar seed volume. The reduction in seed volume due to one year storage might be due to the shrinkage of seed caused by loss of stored food material in the process of seed respiration. It is corroborated by seed index values in which reduction was more (4.33%) in cloth bag where rate of respiration might have been high due to higher seed moisture content compared to polyethylene bag stored seed which showed 3.76% reduction in their seed index (Table 2). There was increase in bulk density during

Table 1: Seedling vigour and growth of *Asparagus racemosus* Willd. as affected by storage containers

Treatment	T_{50} (days)	SG	GV	Seedling length (cm)	Seedling dry wt. (mg)	SVI-I	SVI-II
June, 2009(Initial)	10.06	4.81	440	10.24	7.80	988	752
August, 2009							
Cloth bag	7.94	5.89	500	7.90	6.03	711	543
Polythene bag	8.52	5.59	488	7.40	5.55	665	499
S.Em.±	0.09	0.12	13	0.30	0.20	26	18
CD (5%)	0.28	NS	NS	NS	NS	NS	NS
CV (%)	3.20	5.74	7	10.96	9.90	11	10

† Values in parenthesis are original germination (%). T_{50} =days to 50% germination. SG = speed of germination.
GV = germination value. SVI-I = seedling vigour index on length basis. SVI-II = seedling vigour index on dry wt. basis.

Table 2: Changes in morphological characters of Asparagus racemosus Willd.seed during storage

Period	Treatment	Seed index (g)	Seed volume (ml/100 seeds)	BD (g/cc)
March, 2009	Initial	3.46	2.47	1.40
April, 2010	Cloth bag	3.31	2.17	1.52
April, 2010	Polyethylene Bag	3.33	2.15	1.55
S.Em.±		0.05	0.05	0.04
CD (5%)		NS	0.16	NS
CV (%)		2.69	3.64	5.15

thirteen month storage in both cloth and polyethylene bags, which might be attributed to reduced seed volume during the same period. Verma and Kasera (2008) reported comparable values for seed index (3.611±0.015 g) volume (2.723±0.030 cc) and density (1.326±0.012 g/cc) of *Asparagus racemosus* seed.

From the above discussion, we may conclude that it is better to store the seed of *Asparagus racemosus* in polyethylene bag to maintain seed germinability up to next planting season instead of cloth bag as the rate of moisture absorbance was higher in cloth bag than polythene bag.

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Received: December 17, 2013
Accepted: December 14, 2015