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Impact of Sodium dikegulac and Maleic hydrazide on the seed storage potential of *Zea mays* L.

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Abstract

Seed viability of maize (Zea mays L.) declines at a rapid pace. Maize being an important crop, considered worldwide, any measure effective for its seed potentiation is considered to be of worth. Experimentation with sodium dikegulac (Na-DK) and maleic hydrazide (MH) showed here that pretreatment of maize seeds with either these two chemicals for 8 hours slowed down the aging induced rapid loss of germination. Moreover, such treated seeds showed better performance in terms of percentage of germination, field emergence capacity, fresh weight and dry weight of whole plants, root length shoot length, in comparison to the age accelerated seeds, however devoid of any treatment with sodium dikegulac (Na-DK) and maleic hydrazide (MH) and are considered as control in the experiment. Plants raised from the seeds treated with Na-DK and MH also excelled in having greater amount of DNA, RNA, chlorophyll and protein as well as higher catalase activity and lower amylase activity in comparison to the plants from control samples. Present study thus reveals the positive impact of Na-DK and MH on storage potential of maize seeds. Among two growth regulators sodium dikegulac has been noticed to be more effective in invigorating maize seeds.

Keywords: Sodium dikegulac, Maleic Hydrazide, Accelerated Ageing, Seed Invigoration, Maize Seed Germination, Accelerated ageing.

Introduction

Zea mays L. is an important cash crop in India as well as abroad due to its use as a prominent staple food. Seeds of the species lose vigour and vitality due to higher temperature as well as relative humidity. Since such an environment is prevailing in India, too, long time storage of seeds of this species becomes problematic. Some physical and chemical manipulative techniques have been worked out in recent time to get rid of such climatic as well as biotic hazards which are conducive to earlier deterioration of stored seeds. Use of a host of chemicals like, salts, phenols, organic acids, antioxidants, essential oils, plant growth regulators etc. and also hydration and dehydration treatments have been found to favourably influence the vitality of seeds[1-6].

Sodium dikegulac (Na-DK) has been identified as a growth regulator of plant and has been effectively tried for seed potentiation by many workers[7-9]. Maleic hydrazide (MH) is also considered as a plant growth regulating compound of similar action.

In the present study the efficacy of two growth regulators, sodium dikegulac (Na-DK) and maleic hydrazide (MH) on the seed potentiation of *Zea mays* L. has been tested.

Materials and Methods

Maize seeds of Kaveri, KMH 3712 variety procured from Kaveri Seed Company Limited have been used in the present study.

To reduce the chances of lower performance of germination and plant growth due to infection, surface sterilization of seeds with 0.1% $HgCl_2$ was done for 90 sec. Seeds in three separate lots were then soaked with either of aqueous solution of sodium dikegulac (Na-DK, 100 µg/ml), maleic hydrazide (MH, 100 µg/ml) or double distilled water (DDH_2O) for 8 hours. Seeds were then kept at 32 ±2°C for 6 days to induce. Three more similar seed lots with similar pretreatments and drying but devoid of imposed aging were also prepared for the purpose of comparing with the performance of earlier seed lot and to know about the impact of growth regulators in circumventing aging, if any.

Germinability and field emergence of seeds of all six lots were recorded. Germination percentage for all seed lots were recorded following the rule of ISTA[10] after 7 days of soaking. Field emergence performances were recorded after 15 days of seed sowing. Growth and biochemical parameters were recorded from 30 and 60 day old plants grown from the seeds treated with the two growth regulators. Leaves were used as source plant parts for biochemical studies.

Chlorophyll extraction and estimation were done following the Arnon's[11] method and the quantitation of protein according to Lowry *et. al.* [12]. Extraction of nucleic acids was done as per Cherry[13] and quantitative estimation was done following Choudhuri and Chatterjee[14]. Activity of catalase was evaluated according to Snell and Snell[15] and amylase was analyzed following Khan and Faust[16]. Enzyme activity was deduced as $[(\Delta A \times T_v) / (t \times v)]$; where, ΔA stands for difference in the values of absorbance of the sample after incubation with respect to the control set; the total volume of filtrate as T_v, t as the duration of incubation of the substrate (in minutes) and the volume of the filtrate taken for incubation as v. Enzyme assay were done following the methods of Fick and Qualset[17].

Measurements of fresh weight and dry weight of plants, root length and shoot length, were taken from 30 and 60 day old seedlings, 10 in number for each set of pretreated and control seed samples.

Results and Discussion

Treatments of maize seeds with both of sodium dikegulac and maleic hydrazide, prior to inducing ageing of seeds, were noted to be effective in alleviating the loss of germination and decline in field emergence. Restoration of seed germinability and sprouting capacity is the testimony of the efficacy of the chemicals used for the purpose.

Seeds experiencing accelerated ageing, but without any pretreatment with growth regulators, showed impairment of field performance of plants (Table-1), as reflected by the reduction of lengths of root and shoot (Table-2), weight of whole plants in fresh and dry condition (Table-3), amount of chlorophyll and protein contents (Table-4), DNA and RNA (Table-5), as well as activities of catalase and amylase enzymes (Table-6). Alleviation of deleterious effects of ageing on seed germination, plant growth and metabolism due to the influence of sodium dikegulac and maleic hydrazide indicated the potential of both of the growth regulators in invigorating seeds.

Table-1
Effects of pre-treatment of seeds with sodium dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml), on percentage of germination and field emergence capacity of maize seeds stored under accelerated ageing condition for 6 days

Treatments	Percentage of germination		Field emergence capacity (%)	
	Accelerated ageing (days)			
	0	6	0	6
Control	77.7	48.3	57.2	37.4
Na-DK	80.2	60.1	65.5	49.8
M.H	81.2	53.2	63.1	45.2
LSD (*P*=0.05)	3.01	2.81	5.20	3.70

Table-2
Effect of pretreatment of seeds with sodium dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml), on changes of root length and shoot length of maize plants, raised from seeds stored under accelerated ageing condition for 6 days

Treatments	Root length				Shoot length			
	Plant age (days)							
	30		60		30		60	
	Accelerated ageing (days)							
	0	6	0	6	0	6	0	6
Control	3.06	3.22	12.16	9.01	24.8	11.0	52.3	41.4
Na-DK	3.45	4.21	15.88	12.80	31.2	17.2	61.1	53.3
M.H	3.40	4.17	14.66	11.95	27.1	14.1	60.4	47.2
LSD (*P*=0.05)	3.33	3.27	7.81	6.70	8.50	7.20	10.21	9.85

Table-3
Effect of pretreatment of seeds with sodium-dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml) on changes of fresh weight and dry weight of maize plants, raised from seeds stored under accelerated ageing condition for 6 days

Treatments	Fresh weight				Dry weight			
	Plant age (days)							
	30		60		30		60	
	Accelerated ageing (days)							
	0	6	0	6	0	6	0	6
Control	6.20	5.51	27.9	21.0	0.47	0.39	8.49	6.92
Na-DK	9.32	8.25	34.8	29.3	0.86	0.78	10.31	8.59
M.H	8.15	7.30	30.6	24.1	0.72	0.61	9.16	7.16
LSD (*P*=0.05)	7.25	6.10	29.65	28.10	0.65	0.55	9.16	7.96

Table-4
Effect of pretreatment of seeds with sodium dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml) on changes of chlorophyll and protein contents in leaves of maize plants, raised from seeds stored under accelerated ageing condition for 6 days

Treatments	Chlorophyll (mg/g fr.wt.)				Protein (mg/g fr.wt.)			
	Plant age (days)							
	30		60		30		60	
	Accelerated ageing (days)							
	0	6	0	6	0	6	0	6
Control	1.22	1.07	1.79	0.86	16.47	12.05	37.15	29.30
Na-DK	1.33	1.11	2.07	1.80	20.35	18.79	46.25	38.10
M.H	1.28	1.09	2.01	1.52	17.21	15.31	42.32	31.35
LSD (*P*=0.05)	1.10	1.06	1.86	0.92	6.90	6.43	8.23	7.45

Table-5
Effect of pretreatment of seeds with sodium dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml) on changes of DNA and RNA contents in leaves of maize plants, raised from seeds stored under accelerated ageing condition for 6 days

Treatments	DNA (µg/g fr. wt.)				RNA (µg/g fr. wt.)			
	Plant age (days)							
	30		60		30		60	
	Accelerated ageing (days)							
	0	6	0	6	0	6	0	6
Control	378.2	335.8	490.4	455.0	611.0	552.5	695.5	665.8
Na-DK	484.4	428.4	550.5	508.2	658.7	601.9	774.8	724.4
M.H	408.7	375.8	538.3	474.3	621.0	588.9	735.6	706.1
LSD (*P*=0.05)	37.24	35.32	51.10	48.25	62.01	58.26	71.54	68.58

Table-6
Effect of pretreatment of seeds with sodium dikegulac (Na-DK, 100µg/ml) and maleic hydrazide (MH, 100µg/ml) on changes of catalase and amylase contents in leaves of maize plants, raised from seeds stored under accelerated ageing condition for 6 days

Treatments	Catalase (unit/h/g fr. wt.)				Amylase (unit/h/g fr. wt.)			
	Plant age (days)							
	30		60		30		60	
	Accelerated ageing (days)							
	0	6	0	6	0	6	0	6
Control	51.8	37.7	81.9	53.7	43.6	60.4	63.6	73.7
Na-DK	56.2	52.6	86.7	69.4	35.8	65.3	49.2	60.2
M.H	54.1	45.5	83.6	58.0	40.9	62.4	57.0	68.3
LSD (*P*=0.05)	5.36	4.25	8.52	5.40	4.31	5.25	4.82	6.33

Results show an overall excellence in the performance of the seeds pretreated either with sodium dikegulac or maleic hydrazide prior to inducing ageing, in comparison to the plants raised from the ageing induced seeds. Biochemical parameters have been shown as indices of health of plants and vigour of seeds in earlier literatures[5-9,18-20]. The loss of seed vitality has been shown to be accompanied with the loss of some vital cell components as well as decrease of nucleic acids in many works[21,22]. The ability of the two growth regulators in invigorating seeds has also been expressed by the enhanced seed germinability, plant growth and metabolism. The magnitude of loss of chlorophyll and protein (Table-4), DNA and RNA contents (Table 5) as well as catalase and amylase (Table-6) activities were found to be significantly less in the plants raised from seeds that underwent pretreatment with both of the growth regulators. Earlier works of Haskins and Chapman[23] also report on the increased enzymatic activities of catalase, peroxidase and polyphenolase in the seedlings of *Zea mays* L. treated with maleic hydrazide.

Catalase, regarded as a scavenger enzyme[24], is an integral part of antioxidative system[25] and its greater activity in the pretreated seeds of *Zea mays* indicates higher vigour[4,9]. In view of its importance it has also been studied thoroughly in *Zea may* L.[26,27]. While amylase activity has been found to be greater in aged seeds, pretreatment with the two growth regulators are noted to arrest the higher activity in the plants showing a sign of better health.

Responses with respect to all parameters show the clear evidence of induced ageing and also the impacts of two growth regulators used in the present experiment. The trend of response for every parameter in each set of experiment and the kind of difference between the control set and those of the Na-DK and MH treated sets is almost maintained steadily. In this regard the effectiveness of Na-DK in restoring the vitality of seeds has been noted to be more than MH, as germination percentage, field emergence, lengths of root and shoot, fresh and dry weight of whole plants, chlorophyll, protein, DNA, RNA amount and catalase activity all have been noted to be better in plants raised from Na-DK treated seeds and amylase activity has been noted to be less, also as another index of better health.

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