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# Effect of Iodine Treatment on the Control of Seed Deterioration in Cotton (*Gossypium sp.* L.)

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## ABSTRACT

**The seeds of 15 cotton genotypes belonging *Gossypium hirsutum*, *G. barbadense* and *G. arboreum* were treated (dry) with 3 g of iodine based halogen formulation $Kg^{-1}$ and stored under ambient condition in the laboratory for six months exhibited the significant effect of halogenation treatment by recording higher germination initially (7% over control) and after six months of storage (12% over control), speed of germination, root and shoot length of seedlings, dry matter production and computed vigour index, field emergence and collar thickness of 40 day old seedlings over the control seeds. Among the genotypes Supriya and MCU 5 VT were the best while Anjali was very poor among the genotypes.**

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## INTRODUCTION

Cotton is the most important commercial fibre crop grown extensively for its fibre and seed. Cotton seeds serve as a raw material for agro-based industries besides being a planting material for crop production. Planting of physically sound and physiologically active seeds can increase the yield up to 20%. Viability and vigour are the important facets of physiological activity during seed germination. Upon storage, deterioration of viability and vigour occurs due to various factors, such as high moisture content of seeds, high relative humidity and temperature of storage environment, insect pest attack and pathogen invasion etc., all orienting towards the progressive senescence of seed. Among the factors lipid peroxidation and free radical formation are believed to be the basic causes for seed deterioration. Basu and Rudrapal (1979, 1980), Rudrapal and Basu (1981) suggested that stabilization of unsaturated fatty acid components of lipo-protein membranes by halogen treatment possibly reduces lipid peroxidation and free radical reactions. The loss of membrane function may be one of the basic reasons for senescence in biological systems which involve free radical chain propagation reactions and lipid peroxidation (Tappel, 1973). Rudrapal and Basu (1982) showed that the viability maintaining property of the physico-chemical treatment was always associated with a lowered lipid peroxidation in wheat and mustard seeds. Peroxidation reactions are believed to start at the double bond sites. Reactions of iodine with accessible carbon-

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carbon double bonds would stablise them and render them much less susceptible to peroxidative and free radical reactions. The effect of iodine on the microbial activity (Christensen, 1972), Germinability (Basu and Rudrapal, 1979, Zhang *et al.*, 1989), physiological deterioration in Soyabean and Sunflower (Dey and Mukherji, 1984), Improved germination in vegetable crop seeds (Palanisamy *et al.*, 1994; Punitha 1996) have been studied. However, its effect on the maintenance of vigour and viability during storage and after planting of cotton seeds from different genotypes have not been studied and hence the present experiment was planned.

## MATERIALS AND METHODS

The pre-cleaned, untreated, part of seed in each of 15 Genotypes (Table 1) were treated with iodine based halogen formulation @ 3 g $Kg^{-1}$. The formulations were prepared with different quantities of pure iodine crystal and dehydrated $CaCO_3$. For this 90 mg of iodine crystal weighed and added to 90 g of dehydrated $CaCO_3$ in an airtight container and incubated at 40°C for 48 h. The iodine formulation treated seeds were packed in polythene bags (300 gauge), heat sealed and kept for five days. Then transferred to gada cloth bag after leaving a portion for initial evaluation ($P_0$). The seeds were stored under ambient condition for six months, and then they were evaluated for seed quality ($P_1$) using the following response parameters.

**(i) Standard germination test :** The germination test was conducted using sand medium taken in plastic bucket as described by Dharmalingam and Basu (1978). Four replications of 25 seeds each were sown equidistantly at uniform depth (2 cm). The moisture content of the sand medium was maintained at 50% water holding capacity throughout the test period for better root development. A germination period of 10 days was adopted. The normal seedlings counted were expressed as germination percentage.

*TABLE 1*

**Effect of iodine based halogen formulation on Germination (%) of cotton genotypes.**

| Genotypes | | 7 days after treatment | | | 6 months after storage | | | Overall mean |
|---|---|---|---|---|---|---|---|---|
| | | Control | Halogenated | Mean | Control | Halogenated | Mean | |
| G1 | MCU5 | 63 (52.34) | 71 (57.22) | 67 (54.78) | 53 (46.91) | 65 (53.94) | 59 (50.42) | 63 (52.60) |
| G2 | Supriya | 72 (58.09) | 77 (61.59) | 75 (59.84) | 63 (52.34) | 73 (58.92) | 68 (55.63) | 71 (57.74) |
| G3 | MCU 7 | 59 (50.01) | 60 (50.78) | 60 (50.78) | 53 (46.92) | 57 (49.22) | 55 (48.07) | 58 (49.42) |
| G4 | LRA 5166 | 64 (53.13) | 69 (56.11) | 67 (54.77) | 57 (49.22) | 65 (53.94) | 61 (51.58) | 64 (53.17) |
| G5 | MCU 9 | 61 (51.56) | 67 (54.77) | 64 (53.13) | 52 (46.15) | 64 (53.15) | 58 (49.65) | 61 (51.41) |
| G6 | MCU 5VT | 67 (54.74) | 84 (66.53) | 75 (60.64) | 55 (47.68) | 73 (58.92) | 64 (53.30) | 70 (56.97) |

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|---|---|---|---|
| G7 | Anjali | 61 (51.56) | 63 (53.75) | 63 (52.75) | 47 (43.09) | 53 (46.91) | 50 (45.00) | 57 (48.87) |
| G8 | M 12 | 60 (50.78) | 65 (54.00) | 65 (54.00) | 55 (47.68) | 61 (51.56) | 58 (49.62) | 62 (51.81) |
| G9 | H 777 | 63 (52.34) | 69 (56.53) | 69 (56.53) | 53 (46.91) | 65 (53.94) | 59 (50.42) | 64 (53.48) |
| G10 | TCH 1218 | 64 (53.13) | 69 (56.03) | 69 (56.03) | 57 (49.22) | 71 (57.22) | 64 (53.22) | 66 (54.62) |
| G11 | Suvin | 63 (52.34) | 65 (53.95) | 65 (53.95) | 43 (40.78) | 65 (53.94) | 54 (47.36) | 60 (50.65) |
| G12 | P4 | 67 (54.77) | 67 (55.16) | 67 (55.16) | 39 (38.44) | 61 (51.56) | 50 (45.00) | 58 (50.08) |
| G13 | TCB 209 | 61 (51.56) | 65 (53.97) | 65 (53.97) | 41 (40.01) | 59 (49.99) | 50 (45.00) | 58 (49.48) |
| G14 | Uppam cotton | 69 (56.30) | 70 (56.70) | 70 (56.70) | 57 (49.22) | 65 (53.94) | 61 (51.58) | 66 (54.14) |
| G15 | G 27 | 69 (56.38) | 73 (58.99) | 73 (58.99) | 53 (46.91) | 65 (53.94) | 59 (50.42) | 66 (54.71) |
| Mean | | 64 (53.27) | 68 (55.47) | 68 (55.47) | 52 (46.10) | 64 (53.40) | 58 (49.75) | 63 (52.61) |
| **CD** | | **T** | **P** | **G** | **T x G** | **T x G** | **G x P** | |
| **(P=0.05)** | | **0.49** | **0.49** | **1.30** | **0.70** | **1.91** | **1.91** | |

**(ii) Speed of germination :** Hundred seed was germinated in sterilized sand medium replicated four times. Number of seeds that germinated was counted daily up to the final counting day. From the mean per cent germination of each counting day, the speed of germination was derived by adopting the following formula and expressed as number (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} \ldots + \frac{X_n - X_{(n-1)}}{Y_n}$$

where as

Xn = Per cent germination on the $n^{th}$ day

Yn = Number of days from sowing on $n^{th}$ day.

**(iii) Seedling growth measurement :** Ten normal seedlings were taken at random from the standard germination test and used for measuring the root and shoot length of individual seedlings. Root length was measured from the collar to the tip of primary root and shoot length from the collar region to the tip of the plumule. The mean value in each was expressed in cm.

**(iv) Dry matter production of seedling :** The seedlings used for growth measurements were dried in a hot air over at 85°C for 24 h cooled in a desiccator, weighed and expressed in mg.

**(v) Vigour index :** Vigour index was computed by using following formula and expressed as whole number (Abdul Baki and Anderson, 1973).

Vigour index = Germination x Total length of seedlings in cm percentage (Mean of 10 normal seedlings).

**(vi) Field emergence :** One hundred and fifty seeds in three replications of 50 each were sown equidistantly at uniform depth in raised beds. After sowing, the beds were irrigated judiciously. On the 10th day number of normal seedlings emerged was counted and the mean value expressed as percentage. The seedlings were allowed to grow up to 40 days with proper thinning so as to maintain sufficient between seedlings. At 40th day ten seedlings in each replication were uprooted using digging forks to avoid root damage. Observations on root and shoot length and dry matter production of seedlings were recorded.

**(vii) Collar thickness :** Ten seedlings uprooted for seedling growth measurements from the field emergence test were used for measuring the collar thickness. The diameter of the middle part of the seedling was measured with the help of screw gauge and the mean value expressed as mm.

## RESULTS AND DISCUSSION

The results showed significant differences due to treatments, genotypes, period of storage and their interaction for all the parameters studied. The initial germination potential of genotypes ranged between 59 and 72% and 39 to 63% six months after storage in control seeds (Table 1). In the halogenated seeds the corresponding value ranged from 84 to 67 and 73 to 59% respectively.

It was evident from the analysis of variance that halogenation treatment significantly increased the germination in all the genotypes. The improvement in germination due to halogen treatment was 10% over the control across genotypes (Table 1). The improvement noticed one week after seed treatment was 7% and after 6 months storage 12% (Table 1).

The mean initial germination of 64% for genotypes was almost maintained in halogenated seeds six months after storage, whereas it was reduced to 52% in control. Among the genotypes, Supriya and MCU 5 VT were significantly better in their storage potential irrespective of treatments and storage period by registering higher values, whereas Anjali registered the lowest value, exhibiting the poor storability of seeds. Other genotypes were in between 58 and 66% germination (Table 1).

The speed of germination recorded 7 days after seed treatment as well as six months after storage showed significant superiority of halogenated seeds in all the genotypes. The reduction in speed of germination was rather steep in untreated seeds and less in halogenated seeds irrespective of genotypes. The per cent reduction varied with genotypes exhibiting the variability prevailing in the genotypes. The analysis of variance revealed the superiority of Supriya with respect to mean speed of germination (22.1) closely followed by MCU 5 VT (21.2). In other genotypes it was significantly lower (20.0 to 17.4) and their differences remained at par.

The differences noticed in root length of seedlings were significant due to genotypes

*TABLE 2*

**Effect of iodine based halogen formulation on vigour index of cotton genotypes.**

| Genotypes | | 7 days after treatment | | | 6 months after storage | | | Overall |
|---|---|---|---|---|---|---|---|---|
| | | Control | Halogenated | Mean | Control | Halogenated | Mean | Mean |
| G1 | MCU5 | 1576 | 2087 | 1831 | 1326 | 1992 | 1659 | 1745 |
| G2 | Supriya | 1585 | 2543 | 2064 | 1509 | 2224 | 1867 | 1965 |
| G3 | MCU 7 | 1445 | 1893 | 1669 | 1291 | 1711 | 1501 | 1585 |
| G4 | LRA 5166 | 1769 | 2121 | 1945 | 1441 | 2033 | 1737 | 1841 |
| G5 | MCU 9 | 1609 | 2092 | 1851 | 1227 | 1860 | 1543 | 1697 |
| G6 | MCU 5VT | 1603 | 2574 | 2089 | 1364 | 2121 | 1742 | 1915 |
| G7 | Anjali | 1451 | 1915 | 1683 | 1187 | 1432 | 1310 | 1496 |
| G8 | M 12 | 1638 | 2315 | 1977 | 1503 | 1861 | 1682 | 1829 |
| G9 | H777 | 1784 | 2378 | 2081 | 1383 | 1899 | 1641 | 1861 |
| G10 | TCH 1218 | 1561 | 2054 | 1808 | 1382 | 1995 | 1688 | 1748 |
| G11 | Suvin | 1581 | 2011 | 1796 | 1111 | 1980 | 1546 | 1671 |
| G12 | P4 | 2094 | 2412 | 2253 | 1185 | 2039 | 1612 | 1932 |
| G13 | TCB 209 | 1911 | 2456 | 2184 | 1233 | 1952 | 1592 | 1888 |
| G14 | Uppam cotton | 1112 | 1383 | 1248 | 875 | 1202 | 1038 | 1143 |
| G15 | G 27 | 1238 | 1612 | 1425 | 891 | 1383 | 1137 | 1281 |
| Mean | | 1597 | 2123 | 1860 | 1260 | 1846 | 1553 | 1707 |
| **CD** | | **T** | **P** | **G** | **T x P** | **T x G** | **G x P** | |
| **(P=0.05)** | **28.48** | **28.48** | **28.48** | **78.00** | **40.28** | **110.31** | **110.31** | |

and seed treatment. In all the genotypes the halogenated seeds recorded significantly higher root length when compared to untreated seeds both initially and six months after storage. An invigoration effect of halogenated treatment was clearly evident from the results of initial evaluation done 7 days after seed treatment. It was true in the genotypes except that the percentage increase varied with each genotype. The analytical data pooling the treatment and period of storage highlighted the superiority of P4, TCB 209 and M 12 and inferiority of Uppam cotton and G 27 over other genotypes.

TABLE 3

**Effect of iodine based halogen formulation on field emergence (%) of cotton genotypes.**

| Genotypes | | 7 days after treatment | | | 6 months after storage | | | Overall mean |
|---|---|---|---|---|---|---|---|---|
| | | Control | Halogenated | Mean | Control | Halogenated | Mean | |
| G1 | MCU5 | 73 (58.48) | 85 (67.53) | 79 (63.00) | 50 (45.00) | 65 (53.53) | 57 (49.27) | 68 (56.13) |
| G2 | Supriya | 67 (55.22) | 83 (65.91) | 75 (60.57) | 59 (50.38) | 70 (56.80) | 65 (53.59) | 70 (57.08) |
| G3 | MCU 7 | 54 (47.30) | 62 (51.95) | 58 (49.62) | 53 (46.53) | 53 (46.91) | 53 (46.72) | 56 (48.17) |
| G4 | LRA 5166 | 65 (53.56) | 76 (60.67) | 70 (57.11) | 53 (46.91) | 63 (52.34) | 58 (49.63) | 64 (53.37) |
| G5 | MCU 9 | 73 (58.50) | 77 (61.12) | 75 (59.81) | 49 (44.24) | 61 (51.55) | 55 (47.89) | 65 (53.85) |
| G6 | MCU 5VT | 53 (46.91) | 65 (53.94) | 59 (50.42) | 49 (44.62) | 63 (52.73) | 56 (48.68) | 58 (49.55) |
| G7 | Anjali | 51 (45.76) | 59 (50.39) | 55 (48.08) | 42 (40.39) | 53 (46.53) | 47 (43.46) | 51 (45.77) |
| G8 | M 12 | 53 (46.91) | 71 (57.22) | 62 (52.06) | 51 (45.38) | 55 (48.06) | 53 (46.72) | 58 (49.39) |
| G9 | H 777 | 64 (53.13) | 77 (61.15) | 7 (57.14) | 49 (44.24) | 62 (51.94) | 55 (48.09) | 63 (52.61) |
| G10 | TCH 1218 | 59 (49.99) | 68 (55.62) | 63 (52.81) | 50 (45.00) | 62 (51.95) | 56 (48.47) | 60 (50.64) |
| G11 | Suvin | 61 (51.16) | 69 (55.99) | 65 (53.58) | 39 (38.84) | 57 (49.22) | 48 (44.03) | 57 (48.80) |
| G12 | P4 | 55 (47.68) | 59 (50.38) | 57 (49.03) | 41 (39.62) | 57 (49.22) | 49 (44.42) | 53 (46.72) |
| G13 | TCB 209 | 56 (48.45) | 73 (58.93) | 65 (58.69) | 41 (40.01) | 55 (48.06) | 48 (44.03) | 57 (48.86) |
| G14 | Uppam cotton | 61 (51.16) | 65 (53.59) | 63 (52.37) | 57 (48.83) | 61 (51.55) | 59 (50.19) | 61 (51.28) |
| G15 | G 27 | 69 (56.02) | 79 (62.64) | 74 (59.33) | 49 (44.24) | 57 (49.22) | 53 (46.73) | 63 (53.03) |
| Mean | | 61 (51.35) | 71 (57.80) | 66 (64.58) | 49 (44.28) | 60 (50.64) | 54 (47.46) | 54 (51.02) |
| **CD** | | **T** | **P** | **G** | **T x P** | **T x G** | **G x P** | |
| **(P=0.05)** | | **0.49** | **0.49** | **1.34** | **NS** | **1.89** | **1.89** | |

The differences in shoot length due to genotypes and seed treatment depicted parallel results of root length. An invigoration effect of halogenated was also seen with shoot growth of seedlings.

The dry matter production of seedlings exhibited significant differences due to seed treatment and genotypes. As in other parameters the halogenated seeds excelled over the control at initial (7 days after treatment) and six months after natural storage. The genotypes Supriya and MCV 5 VT while on par recorded significantly higher dry matter production (592, 581 mg) over other genotypes, while Uppam cotton and G 27 recorded minimum mean values (225 and 255 mg).

The seed treatment effect on genotypes had reflected on the vigour index values explicitly, where the halogenated seeds were significantly superior to the respective control intially as well as six months after storage (Table 2). Among the genotypes Supriya, P4, MCV 5 VT and TCB 209 were significantly superior and Uppam cotton was inferior to all (Table 2).

The results of field emergence and standard germination exhibited parallelism. The genotypes had the emergence potential ranging from 7 to 51%. The evaluation carried out one week after seed treatment showed significant improvement in field emergence in each one of the genotypes when compared to their respective control accounting for an increase of about 10% across genotypes (Table 3). Upon storage for six months, the reduction in field emergence potential was drastic in untreated seeds compared to halogenated ones. The overall analytical data brought out superiority of Supriya and MCV 5 VT and inferiority of Anjali and P4 over other genotypes. The differences noticed among other genotypes were intermediate (53 to 65%) and were on par to one another (Table 3).

The collar thickness of seedlings measured 40 days after sowing in treated and untreated seeds of 15 genotypes revealed that the intial evaluations made 7 days after seed treatment and six months after storage followed the same trend where the halogenated seeds had higher collar thickness than their counterpart control to an extent of 27.4% (Table 4). The analysis of variance brought out the superiority of genotypes M 12, H 777 and Supriya and the inferior nature of Uppam cotton and 27 over other genotypes (Table 4).

The recent research findings have pinpointed the definite involvement of free radicals in the deterioration of seeds (Basu, 1976). The free radicals having unpaired electrons in them presumably cause damage to membrane systems in the cell leadings to loss of vigour and viability. To counteract this damage, Basu (1976) has suggested hydration of seeds followed by dehydration to scavenge the free radicals thereby the seeds can be stored further without appreciable loss in quality for a reasonable period. This treatment was proved excellent for a number of crop seeds, e.g., in jute (Basu and Dasgupta, 1978); in wheat (Basu and Pal, 1979 and Sujit kumar Ray, 1982): in sunflower (Dharmalingam and Basu, 1990). Inspite of the best effort conferred by hydration and dehydration treatment it did not gain adoption by farmers or seed producers. Any seed treatment that will go along with routine post harvest operations would be most welcome and acceptable for easy adoption. One such approach is the iodine treatment, a halogen which rapidly passes into the vapour phase

*TABLE 4*

**Effect of iodine based halogen formulation on collar thickness (mm) of seedling from field emergence of cotton genotypes (40 DAS).**

| Genotypes | | *Initial* | | | *6 months after storage* | | | *Overall mean* |
|---|---|---|---|---|---|---|---|---|
| | | *Control* | *Halogenated* | *Mean* | *Control* | *Halogenated* | *Mean* | |
| G1 | MCU 5 | 2.18 | 2.70 | 2.44 | 2.33 | 2.90 | 2.62 | 2.53 |
| G2 | Supriya | 2.38 | 3.35 | 2.86 | 2.42 | 3.40 | 2.91 | 2.81 |
| G3 | MCU 7 | 1.87 | 2.77 | 2.32 | 1.92 | 2.85 | 2.39 | 2.36 |
| G4 | LRA 5166 | 1.95 | 2.22 | 2.09 | 2.38 | 2.85 | 2.62 | 2.35 |
| G5 | MCU 9 | 2.02 | 2.66 | 2.34 | 2.39 | 2.97 | 2.68 | 2.51 |
| G6 | MCU 5 VT | 2.34 | 3.28 | 2.81 | 2.27 | 2.97 | 2.62 | 2.71 |
| G7 | Anjali | 2.35 | 2.96 | 2.65 | 2.44 | 2.78 | 2.61 | 2.63 |
| G8 | M 12 | 2.79 | 3.29 | 3.04 | 2.75 | 3.22 | 2.98 | 3.01 |
| G9 | H 777 | 2.75 | 3.27 | 3.01 | 2.61 | 3.17 | 2.89 | 2.95 |
| G10 | TCH 1218 | 2.21 | 3.35 | 2.78 | 2.39 | 2.78 | 2.58 | 2.68 |
| G11 | Suvin | 2.53 | 3.31 | 2.92 | 2.27 | 3.03 | 2.65 | 2.78 |
| G12 | P4 | 2.73 | 3.19 | 2.96 | 2.45 | 2.87 | 2.66 | 2.81 |
| G13 | TCB 209 | 2.62 | 3.20 | 2.91 | 2.31 | 2.82 | 2.57 | 2.74 |
| G14 | Uppam cotton | 1.31 | 1.95 | 1.63 | 1.27 | 1.78 | 1.53 | 1.58 |
| G15 | G 27 | 1.78 | 2.40 | 2.09 | 1.69 | 2.21 | 1.95 | 2.02 |
| Mean | | 2.25 | 2.93 | 2.59 | 2.26 | 2.84 | 2.55 | 2.57 |
| **CD** | | **T** | **P** | **G** | **T x P** | **T x G** | **G x P** | |
| **(P=0.05)** | | **0.03** | **0.03** | **0.07** | **0.04** | **0.11** | **0.11** | |

and characterized by its great affinity for double bonds of unsaturated lipid constituents of the cell (Dey and Mukherjee, 1984). In the present study seeds of 15 cotton genotypes dry dressed with iodine formulation @ 3 g $kg^{-1}$ not only controlled the physiological deterioration but also improved the germination even after six months of natural storage (Table 1) Basu and Rudrapal (1980) suggested that iodine might react with Carbon-Carbon double bonds of poly unsaturated fatty acids and make them less susceptible for further oxidation.

In the present investigation improvement in root length, shoot length, dry matter production, computed vigour index (Table 2), field emergence potential, collar thickness of field emerged seedlings were noticed soon after storage. Improvement in germination and control of physiological deterioration were also observed. Considering the seed and seedling quality parameters of cotton genotypes the iodine treatment upheld its beneficial effect beyond any apprehension.

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