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PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN GRAIN AMARANTHUS GENOTYPES DURING SEED STORAGE

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ABSTRACT

The laboratory studies were conducted at Tamil Nadu Agricultural University, Coimbatore to elucidate the storability of grain amaranthus genotypes. Ten different genotypes of grain amaranthus viz., RMA 19, RMA 4, RMA 3, RMA 22, RMA 24, RMA 30, GA 1, SKNA 21, SKNA 601, and BGA 15 were individually packed in cloth bag and evaluated for seed and seedling quality characters at bimonthly intervals upto six months of storage. The results revealed that, among ten genotypes, eight genotypes preserved the viability above MSCS level upto the study period of six months compared to SKNA 601 and SKNA 21 as poor storers. RMA 19, GA 1 and RMA 4 genotypes were good storers with best storability for long term carry over of seeds, while RMA 22 (82 %) and by RMA 24 (80 %) were medium storers. Among them, SKNA 21 was found to be the poor storer, who recorded 19 % germination followed by SKNA 601 (45 %) after 6 months of storage. Irrespective of genotypes, the maximum leaching of electrolytes (69 %) were observed in SKNA 601 followed by SKNA 21 (67 %). Among the genotypes, highest seed protein content was recorded in RMA 24 (15.2 %) followed by GA 1 (15.0 %) at the end of six months of storage. The seed quality characters in terms of seed germination, vigour index, electrical conductivity and protein content decreased with ageing irrespective of genotypes of grain amaranthus.

Key words: Grain amaranthus, genotypes, seed storage, physiological, biochemical, quality

INTRODUCTION

Grain amaranthus belongs to the family of Amaranthaceae. Pale-seeded, highly nutritive grain amaranthus is rich in lysine and sulphur aminoacid. Hence, it is considered as an alternative to cereal and this leafy vegetable propagated only through seeds. Good quality seed play a vital role in successful seed or crop production as the end product depends on the quality of seed used for sowing. Grain amaranthus is one of the most sensitive seeds susceptible to significant deterioration after year's storage. Seeds are required to be kept in safe storage since they are harvested in the preceding season and usually used for sowing in the subsequent season often after a time gap of six months or longer. During the aging process, seeds lose their vigor, ability to germinate and ultimately become less viable (Maity *et al.*, 2000). Losses in seed quality occur during field weathering, harvesting and storage. Several intrinsic and extrinsic factors influence the viability of seeds during storage. Among intrinsic and extrinsic factors, seed moisture content, relative humidity, temperature of storage, pests and diseases and oxygen availability are more important. Seed deterioration is an inexorable and an irreversible process. Genotype is one of the intrinsic characters that influence the deteriorative rate of seed in storage. The deterioration is also hastened by adverse storage environment, seed moisture content and the containers used for storage besides its susceptibility to fungal invasion. Therefore, evolving an improved storage strategy to prolong the shelf life of the seeds under ambient storage conditions with easily available cost effective resources would greatly help the Amaranthus growers to augment the net returns. With these backgrounds, studies were carried out in amaranthus genotypes to study the physiological and biochemical changes in seeds during storage. The main aim of this investigation was to identify the performance of genotypes with best storability for long term carry over of seeds of grain amaranthus seed.

MATERIALS AND METHODS

The laboratory experiments were carried out at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Ten different genotypes of grain amaranthus *viz.*, RMA 19, RMA 4, RMA 3, RMA 22, RMA 24, RMA 30, GA 1, SKNA 21, SKNA 601, and BGA 15 were collected from Forest College and Research Institute, Mettupalayam were individually packed in cloth bag and evaluated for seed and seedling quality characters as below at bimonthly intervals upto six months of storage. The seeds obtained through all grading techniques as well as the control (not graded) were evaluated for the seed physiological, biochemical and seedling quality characters *viz.*, moisture content, seed germination, seedling length and drymatter production were observed as per ISTA (1999). The seeds size graded with sieves were also evaluated for protein content (Alikhan and Youngs, 1973) and

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vigour index values (Abdul baki and Anderson, 1973). Electrical conductivity was measured in a digital conductivity meter. The data collected for the various parameters of the grading experiments were subjected to statistical analysis in an IBM PC compatible, HCL computer using Agrostatistical format for evaluating the analysis of variance and tested for significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Physiological parameters: The fluctuation in moisture content, irrespective of genotypes, increased to a tune of 0.06 to 0.58 %, while the initial seed moisture content ranged from 10.0 to 10.5 %. This slight increase in seed moisture with in six months might be due to lower level of environmental fluctuations of relative humidity and temperature during the storage period. The seed packed in cloth bags lost their complete viability and vigour within 18 months of storage in onion (Tripathi and Lawande, 2014). The germinability of seeds evaluated after six months of storage period expressed that among the genotypes RMA 19, GA 1 and RMA 4 were the good storers which maintained a germination of 85, 85 and 84 %, respectively followed by RMA 22 (82 %) and by RMA 24 (80 %). Among them, SKNA 21 was found to be the poor storer, who recorded 19 % germination followed by SKNA 601 (45 %) after 6 months of storage (Table 1). The seed vigour index in seeds packed in cloth bags decreased rapidly at six month after seed storage. Among the genotypes RMA 19 (688) and RMA 24 (792) recorded the maximum vigour index, which was only 17 and 21 % lesser than the initial storage period (Figure 1). Among them, SKNA 21 and SKNA 601 was recorded the lowest vigour index 152 and 337 respectively, after six months of storage. The results show that similar to seed germination, the seedlings growth is also affected by internal seed moisture and genotype. The viability and vigour of seed to a great extend depends on the storability which determined by the moisture, seed relative humidity and temperature. The low germination ability and viability of seed storage in the cloth bags may be due to the changes in the physiochemical state of seeds particularly the seed metabolism due to the reduction in moisture content. Seeds viability generally deteriorated with storage duration and deterioration was particularly strong for seed stored with higher than lower initial moisture content (Sucheta *et al*, 2007). The dry weight of seedling, the eminent seedling vigour parameter widely varied with genotypes due to changes in the initial capital of seed and also due to their genetic background. Genotypes could be attributed due to test weight difference observed between the genotypes (RMA 19, 7.0 mg, RMA 4, 6.7 mg, RMA 3, 6.2 mg, RMA 22, 6.5 mg, RMA 24, 7.0 mg, RMA 30, 6.0 mg, GA 1, 7.0 mg, SKNA 21, 6.0 mg, SKNA 601, 6.0 mg and BGA 15, 6.4 mg) at initial storage period. Among the evaluated genotypes RMA 24 recorded higher dry weight followed by GA 1 and RMA 22 (Table 1). Among them, SKNA 21 and SKNA 601 were recorded lowest dry matter production 4.0 and 4.2 mg, respectively at the end of storage period. The changes in seed metabolism are reported as one of the major factors for low seed germination, viability and DMP of seedling (Narender Kumar, 2009).

Table 1: Influence of genotypes on seed germination (%) and seed DMP Seedling^{-1}(mg) during storage

Genotypes (G)	Seed germination (%)					DMP Seedling^{-1}(mg)				
	Storage period in months (P)					Storage period in months (P)				
	0	2	4	6	Mean	0	2	4	6	Mean
RMA 19	90	90	88	85	88	7.0	6.5	6.0	5.6	6.3
RMA 4	99	99	95	84	94	6.7	6.0	5.0	5.0	5.7
RMA 3	99	93	87	80	90	6.2	6.0	5.3	4.7	5.5
RMA 22	90	87	85	82	86	6.5	6.4	6.2	6.0	6.3
RMA 24	85	82	80	80	82	7.0	6.8	6.6	6.5	6.7
RMA 30	96	89	80	78	86	6.0	5.8	5.6	5.5	5.7
GA 1	92	90	80	85	87	7.0	6.9	6.7	6.3	6.7
SKNA 21	50	32	25	19	32	6.0	5.1	4.8	4.0	5.0
SKNA 601	66	58	50	45	55	6.0	5.5	5.0	4.2	5.2
BGA 15	99	95	90	82	92	6.4	6.3	6.0	5.5	6.0
Mean	87	81	76	72		6.5	6.1	5.7	5.3	6.0
CD (P= 0.05)	P 1.02	G 1.61	G X P 3.22			P 0.08	G 0.13	G X P 0.26		

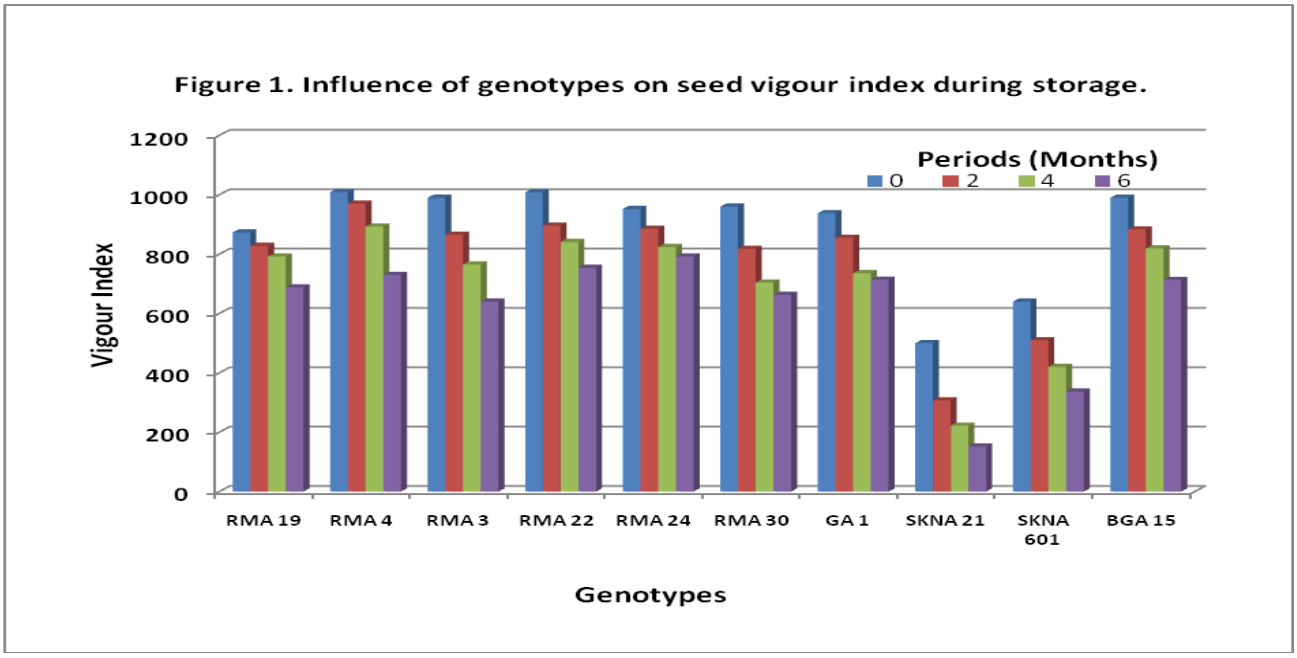
Biochemical parameters Biochemical changes that favour the degradation of protein and enzymes are the first step in seed deterioration process and these could be measured through electrical conductivity as the water soluble degraded produces will be oozed out into the seed steep water. Irrespective of

genotypes, the maximum leaching of electrolytes (69 %) were observed in SKNA 601 followed by SKNA 21 (67 %). Among the genotypes, the RMA 24 and RMA 19 recorded the least electrical conductance (0.18 dSm^{-1}) and (0.18 dSm^{-1}), respectively followed by RMA 3, RMA 22, RMA 30, GA 1 and BGA 15at the end of storage period. The highest electrical conductance with genotype SKNA 601 (0.39 dSm^{-1}). The electrical conductivity increased with storage period while the recorded germination percentage was in decreasing order indicating the negative association of the evaluated biochemical characters on seed germination and vigour (Parameswari, 2002). The seed protein content is another essential component of greens responsible for seed quality degradation at their entrance into senescence phase (Dharmalingam and Basu, 1990). The seed protein content reduced with advances in storage period due to their degradation. Among the genotypes, highest seed protein content was recorded with RMA 24 (15.2 %) followed by GA 1 (15.0 %) at the end of six months of storage confirming the singling of RMA 24 for better seed storability followed by RMA 19 and RMA 22 were recorded during storage. The genotype SKNA 21 and SKNA 601was found to be lowest protein content 12.2 % and 12.3 %, respectively compared to others (Table 2). High seed moisture and relative humidity are congenial for seed metabolites as well as for growth of fungus. It has been reported that lepoxygenase enzyme generate free radicals as the

Table 2: Influence of genotypes on seed electrical conductivity and protein content during storage

Genotypes (G)	Electrical Conductivity (dSm^{-1})					Protein (%)				
	Storage period in months (P)					Storage period in months (P)				
	0	2	4	6	Mean	0	2	4	6	Mean
RMA 19	0.08	0.16	0.17	0.18	0.15	17.0	16.9	16.1	14.6	16.2
RMA 4	0.08	0.15	0.18	0.20	0.15	16.0	15.8	15.0	13.6	15.1
RMA 3	0.08	0.17	0.19	0.19	0.16	16.0	15.9	15.4	13.4	15.2
RMA 22	0.07	0.16	0.17	0.19	0.15	17.0	17.0	16.0	14.5	16.1
RMA 24	0.10	0.11	0.14	0.18	0.13	17.0	17.0	16.6	15.2	16.4
RMA 30	0.08	0.14	0.17	0.19	0.15	16.0	15.6	15.2	13.4	15.0
GA 1	0.07	0.14	0.17	0.19	0.14	17.0	16.7	16.4	15.0	16.3
SKNA 21	0.12	0.16	0.18	0.38	0.19	15.0	14.0	13.4	12.2	13.7
SKNA 601	0.12	0.15	0.18	0.39	0.19	15.0	14.0	13.2	12.3	13.6
BGA 15	0.07	0.12	0.16	0.19	0.14	16.0	15.4	15.4	13.4	15.0
Mean	0.09	0.15	0.17	0.23	0.15	16.2	15.8	15.3	13.8	15.3
CD (P= 0.05)	P 0.002	G 0.003	G X P		0.007	P 0.228	G 0.361	G X P		NS

seed moisture increases. These are responsible for chromosomal abnormalities which adversely affect seed germination, seedling growth and its finally affect the seed quality. As the seed aged, the proportionate of genetic mutation increase. Many of these mutations can be detected as chromosomal aberrations .These chromosomal aberrations delay seedling growth and adversely affect seed germination and quality of seed (Murata *et al.*, 2000).



Thus, the study highlighted that among ten genotypes, eight genotypes preserved the viability above MSCS level upto the study period of 6 months compared to SKNA 601 and SKNA 21 as poor storer. Irrespective of genotypes, the seed quality characters in terms of physiological and biochemical characters degraded with seed ageing.

REFERENCES

Abdul Baki, A.A. and Anderson, J.D. (1973) Vigour determination in soybean by multiple criteria. *Crop Sciences* **13:**63.

Alikhan, S.T. and Youngs, C.G. (1973) Variation in protein content of field peas. *Journal of Plant Sciences* **53:** 37-41.

Dharmalingam, C. and Basu, R.N. (1990) Maintenance of viability and vigour in sunflower. *Seed Research* **18(1):** 15-24.

Gomez, K.A. and Gomez, A.A. (1984) *Statistical Procedures for Agricultural Research*. John Wiley and Sons, New York.

ISTA, (1999) International Rules for Seed Testing. *Seed Science & Technology* **13**: 209-355.

Maity, S., Banerjee Roy, G. Pal, M. Pal, C. Chakrabarti, B. and Bhattacharjee, A. (2000) Chemical induced prolongation of seed viability and stress tolerance capacity of mung bean seedlings. *Seed science and Technology* **28:** 155-162.

Murata, M., Ross, E.E. and Tsuchiya, T. (2000) Chromosomal damage induced by artificial seed aging in barley. III. Behavior of chromosomal aberration during plant growth. *Theoretical and applied Genetics* **67:** 161-170.

Narender Kumar, V., Anil Kumar, V. and Dharminder Kumar (2009) Effect of storage containers on seed germination and viability in *Aconitum eterophyllum* and *Podophyllum hexandrum* – endangered medicinal plants species of Himalayan region, *Biological Forum – An International Journal* **1(1):** 8-11.

Parameswari, K. (2002) Strategies to improve seed production and shelf life of pigeonpea (*Cajanus cajan* L. mill sp.) hybrid COPH2. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Rabindra, T.S. and Mohan, S. (2002) Storage of pulses and pest management. In: Pulses and oilseeds production for sustainable agriculture (Ed. M. Subramanian). Director of Research, Tamil Nadu Agricultural University, Coimbatore. pp: 151-159.

Rahman, M.M., Hagidok, B., Masood, M.M. and Islam, M. N. (2010) Effect of storage container and relative humidity on the quality of wheat seed. *Bangladesh Journal of Seed Science Technology* **14** (1&2): 89-94.

Sucheta, S., Sakshi, G. and Munshi, S.K. (2007) Changes in lipid and carbohydrate composition of germinating soybean seeds under different conditions. *Asian Journal of Plant Sciences* **6(3):** 502-507.

Tripathi, P.C. and Lawande, K.E. (2014) Effect of seed moisture and packing material on viability and vigour of onion seed. *Journal of Engineering Computers & Applied Sciences* **3(7):** 1-5.