Eco. Env. & Cons. 28 (October Suppl. Issue) : 2022; pp. (S196-S199)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i06s.032

Electrical conductivity and accelerating ageing of carrot (*Daucus carota*) seeds as affected by manure and biofertilizers

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(Received 20 February, 2022; Accepted 24 March, 2022)

ABSTRACT

The aim of this experiment was to test the effect of manure and biofertilizers on electrical conductivity and germination potential after accelerated ageing of fresh, 3 and 6 months stored carrot seeds. The experiment was conducted in the laboratory of seed science and technology, CCS HAU, Hisar during the year 2019-20. The results revealed that, application of T14 (FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + Azo+PSB) significantly reduced the electrical conductivity as compared to control and other treatments. Further, artificially aged seeds through accelerated ageing test also recorded higher germination potential in the same treatment for fresh, 3 and 6 months stored seeds.

Key words : *Ageing, Carrot, Conductivity, Manures, Seeds*

Introduction

Carrot (*Daucus carota* var. *atrorubens*) is a popular cool-season vegetable root crop that belongs to the Umbelliferae family and has chromosomal number 2n=18. It is grown all throughout the world, primarily in temperate nations during the spring and summer seasons, and in tropical places during the winter. Its domesticated variants are derived from wild species. It produces high-quality edible root in one season and seeds in two seasons. Because of andromonoecy, protandry, and male sterility, carrots are a heavily cross pollinated crop.Seed is a true fruit, consisting of an indehiscent mericarp with a single seed. Two mericarps combine to make the schizocarp, the actual carrot fruit that grows from a two-located ovary. Carrots are developed from genuine seeds, and their effective production is based on a consistent and reliable supply of high-quality seed. One of the primary issues that carrot growers in India encounter is the lack of sufficient quantities of high-quality seed. Thus, the availability of high-quality seed is critical for increasing carrot production and productivity in the country.Seed vigour is an important feature of seeds for long-term use. The amount of electrolytes that drain out of the seed is calculated using the electrical conductivity test. Seed degeneration, which is linked to vigour and viability loss, is invariably associated with increased electrical conductivity of seed leachates. Low metabolic activity of the seed is linked to increased leachate (Abdul-Baki and Anderson, 1972). Electrical conductivity of the seed leachates increased progressively with the ageing treatment Goel, *et al*., 2003). The accelerated ageing (AA) test is used to establish a seed's relative storability and is commonly used to assess seed vigour (Delouche and Baskin, 1973). The test's idea is based on the fact that the seed's resilience to harsh conditions decreases as degradation or vigour increases. Increased electrical conductivity was linked to a loss of seed viability (electrolyte leakage). There is a scarcity of information on the use of organics and biofertilizers in vegetable seed vigour, particularly in carrots. Thus, this study was carried out to explore the effect of manure and biofertilizers on electrical conductivity and germination ability of accelerated aged seeds.

Materials and Methods

This experiment was conducted at Seed Farm of Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar (29°09'N and 75°43'E, elevation 215 m) during the spring-summer season of 2019-20. The experiment included fourteen treatments, *viz.*, T1- Absolute control, T2- RDF (N:P:K 80:40:40 kg/ha), T3- Farmyard manure 25t/ha, T4- Poultry manure 4t/ha, T5- Vermicompost 8t/ha,T7- FYM 12.5t/ha+ PM 2t/ha, T8- FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha, T9- FYM 12.5t/ha+ PM 2t/ha+ *Azo+PSB*, T10-FYM 12.5t/ha+ *Azo+PSB*, T11- FYM 12.5t/ha+ VC 4t/ha+ *Azo+PSB*, T12- VC 8t/ha+ *Azo+PS*B, T13- PM 4t/ha+ *Azo+PS*B and T14- FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + *Azo+PSB* and was laid out in Randomized Block Design with three replications. The crop was sown on 8th October 2019. The seeds were collected manually on 1st June 2020 and stored in the laboratory of seed science and technology for analysis of quality parameters such as electrical conductivity and germination potential after accelerating ageing for 48 hrs. The parameters were estimated in the following manner during storage of carrot seeds:

Electrical Conductivity

50 healthy seeds were soaked in 75 ml deionized water in 100 ml beakers. Seeds were immersed completely in water and beakers were covered with foil. Thereafter, these samples were kept at 25 °C for 24 hrs. The electrical conductivity of the seed leachates was measured using a direct reading conductivity meter. The data was measured of fresh seeds, three and six months stored seeds. The conductivity is estimated in the terms of µS/cm/seed.

Accelerating Ageing test

Sufficient number of seeds from each treatment was taken on wire mesh tray fitted in plastic boxes having 40 ml of distilled water. The boxes were placed in ageing chamber after closing their lids. The 100 seeds were aged (placed) at 40±1°C temperature and about 100 % RH for 48 hrs and tested for germination. The number of normal seedlings including hard seeds were counted on 14th day and expressed as per cent germination. The data was measured of fresh seeds, three and six months stored seeds.

Results and Discussion

Electrical conductivity (dS/m): Significant differences found between all the treatments and also during storage period of 3 and 6 months (Table 1). Maximum EC (0.27, 0.33 and 0.48 µS/cm/seed) was recorded in control, whereas, treatment T14 (FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + *Azo+PSB)* showed the minimum EC (0.10, 0.15 and 0.30 µS/cm/seed) from fresh, 3 and 6 months stored seeds, respectively. Electrical conductivity of seed leachates was found low in fresh seeds (0.10 µS/cm/seed) in T14 which increased (0.15 µS/cm/seed and 0.30 µS/cm/seed) with the ageing period of 3 and 6 months, respectively. Seeds with a higher EC are less vigorous. Increased electrical conductivity with storage indicates that the seed has begun to deteriorate and more solute leakage has occurred, resulting in increased electrical conductivity. Seed degeneration, which is linked to vigour and viability loss, is invariably associated with increased electrical conductivity of seed leachates. The seed leachates' electrical conductivity increased over time as they were aged (Goel *et al*., 2003). Electrical conductivity of seed leachates was found to be low in freshly harvested seeds, but increased with ageing due to loss of membrane integrity, resulting in higher electrolyte loss into the imbibing media (Delouche and Baskin, 1973). Singh, and Dadlani, (2003) reported similar results in fenugreek. The rate of leakage is determined by the extent of cell membrane damage and repair as the seeds age (Larson, 1997; Crowe and Clegg, 1978).

Accelerated ageing: After accelerated ageing of 48 hours, significant variation was found in all the treatments of manure and biofertilizers for standard germination (Table 2). Maximum germination (39.00 %, 36% and 22.33 %) was found in treatment T14 (FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha +*Azo+PSB)* for fresh seeds. After 3 months of storage, maximum germination (36 %) was found in treatment T14 which was found to be at par with treatment T8 (35.67 %). Similar results were found after 6 months

Table 1. Effect of manure and biofertilizers on electrical conductivity (µS/cm/seed) of carrot seeds

Treatments (T)		Electrical conductivity (µS/cm/seed)		
		Storage period (M)		
		Fresh seeds	3 months	6 months
T1	Absolute control	0.27	0.33	0.48
T2	RDF (N:P:K 80:40:40 kg/ha)	0.16	0.21	0.36
T3	Farmyard manure (FYM) 25t/ha	0.25	0.30	0.45
T4	Poultry manure (PM) 4t/ha	0.21	0.26	0.41
T5	Vermicompost (VC) 8t/ha	0.24	0.28	0.43
T6	FYM 12.5t/ha+ PM 2t/ha	0.18	0.22	0.37
T7	FYM 12.5t/ha+ VC 4t/ha	0.19	0.24	0.39
T8	FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha	0.12	0.17	0.32
T9	FYM 12.5t/ha+ PM 2t/ha+ Azo+PSB	0.14	0.20	0.35
T10	FYM 12.5t/ha+ Azo+PSB	0.26	0.31	0.46
T11	FYM 12.5t/ha + VC 4t/ha+ Azo+PSB	0.15	0.20	0.36
T12	VC 8t/ha+ Azo+PSB	0.22	0.27	0.42
T13	PM 4t/ha+ Azo+PSB	0.20	0.25	0.41
T14	FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + Azo+PSB	0.10	0.15	0.30
	C.D. at 5%	M	0.013	
	T	0.027		
	M×T	NS		

Table 2. Effect of manure and biofertilizers on germination % after accelerating ageing test of carrot seeds

Treatments (T)		Storage period (M)		
		Fresh seeds	3 months	6 months
T1	Absolute control	34.00 (35.65)	31.50 (34.42)	19.33 (26.07)
T2	RDF (N:P:K 80:40:40 kg/ha)	36.67 (37.25)	34.00 (35.65)	21.44 (27.49)
T3	Farmyard manure (FYM) 25t/ha	35.33 (36.45)	32.67 (35.04)	19.56 (26.31)
T4	Poultry manure (PM) 4t/ha	35.67 (35.65)	33.50 (35.45)	20.22 (26.55)
T5	Vermicompost (VC) 8t/ha	35.33 (36.45)	33.17 (35.25)	20.11 (26.79)
T6	FYM 12.5t/ha+ PM 2t/ha	36.33 (37.05)	33.83 (35.65)	21.11 (27.49)
T7	FYM 12.5t/ha+ VC 4t/ha	36.33 (37.05)	33.67 (35.65)	21.11 (27.26)
T8	FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha	37.67 (37.84)	35.67 (36.85)	22.00 (27.96)
T9	FYM 12.5t/ha+ PM 2t/ha+ *Azo+PSB*	37.67 (37.84)	35.00 (36.25)	21.78 (27.72)
T10	FYM 12.5t/ha+ *Azo+PSB*	34.33 (35.85)	32.17 (34.84)	19.22 (26.07)
T11	FYM 12.5t/ha + VC 4t/ha+ *Azo+PSB*	36.67 (37.25)	34.50 (36.25)	21.44 (27.49)
T12	VC 8t/ha+ *Azo+PSB*	35.67 (36.65)	33.33 (35.25)	20.22 (26.55)
T13	PM 4t/ha+ *Azo+PSB*	36.00 (36.85)	33.67 (35.65)	20.78 (27.02)
T14	FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + *Azo+PSB*	39.00 (38.62)	36.00 (37.05)	22.33 (34.62)
	C.D. at 5%	M	0.21	
	T	0.47		
	M×T	NS		

(Values in parenthesis are transformed values)

of storage. Significantly minimum germination (34%, 31.50% and 19.33 %) of freshly harvested seeds, 3 and 6 months stored seeds, respectively was found in control after 48 hours of accelerated ageing. Accelerated ageing increased the seed leakage which in turn deteriorated the seed and, hence, germination % got reduced. Loss of seed viability was associated with the increased electrical conductivity (electrolyte leakage). Similar findings were reported by (Maskri *et al.*, 2003) in carrot.

Conclusion

It is concluded that the seed vigourness in terms of germination potential and electrical conductivity is maximum when nutrients are applied in the combination of FYM 12.5t/ha+ PM 2t/ha+ VC 4t/ha + Azo+PSB for fresh as well as 3 and 6 months stored carrot seeds.

Acknowledgements

We thank the Chaudhary Charan Singh Haryana Agricultural University, Hisar for their financial support.

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