Seed Deterioration Pattern of Some China Aster During Storage

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China aster [Callistephus chinensis (Linn.) Ness] belongs to the family Asteraceae, is an important commercial ornamental annual grown in many parts of the world for cut flower, loose flower, bedding plant. The objective of this study was to evaluate the trend in seed deterioration of China aster during storage. The experiments were conducted during 2017-18 in the Seed Testing laboratory, BCKV, Mohanpur, Nadia, West Bengal, India. Seven China aster varieties were stored in different storage conditions like Freeze condition (T₁), Aluminum foil (T₂), Polythene packet (T₃), Earthen pot (T₄), Cloth bag (T₅) and Brown paper (T₆). Deterioration pattern were observed by checking germination percentage and vigour index change at just after harvesting and every two months interval up to eight months of storage that means the next growing season. Freeze condition is proved to be the best than the other conditions as germination percentage (71.83, 66.93, 63.77 and 61.10, respectively) and vigour index (465.28, 433.88, 414.43 and 450.86 respectively) recorded highest at two months, four months, six months and eight months after storage. So, the Freeze condition can be recommended for storing seeds of China aster with maintenance of better seed quality storage.

Keywords
China aster, storage, container and deterioration.

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Abstract

Introduction

From the dawn of civilization flowers are very much interrelated with mankind. India has a long tradition of floriculture. China aster is one of the most important flower crops throughout the world as well as in India also. China aster is ranked third next only to chrysanthemum and marigold. It is native to China and it was introduced from China into France by a missionary in the 18th century (Desai, 1967). The present day China asters have been developed from a single form of wild species, Callistephus chinensis. The genus Callistephus is derived from two Greek words Kalistos meaning ‘most beautiful’ and
Stephus, ‘a crown’ referring to the flower head. It belongs to the largest families of flowering plants, ‘Asteraceae’. It is an erect, hispid, hairy and branched annual with ovate or triangular ovate leaves spirally attached to the stems (Cockshull, 1985). It is a long day plant (Hughes and Cockshull, 1969) and suitable for intercropping with fruit crops. It is widely cultivated due to its wide spectrum of attractive colours and comparatively longer vase life (Chaitra and Patil, 2007).

It is commercially cultivated in India, France, Germany, Netherlands, U.K., Siberia, Russia, Japan, North America, Switzerland and Europe. In India, it is largely grown on commercial scale in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. Now a day the demand for cut flowers of China aster is increasing every year and for that adaptation of genotypes to varying soil and climatic conditions is important for harnessing the best out of it in a particular area (Mahato et al., 2017).

Evaluation of genotypes, thus, gives an idea for its potential utilization by the growers. In China aster, sufficient numbers of genotypes are under cultivation but their performance related to seed yield varies based on changing agro climatic condition of the growing locations (Chakraborty et al., 2019). The quality of cut flowers as well as seed is primarily a varietal trait and is generally influenced by climatic conditions prevailed during the growing period at a particular place (Singh Rai and Chaudhary, 2016).

It is very essential to study the performance of varieties mainly in relation to seed production and their storability at a particular place (Kumari et al., 2016 and Tejashwi, et al., 2014). The objective of study was to evaluate the seed deterioration pattern of China aster during storage in the gangetic new alluvial zone of West Bengal, India.

Materials and Methods

Seeds of the seven varieties of China aster (Callistephus chinensis) viz, Arka Aadya (V1), Arka Archana (V2), Arka Kamini (V3), Arka Poornima (V4), Local White (V5), Local Pink (V6), Ranaghat 1 (V7) were raised in individual plots with three replications. Just after harvesting, the laboratory experiment was done in seed testing laboratory, BCKV, West Bengal during 2017-18.

Harvested seeds were dried and stored in 6% moisture content in six different conditions namely Freeze condition (T1), Aluminium foil (T2), Polythene packet (T3), Earthen pot (T4), Cloth bag (T5), Brown paper (T6). The different seed quality parameters such as root length shoot length, seedling length, seedling dry weight and fresh weight, germination percentage and vigour index were recorded after harvesting and every two months interval upto eight months storage that means next growing season (Kumari et al., 2017).

Germination test was carried out using germination papers by between papers (BP) method (ISTA, 1985) and calculated as Germination (%) = No. of normal seedlings germinated × 100 / Total no. of seeds placed for germination. Vigour Index was also calculated after Abdul-Baki and Anderson (1973) as: Vigour index = Germination (%) × root and shoot length (cm).

Results and Discussion

At just after harvesting of different genotypes root length ranged from 3.72 cm to 5.28 cm. Longest root length was found in V5 (5.28cm) and shortest in V4 (3.72cm). Root length varied significantly among the genotypes. Shoot length ranged from 1.76cm to 2.40 cm. Highest shoot length was recorded in V6 (2.40cm) and lowest in V1 (1.76cm). Shoot length varied significantly among the
genotypes. In case of fresh weight, it ranged from 0.83g to 0.99g. Maximum fresh weight was found in V1 (0.99g) and minimum was found in V6 (0.83 g). Fresh weight significantly varied among the genotypes. Among the genotypes dry weight ranged from 0.07g to 0.13g. In case of dry weight maximum was found in V4 (0.13g) and minimum in V2 and V6 (0.07g). Dry weight varied significantly among the genotypes. Germination percentage ranged from 81.77 to 94.40.

With regards to germination percentage highest was found in V6 (94.40) and lowest in V5 (81.77). Non-significant variation among the genotypes was noted for germination percentage at just after harvest or before storage. Among the genotypes vigour index ranged from 485.24 to 662.37. Highest vigour index was determined in V6 (662.37) whereas lowest was determined in V3 (485.24). Genotypes are not significantly varied among themselves for vigour index. Test weight was from 1.66g to 1.82g. Maximum test weight was found in V3 (1.82g) and minimum was found in V4 (1.66g). Test weight significantly varied among the genotypes. Similar type of experiment was also done by Moharana et al., 2017.

So, according to storability Local Pink (V6) is the best as it shows the high vigour index and germination percentage than other genotypes. After two months of storage, root length varied between 4.40 cm and 4.42 cm. Highest root length was recorded after T4 and T6 (4.42cm) and lowest was found for T2 and T5 (4.40cm). Root length significantly varied among the treatments over genotype. Among the treatments over Genotypes, shoot length varied from 2.06 cm to 2.08 cm. Maximum shoot length was found for T1 and T4 (2.08 cm) and minimum shoot was found in T2 (2.06 cm). Shoot length also varied significantly among the treatments. Seedling fresh weight ranged from 0.89g to 0.90g. But, the treatments over genotypes vary significantly among themselves for this parameter. Dry weight ranged from 0.09 g to 0.10 g. Dry weight of seedling also varied significantly among the treatments over genotypes. Germination percentage varied from 68.29 to 71.83. The germination percentage was found as maximum (71.83) for T1 and minimum was recorded for T6 (68.29).

It showed significant variation within the treatments over genotypes for germination percentage. The range of vigour index was 441.98 to 465.28. Vigour index was found maximum for T1 (465.28) and minimum value was for T6 (441.98). Treatment over genotype showed non-significant variation for vigour index. At two months after storage T1 (freeze condition) treatment over genotypes showed the highest germination and vigour index than other treatments over genotypes. So, at two months after storage T1 (freeze condition) treatment over genotypes i.e., freeze condition was best.

After four months storage, root length varied between 4.39 cm and 4.41 cm. Highest root length was recorded in T3 and T4 (4.41cm) and minimum was found in T2 (4.39cm). Root length significantly varied among the treatments over genotypes. Shoot length ranged from 2.05 cm to 2.09 cm. Maximum shoot length was found in T6 (2.09 cm) and minimum shoot was found in T2 (2.05 cm). Shoot length also varied significantly among the treatments over genotypes. Seedling fresh weight were same for all treatments i.e. 0.89.

The treatments varied significantly among the treatments over genotypes. Dry weight ranged from 0.09 g to 0.10. Dry weight of seedling also varied significantly among the treatments over genotypes. Germination percentage varied from 52.17 to 66.93. Germination
percentage was found maximum as 66.93 in T₁ and minimum was recorded in T₆ (52.17). It showed significant variation among the treatments over genotypes. The range of vigour index was from 338.17 to 433.88. Vigour index was found maximum in T₁ (433.88) and minimum in T₆ (338.17). Non-significant variation was found among the treatments over genotypes for vigour index.

At four months after storage, T₁ (freeze condition) treatment over genotypes showed the highest germination and vigour index than other treatments. So, at four months after storage T₁ (freeze condition) treatment over genotypes i.e., freeze condition is best. Treatments over genotypes of root length varied between 4.39 cm and 4.42 cm. Highest root length was recorded in T₅ (4.42 cm) whereas minimum in T₃ (4.39 cm).

Root length significantly varied among the treatments over genotypes. Treatments over genotypes, shoot length ranged from 2.06 cm to 2.10 cm. Highest shoot length was found in T₁ (2.10 cm) and lowest in T₆ (2.06 cm). Shoot length also varied significantly among the treatments over genotypes. Seedling fresh weight ranged from 0.89 g to 0.90 g. The treatments over genotypes vary significantly among themselves for fresh weight. Dry weight ranged from 0.09 g to 0.10 g. Dry weight of seedling also varied significantly among the treatments over genotypes.

Germination percentage varied from 38.93 to 63.77. Germination percentage was found as maximum in 63.77 for T₁ and minimum was recorded in T₆ (38.93). Significant variation was recorded among the treatments over genotypes for germination percentage. The range of vigour index was from 250.79 to 414.43. Vigour index was found as maximum in T₁ (414.43) and minimum in T₆ (250.79).

Table 1 Mean values of root length, shoot length, seedling fresh and dry weight, germination percentage and vigour index of different China aster genotypes just before storage.

| Genotypes | Root Length (cm) | Shoot Length (cm) | Fresh Weight (g) | Dry Weight (g) | Germination % | Vigour Index | Test Weight (g) |
|------------|------------------|-------------------|------------------|---------------|---------------|--------------|----------------|
| V₁         | 4.63             | 1.76              | 0.99             | 0.10          | 82.43         | 526.41       | 1.74           |
| V₂         | 4.23             | 1.86              | 0.92             | 0.07          | 89.10         | 542.30       | 1.68           |
| V₃         | 3.93             | 1.95              | 0.89             | 0.09          | 82.57         | 485.24       | 1.82           |
| V₄         | 3.72             | 2.18              | 0.92             | 0.13          | 92.27         | 544.73       | 1.66           |
| V₅         | 5.28             | 2.09              | 0.86             | 0.09          | 81.77         | 603.17       | 1.71           |
| V₆         | 4.62             | 2.40              | 0.83             | 0.07          | 94.40         | 662.37       | 1.74           |
| V₇         | 4.44             | 2.30              | 0.89             | 0.11          | 86.40         | 582.83       | 1.79           |
| SEm(±)     | 0.04             | 0.06              | 0.01             | 0.02          | 3.35          | 20.23        | 0.04           |
| LSD(0.05)  | 0.01             | 0.02              | 0.01             | 0.01          | 1.10          | 6.61         | 0.01           |

Arka Aadya (V₁), Arka Archana (V₂), Arka Kamini (V₃), Arka Poornima (V₄), Local White (V₅), Local Pink(V₆), Ranaghat 1 (V₇)
Table 2 Mean values of root length, shoot length, seedling fresh and dry weight, germination percentage and vigour index of different treatments over genotypes stored in different conditions at two months after storage.

| Treatment | Root Length (cm) | Shoot Length (cm) | Fresh Weight (g) | Dry Weight (g) | Germination % | Vigour Index |
|-----------|------------------|-------------------|------------------|----------------|---------------|--------------|
| T₁        | 4.41             | 2.08              | 0.89             | 0.10           | 71.83         | 465.28       |
| T₂        | 4.40             | 2.06              | 0.89             | 0.10           | 71.21         | 459.13       |
| T₃        | 4.41             | 2.07              | 0.90             | 0.10           | 70.53         | 455.83       |
| T₄        | 4.42             | 2.08              | 0.89             | 0.09           | 69.77         | 452.49       |
| T₅        | 4.40             | 2.07              | 0.90             | 0.10           | 68.99         | 445.32       |
| T₆        | 4.42             | 2.07              | 0.89             | 0.09           | 68.29         | 441.98       |
| SEm(±)    | 0.00             | 0.00              | 0.00             | 0.00           | 0.00          | 0.21         |
| LSD(0.05) | 0.01             | 0.01              | 0.01             | 0.01           | 0.00          | 0.60         |

Freeze Condition (T₁), Aluminium foil (T₂), Polythene Packet (T₃), Earthen pot (T₄), Cloth bag (T₅), Brownpaper (T₆)

Table 3 Mean values of root length, shoot length, seedling fresh and dry weight, germination percentage and vigour index of different treatments over genotypes stored in different conditions at four months after storage.

| Treatments | Root Length (cm) | Shoot Length (cm) | Fresh Weight (g) | Dry Weight (g) | Germination % | Vigour Index |
|------------|------------------|-------------------|------------------|----------------|---------------|--------------|
| T₁         | 4.40             | 2.08              | 0.89             | 0.10           | 66.93         | 433.88       |
| T₂         | 4.39             | 2.05              | 0.89             | 0.10           | 54.86         | 352.90       |
| T₃         | 4.41             | 2.07              | 0.89             | 0.10           | 54.01         | 349.63       |
| T₄         | 4.41             | 2.07              | 0.89             | 0.09           | 53.41         | 345.76       |
| T₅         | 4.40             | 2.07              | 0.89             | 0.10           | 52.66         | 340.34       |
| T₆         | 4.40             | 2.09              | 0.89             | 0.10           | 52.17         | 338.17       |
| SEm(±)     | 0.00             | 0.00              | 0.00             | 0.00           | 0.00          | 0.18         |
| LSD(0.05)  | 0.01             | 0.01              | 0.01             | 0.01           | 0.00          | 0.51         |

Freeze Condition (T₁), Aluminium foil (T₂), Polythene Packet (T₃), Earthen pot (T₄), Cloth bag (T₅), Brownpaper (T₆)
Table 4 Mean values of root length, shoot length, seedling fresh and dry weight, germination percentage and vigour index of different treatments over genotypes of China aster stored in different conditions at six months after storage

| Treatments | Root Length (cm) | Shoot Length (cm) | Fresh Weight (g) | Dry Weight (g) | Germination % | Vigour Index |
|------------|-----------------|-------------------|------------------|---------------|---------------|-------------|
| T₁         | 4.41            | 2.10              | 0.90             | 0.10          | 63.77         | 414.43      |
| T₂         | 4.40            | 2.08              | 0.90             | 0.10          | 42.36         | 273.73      |
| T₃         | 4.39            | 2.06              | 0.90             | 0.09          | 41.53         | 267.21      |
| T₄         | 4.41            | 2.07              | 0.89             | 0.09          | 40.53         | 262.29      |
| T₅         | 4.42            | 2.07              | 0.90             | 0.10          | 39.80         | 257.47      |
| T₆         | 4.39            | 2.06              | 0.90             | 0.10          | 38.93         | 250.79      |
| SEm(±)     | 0.00            | 0.00              | 0.00             | 0.00          | 0.00          | 0.13        |
| LSD(0.05)  | 0.01            | 0.01              | 0.00             | 0.01          | 0.00          | 0.36        |

Freeze Condition (T₁), Aluminium foil (T₂), Polythene Packet (T₃), Earthen pot (T₄), Cloth bag (T₅), Brownpaper (T₆)

Table 5: Mean values of root length, shoot length, seedling fresh and dry weight, germination percentage and vigour index of different genotypes of China aster stored in freeze conditions as other treatments shows germination and vigour index zero at eight months after storage.

| Genotypes | Root Length (cm) | Shoot Length (cm) | Fresh Weight (g) | Dry Weight (g) | Germination % | Vigour Index |
|-----------|-----------------|-------------------|------------------|---------------|---------------|-------------|
| V₁        | 4.62            | 1.74              | 0.98             | 0.15          | 59.90         | 380.96      |
| V₂        | 4.20            | 1.88              | 0.91             | 0.10          | 60.20         | 366.22      |
| V₃        | 3.96            | 1.92              | 0.92             | 0.09          | 59.70         | 350.84      |
| V₄        | 3.04            | 1.84              | 0.91             | 0.11          | 60.50         | 295.04      |
| V₅        | 5.25            | 2.15              | 0.87             | 0.09          | 60.90         | 450.86      |
| V₆        | 4.70            | 2.34              | 0.81             | 0.08          | 61.10         | 429.94      |
| V₇        | 4.50            | 2.39              | 0.89             | 0.10          | 60.60         | 417.74      |
| SEm(±)    | 0.26            | 0.01              | 0.01             | 0.01          | 0.095         | 15.23       |
| LSD(0.05) | 0.78            | 0.02              | 0.02             | 0.004         | 0.291         | 46.82       |

Arka Aadya (V₁), Arka Archana (V₂), Arka Kamini (V₃), Arka Poornima (V₄), Local White (V₅), Local Pink (V₆), Ranaghat (V₇)
Non-significant variation was seen among the treatments over genotypes for vigour index. At six months after storage T₁ (freeze condition) treatment over genotypes showed the highest germination and vigour index than other genotypes. So, at six months after storage T₁ (freeze condition) treatment over genotypes i.e., freeze condition is best.

After eight months storage, seed germination observed only in freeze condition stored seed of China aster but it was zero for any other condition. That means the other parameters like root length, shoot length, fresh weight, dry weight and vigour index were also zero for other treatments. Genotypes stored in freeze condition after eight months storage, root length ranged from 3.04 cm to 5.25 cm among the genotypes over freeze condition. Maximum root length was found in V₅ (5.25cm) and minimum in V₄ (3.04 cm). Shoot length ranged from 1.74 cm to 2.39 cm. Longest shoot length was recorded in V₇ (2.39 cm) and shortest mean value was noted in V₁ (1.74 cm). Fresh weight was from 0.81g to 0.98 g. Maximum fresh weight was found in V₁ (0.98g) and minimum in V₆ (0.81g).

Among the genotypes over freeze condition dry weight ranged from 0.08 g to 0.15 g. Maximum dry weight was found in V₁ (0.15g) and minimum in V₆ (0.08g). In case of germination percentage, it ranged from 59.70 to 61.10. Highest germination percentage was found in V₆ (61.10) whereas lowest in V₃ (59.70). Among the genotypes stored in freeze condition vigour index varied within a range from 295.04 to 450.86. Maximum vigour index was determined in V₅ (450.86) and minimum in V₄ (295.04). So, according to storability Local White (V₅) is the best genotypes as it shows the high vigour.
than other genotypes and in case of germination, it is second highest. Local Pink (V₆) shows best performance in storing condition as it continuously performs better than other genotypes from just before storage to eight months after storage. Freeze condition is the best over the other conditions as germination percentage (71.83, 66.93, 63.77 and 61.10, respectively) and vigour index (465.28, 433.88, 414.43 and 450.86 respectively) recorded highest at two months, four months, six months and eight months after storage.

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