INFLUENCE OF HALO PRIMING TREATMENTS ON SEED QUALITY IN CERTAIN MINOR MILLETS UNDER DROUGHT CONDITION

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Abstract

Small millets comprising six species are grown in India over covers 2 million ha, mostly in semi-arid, hilly and mountainous regions. India has the third largest area under small millets cultivation in the world. Millets require few inputs and withstand severe biotic and a biotic stresses. They are also more nutritious than major cereals. Despite these advantages, neglect in several arenas has resulted in a steady decline in the cultivation of minor millets in India over the past few decades. Seed priming conditioning is one of the physiological methods that improves seed performance and provides faster and synchronized germination. It is an easy, low cost and low risk technique and recently being used to overcome the salinity and drought problem in agricultural lands. *In vitro* evaluation was carried out to study the influence of halo priming treatments on seed quality in certain minor millets under drought condition. Freshly harvested bulk seeds of above minor millets of Varagu, Samai, Kuthiraivali, Tenai and Panivaragu were imposed with the following seed treatments i.e. Water (hydro priming), Kcl @ 2 % , Kcl @ 3 % , KNO_3 @ 2 %, KNO_3@ 3 %, KH_2PO_4 @ 2 % and KH_2PO_4 @ 3 %. Priming the seeds of above millets seeds were soaked in above solution for 6 hrs by adopting the seed to solution ratio of 1:1 under ambient conditions. The treated seeds were evaluated for its seedling quality characters. The study revealed that the minor millet, Varagu cv CO 3 and Kuthiraivali cv CO 1 seeds halo primed with KH_2PO_4 2 % for 6 h and Tenai cv. CO 6, Samai cv. CO 3 and Panivaragu cv. CO 4 seeds halo primed with KH_2PO_4 3 % for 6 h recorded higher seed qualities i.e. higher speed of emergence, germination percentage, seedling length, dry matter production and vigour index, when compared to other treatments.

Key words: Minor millets, halo priming, seed quality, etc.

1. Introduction

Millets are small grained cereals, the smallest of them include finger, kodo, foxtail, proso, little and barnyard millets. They are the staple food of the millions inhabitating the arid and semiarid tropics of the world. The grains of small millets, being nutritionally superior to rice and wheat, provide cheap proteins, minerals and vitamins to poorest of the poor where the need for such ingredients is the maximum millets are generally grown on marginal land as rainfed crops and have a wider range of adaptation and can withstand certain degree of soil acidity and alkalinity stress due to moisture and temperature variations in soil from heavy to sandy infertile soils but often have low productivity. Seed is a living entity and is subjected to various environmental stresses which affect the quality. Pre-sowing seed treatments are generally recommended for crops grown under any stress condition, particularly for crops grown as rainfed crop and among them seed priming is widely recommended as it has been proven for its invigorative effect that extent upto productivity. Seed priming is employed for better crop stand and higher yields in a range of crops. Heydecker, et al. (1973) revealed that controlled hydration of seeds to a level that permits pre-germinative metabolic activity to proceed, but arrests the actual emergence of the radicle which improve the quality of the seed. In minor millets, standardized priming techniques are not in vogue for adoption. Hence with the above background, the present study was carried out to study the influence of halo priming seed treatment on seed qualities in kodo, foxtail, proso, little and barnyard millets.

2. Materials and methods

The present investigation was carried out at the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University to study the influence of various seed hardening treatments on seed quality in certain minor millets. Genetically pure seeds of small millets viz., Foxtail millet (Tenai) cv. CO 6 (*Setaria italica* Beauv.), little millet (Samai) cv. CO 3 (*Panicum Miliare* L.), Kodo millet (Varagu) cv. CO 3 (*Paspalum scrobiculatum* L.), Proso millet (Panivaragu) cv. CO 4 (*Panicum miliaceum* L.) Barnyard millet (Kudiraivali) cv. CO 1. (E*chinochloa frumentacea* Link.) were obtained from the Centre of Excellence in Millets, TNAU, Athiyandal, Thiruvannamalai constituted the basic material for the study. Freshly harvested bulk seeds of above minor millets were imposed with the following seed treatments:

T_0 - Control (Unprimed)
T_1 - Water (hydro priming)
T_2 - Kcl @ 2 %
T_3 - Kcl @ 3 %
T_4 - KNO_3 @ 2 %
T_5 - KNO_3@ 3 %
T_6 - KH_2PO_4 @ 2 %
T_7 - KH_2PO_4 @ 3 %

During priming the seeds of small millets were soaked in water for 6 hrs by adopting the seed to solution ratio of 1:1 under ambient conditions (28-30^{0}C) and air dried in shade to their original moisture content. The above treated seeds were surface sterilized with 0.1% (w/v) $HgCl_2$ for 3 minutes and then washed thoroughly with glass distilled water. External water potential of -3.0 bars was prepared by using Poly Ethylene Glycol (PEG) 6000 and used for this experiment as the above millet seedling survives only upto the osmotic potential of -1.0 bar. Surface sterilized seeds of different treatments were soaked in PEG solution for five hours. Pre-soaked seeds were then allowed to develop seedlings in -1.0 bar PEG solution for seven days for proso millet and after 10 days for foxtail, little, kodo and barnyard millet under indoor laboratory condition following standard glass plate technique and observed for the seed quality parameters viz., imbibition rate (%), speed of germination, germination percentage, shoot length, root length, dry matter production, and vigour index under laboratory condition. The data were statistically analyzed as per the method of Panse and Sukhatme.

3. Results and discussions

Seed priming conditioning is one of the physiological methods that improves seed performance and provides faster and synchronized germination. Stand establishment is of primary importance for optimizing field production of any crop plant. Emergence and establishment are the two basic requirements for the successful seed programme as they offer scope not only for uniformity in the field but also for full exploitation of yield potential of the crop. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role. Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. It is a simple and low cost hydration technique in which seeds are partially hydrated to a point where pre-germination metabolic activities start without actual germination, and then re-dried until close to the original dry weight. It entails the partial germination of seed by soaking in either water or in a solution of salts for a specified period of time and then re-drying them just before the radicle emerges. Generally seed priming increases the uniformity and rate of seed emergence in crop seeds. Pre-sowing seed treatment with inorganic salts is easier, economic and with lower risk that alleviate the salinity hazards in agricultural lands. Halo priming leads to better germination and establishment in many crops such as maize, wheat, rice, and canola.

Farooq, et al. reported that presoaking with inorganic salts improved the seedling emergence, shoot and root length and biomass. In the present study, influence of halo priming treatments on seed quality in certain minor millets revealed that the seeds soaked in KH_2PO_4 2% and KH_2PO_4 3% for 6 h was able to germinate earlier. The seeds primed with KH_2PO_4 2% for 6 h produced higher speed of emergence (66.6), germination percentage (94%), seedling length (18.9 cm), dry matter production (41.9 mg) and vigour index (1776) and speed of emergence (80), germination percentage (93%), seedling length (23.1 cm), dry matter production (24.5 mg) and vigour index (2148) when compared to unprimed seed and other treatments in respect with Varagu and Kuthiraivali (Table 1 and 2). The seeds primed with KH_2PO_4 3% for 6 h produced higher speed of emergence (39.9), germination percentage (90%), seedling length (17.2 cm), dry matter production (19.8 mg) and vigour index (1548), speed of emergence (77.2), germination percentage (90%), seedling length (15.1 cm), dry matter production (17.7mg) and vigour index (1359) and speed of emergence (57.2), germination percentage (94%), seedling length (22.9 cm), dry matter production (39.8 mg) and vigour index (2153) when compared to unprimed seed and other treatments in respect with Tenai, Samai and Panivaragu (Table 3,4 and 5). The promotory effect observed in the KH_2PO_4 primed seed for speed of germination and germination parameters has been referred to the invigorating effect of presoaking. According to Austin, et al. the KH_2PO_4 seed priming treatment had improved the velocity of germination and seedling emergence. Afzal, et al. reported that enhancement in α-amylase activity in primed seeds may be attributed to proper hydration during imbibition that increased the starch hydrolysis and suggested that starch was converted into reducing sugars. The effect of the increased starch hydrolysis due to hydration treatments was not lost during the redrying process, as seen in the faster germination and increased uniformity of germination, higher seedling dry weight.

They have also observed that partial soaking and subsequent drying back had shown the invigorating effect upon the seeds of a number of species. Studies have indicated that relatively short pre-hydration treatments, either brief imbibition in water or exposure to high relative humidity can improve the vigour of the seeds. Many studies have related the KH_2PO_4 priming induced germination enhancement to the improvement in membrane integrity as well as the increases in protein and nucleic acid syntheses. It was plausible to presume that the enhanced germination due to potassium dihydrogen phosphate might be due to ions absorption during priming. Moreover, the potassium salts had been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle. In the present study, increase in shoot length, root length and dry matter production in irrespective of the crops due to priming might be due to earlier start of emergence. This paved way to conclude that the potassium ions were absorbed during seed priming with KH_2PO_4 solution and it was utilized rapidly during the course of germination. This might be one of the reason for germination enhancement and production of longer root, shoot and heaviest seedlings by seeds primed with KH_2PO_4 1% for 6 h. The pre-soaking with inorganic KH_2PO_4 salts improved seedling emergence, shoot and root length, and biomass, which leads to increase in the vigour index and protein. The beneficial effects of priming are associated with the repair and build up of nucleic acids the increased synthesis of proteins as well as the repair of membranes. The KH_2PO_4 priming also enhances the activities of anti–oxidation in treated seeds. Moreover, priming increases the activities of isocitrate lyase and malate synthase, enzyme activity and this increase in the activities of glyoxysome enzymes were linked to the improved emergence responses in primed bitter gourd seeds. Hence, the study revealed that the minor millet, Varagu cv CO 3 and Kuthiraivali cv CO 1 seeds halo primed with KH_2PO_4 2 % for 6 h and Tenai cv. CO 6, Samai cv. CO 3 and Panivaragu cv. CO 4 seeds halo primed with KH_2PO_4 3 % for 6 h recorded higher seed qualities i.e. higher speed of emergence, germination percentage, seedling length, dry matter production and vigour index in drought condition, when compared to other treatments.

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TABLE 1

Effect of Various Halo Priming Treatments on Seed Quality in Tenai cv. CO 6

Treatments	Imbibition rate (%)	Speed of emergence	Germination (%)	Seedling length (cm)	Dry matter production 10 seedlings^{-1} (mg)	Vigour index
T_0 - Control	-	27.2	76 (60.66)	15.5	15.7	1178
T_1 - Water	20	32.8	81 (63.43)	16.2	16.3	1312
T_2 - Kcl @ 2 %	18	32.0	82 (64.89)	16.5	16.9	1353
T_3 - Kcl @ 3 %	17	37.0	80 (63.43)	16.2	19.0	1296
T_4-KNO_3 @ 2 %	18	32.8	83 (64.89)	16.8	17.5	1394
T_5-KNO_3 @ 3 %	18	35.4	84 (66.42)	15.5	18.1	1302
T_6- KH_2PO_4 @ 2 %	18	32	85 (67.21)	16.2	17.3	1377
T_7- KH_2PO_4 @ 3 %	19	39.9	90 (70.73)	17.2	19.8	1548
Mean	18	33.6	83 (64.89)	16.3	17.6	1345
SEd	0.09	0.14	(0.30)	0.07	0.10	6.65
CD(P=0.05)	0.18	0.28	(0.60)	0.19	0.21	13.39

(Figures in the parenthesis are Arcsine transformed value)

TABLE 2

Effect of Various Halo Priming Treatments on Seed Quality in Varagu cv.CO 3

Treatments	Imbibition rate (%)	Speed of emergence	Germination (%)	Seedling length (cm)	Dry matter production 10 seedlings^{-1} (mg)	Vigour index
T_0 - Control	-	43.6	77 (62.02)	17.0	36.0	1309
T_1 - Water	13	53.4	82 (64.89)	17.9	38.1	1468
T_2 - Kcl @ 2 %	18	57.0	84 (66.42)	18.2	38.5	1529
T_3 - Kcl @ 3 %	15	63.2	88 (69.73)	17.8	37.9	1566
T_4-KNO_3 @ 2 %	14	58.8	81 (63.43)	17.4	40.4	1409
T_5-KNO_3 @ 3 %	14	67.2	84 (66.42)	17.7	37.9	1486
T_6- KH_2PO_4 @ 2 %	18	66.6	94 (75.82)	18.9	41.9	1776
T_7- KH_2PO_4 @ 3 %	16	60.8	91 (73.57)	18.0	40.3	1638
Mean	15	58.8	85 (67.21)	17.9	38.9	1523
SEd	NS	0.21	(0.45)	0.08	0.19	8.23
CD(P=0.05)	NS	0.43	(0.91)	0.17	0.39	16.56

(Figures in the parenthesis are Arcsine transformed value)

TABLE 3

Effect of Various Halo Priming Treatments on Seed Quality in Varagu and Kuthiraivali cv. CO 1

Treatments	Imbibition rate (%)	Speed of emergence	Germination (%)	Seedling length (cm)	Dry matter production 10 seedlings^{-1} (mg)	Vigour index
T_0 - Control	-	64.2	79 (62.02)	20.7	20.6	1635
T_1 - Water	26	74.8	86 (68.02)	20.9	21.9	1797
T_2 - Kcl @ 2 %	20	75.1	86 (68.02)	21.9	22.7	1883
T_3 - Kcl @ 3 %	18	77.2	90 (71.56)	21.3	21.3	1917
T_4-KNO_3 @ 2 %	26	75.2	88 (69.73)	20.8	20.5	1830
T_5-KNO_3 @ 3 %	26	79.2	84 (66.42)	20.7	24.1	1739
T_6- KH_2PO_4 @ 2 %	20	80.0	93 (73.57)	23.1	24.5	2148
T_7- KH_2PO_4 @ 3 %	19	76.8	86 (68.02)	21.3	23.7	1832
Mean	22	75.6	87 (68.86)	21.3	22.4	1847
SEd	0.11	0.35	NS	0.10	0.09	8.84
CD(P=0.05)	0.22	0.70	NS	0.20	0.18	17.78

(Figures in the parenthesis are Arcsine transformed value)

TABLE 4

Effect of Various Halo Priming Treatments on Seed Quality in Samai cv. CO 3

Treatments	Imbibition rate (%)	Speed of emergence	Germination (%)	Seedling length (cm)	Dry matter production 10 seedlings^{-1} (mg)	Vigour index
T_0 - Control	-	55.2	78 (62.02)	13.1	14.8	1022
T_1 - Water	16	67.8	84 (66.42)	14.6	15.3	1226
T_2 - Kcl @ 2 %	16	74.2	84 (66.42)	14.5	14.7	1218
T_3 - Kcl @ 3 %	15	60.2	82 (64.89)	14.6	15.1	1197
T_4-KNO_3 @ 2 %	15	75.8	83 (65.65)	14.5	17.1	1204
T_5-KNO_3 @ 3 %	16	69.2	86 (68.02)	14.6	15.1	1256
T_6- KH_2PO_4 @ 2 %	16	65.2	84 (66.42)	14.8	15.9	1243
T_7- KH_2PO_4 @ 3 %	15	77.2	90 (69.73)	15.1	17.7	1359
Mean	16	68.0	84 (66.42)	14.5	15.7	1216
SEd	0.08	0.29	(0.27)	0.08	0.07	6.07
CD(P=0.05)	0.17	0.58	NS	0.16	NS	12.20

(Figures in the parenthesis are Arcsine transformed value)

TABLE 5

Effect of Various Halo Priming Treatments on Seed Quality in Panivaragu cv. CO 4

Treatments	Imbibition rate (%)	Speed of emergence	Germination (%)	Seedling length (cm)	Dry matter production 10 $seedlings^{-1}$ (mg)	Vigour index
T_0 - Control	-	48.2	80 (63.43)	20.8	34.6	1664
T_1 - Water	19	51.2	89 (73.57)	21.7	36.5	1931
T_2 - Kcl @ 2 %	10	58.0	91 (72.54)	20.9	39.1	1902
T_3 - Kcl @ 3 %	13	52.0	90 (71.56)	19.9	39.3	1791
T_4-KNO_3 @ 2 %	13	56.8	87 (68.86)	20.5	39.5	1784
T_5-KNO_3 @ 3 %	15	52.0	88 (69.73)	21.9	38.6	1927
T_6- KH_2PO_4 @ 2 %	11	55.2	87 (68.86)	21.8	38.9	1897
T_7- KH_2PO_4 @ 3 %	11	57.2	94 (77.08)	22.9	39.8	2153
Mean	12	54.0	89 (70.63)	21.3	38.2	1881
SEd	0.07	0.21	(0.37)	0.10	0.15	9.18
CD(P=0.05)	0.13	0.43	(0.74)	NS	0.30	18.46

(Figures in the parenthesis are Arcsine transformed value)