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Effect of Priming and Growth Regulator Treatments on Emergence and Seedling Growth of Hybrid Maize (*Zea mays* L.)

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ABSTRACT

Impact of priming and growth regulator treatment on a hybrid maize seeds on the emergence and seedling growth was studied both under laboratory and field conditions. The seeds were subjected to hydropriming, osmotic priming (PEG-10,000), matriconditioning with compost, press mud or gunny bag and GA_3. Early germination was recorded in seeds matriconditioned with compost, press mud or GA_3 in laboratory experiments while all treatments except osmoconditioning exhibited early emergence under field condition. Maximal final germination percentage was recorded from matriconditioned and untreated seeds under both experimental conditions. Minimal root and shoot lengths were recorded from seeds treated with PEG. Higher electrical conductivity of seed leachates treated with PEG, control and press mud were recorded as compared to seeds treated with GA_3, distilled water, gunny bag and compost.

Key Words: Osmoconditioning; Matriconditioning; Hydropriming; GA_3; Maize

INTRODUCTION

High and rapid germination, determine good stand establishment which results in higher yields. So fast and uniform germination are as important for superior crop production as is total germination while slow, asynchronous and unreliable germination and emergence due to low vigor seeds (Matthews, 1980) leads to problems for successful crop production. Seed invigoration treatments have therefore, been developed to improve seed performance during germination and emergence. Most of these involve a period of controlled hydration of the seed to a point close to, but before, the emergence of the radicle after which the seeds are dried back to their initial moisture before sowing (Khan, 1992). Such treatments include water soaking (Bradford, 1986), priming in which hydration is controlled in an osmoticum such as polyethylene glycol (PEG) or a salt solution (Heydecker & Coolbear, 1977), solid matrix priming in which seeds are imbibed in an inert medium held at a known matrix potential (Cantliffe, 1997) and presoaking seed treatment with plant growth regulators in many vegetable crops (Nakamura *et al.,* 1982).

These pre-sowing hydration treatments improve germination or seedling growth or facilitate the delivery of seeds and other materials required at the time of sowing. In osmoconditioning seeds are held at low water potential solutions while during matriconditioning seed hydration is controlled by the physical and osmotic characteristic of a solid matrix carrier (Kubik *et al*., 1989). Priming is the enhancement of physiological and biochemical events in seeds during suspension of germination by low osmotic potential and negligible matric potential of the imbibing medium. Salts or non-penetrating organic solutes in liquid medium (osmoconditioning) or matrix solutions (matriconditioning) are used to establish equilibrium water potential between seed and the osmotic medium needed for conditioning (Khan, 1993).

Plant growth regulators are organic compounds, which are produced in very small amount in plants and play an important role in growth and development and yield of crops and are becoming quite popular in field of agriculture. Gibberellic Acid (GA_3) is the most important growth regulator, which breaks seed dormancy, promotes germination, internodal length, hypocotyl growth and cell division in cambial zone and increases the size of leaves. GA stimulates hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle and thus speeds germination by promoting seedling elongation growth of cereal seeds (Rood *et al*., 1990).

The aim of this paper were to examine whether priming with water, osmotica or solid matrix carrier and pretreatment with GA_3 results in enhancement of seed vigor in hybrid maize and to find out an effective seed enhancement technique for hybrid maize under our local ecological conditions and genetic material and to evaluate the vigour changes induced by these treatments both.

MATERIALS AND METHODS

Seeds of maize cv. Monsanto-7878 were obtained from Monsanto seeds (Pvt.) Ltd., Depalpur without chemical treatment. Monsanto-7878 is a yellow kernel double cross hybrid.

Osmotic priming. The seeds were soaked in aerated -1.1 MPa solution of PEG-10, 000 for 24 h (Bennet & Waters, 1987).

Gibberellic acid treatment. Seeds were soaked in 1L of aerated GA_3 solution for 24 h and surface dried with distilled water and redried to original weight with forced air under shade (Sundstrom *et al.,* 1987).

Hydropriming. Seeds were soaked in distilled water for 24 h. After soaking seeds were redried to original weight with forced air under shade (Bennett & Waters, 1987).

Solid matrix priming. Solid matrix priming was carried out with compost, press mud or gunny bags that are cheaper as compared to calcined clay and Micro Cell E. First of all 500 g seeds were mixed with I kg sterilized compost or press mud and 350 mL of distilled water in closed plastic containers. The containers were placed under shade at room temperature for 24 h. For gunny bag matriconditioning the seeds were placed within two saturated gunny bags for 24 h under shade (Bennett & Waters, 1987).

Post priming operations. After osmoconditioning or matriconditioning, seeds were given 3 washings with distilled water (Khan *et al.,* 1992) and redried to original weight with forced air under shade. At the end, all the treated seeds were sealed in airtight container and placed in refrigerator at 8±2ºC till further use. Seed Moisture contents were determined by using three seed samples according to the recommendations of Ellis *et al.* (1985) The seed moisture was 14.2%.

Vigour evaluation:

Cold test. Control and treated seeds were sown in plastic trays having moist sand and incubated at temperature of 10ºC for seven days and then at 25ºC for further four days. The experiment was replicated thrice with 25 seeds in each repeat. The seeds were placed with the embryo in direct contact with the sand (facing down). The seedlings were evaluated as described in the Seedling Evaluation Handbook (AOSA, 1991). Germination was obtained directly by daily inspection of the data.

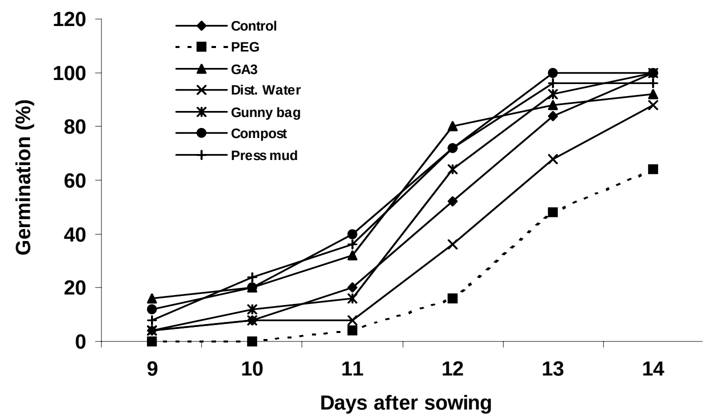
Electrical conductivity of seed leachates. After washing with distilled water, 5 g seeds were soaked in 50 mL of distilled water at 25ºC. Electrical conductivity of seed leachates was measured 0.5, 1, 1.5, 2, 6, 12 and 24 h after the soaking period using the conductivity meter (Model Twin Cod B-173) and expressed as uS/cm/g. The experiment was replicated twice.

The data collected was analyzed using Fisher's analysis of variance technique and treatment means were compared using least significant test (LSD) at 5% level of probability (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Germination. Different priming techniques significantly affected daily germination in laboratory conditions (Fig. 1). Germination was started after nine days of sowing in all the treatments except that of osmotically primed seeds. Faster germination was recorded in all the hydrated seeds except osmotically primed seeds than that of control at first count {9 DAS (days after sowing)}. In osmotically primed seeds, germination started after 11 days of sowing. Maximum germination was observed in GA_3 treated and matriconditioned with compost seeds during the first count. Maximum germination was observed in GA_3 treated and matriconditioned with compost seeds during the first count. It is well documented (Tekrony & Egli, 1977) that the first count is a better predictor of field emergence. Generally fast germination is due to high synthesis of DNA, RNA and protein during priming (Bray *et al*., 1989). Similar results were reported by Bennett and Waters (1987) who indicated early emergence was significantly lower in osmoconditioned seeds than that of other hydrated seeds under both laboratory and field condition.

Fig. 1. The effect of priming and growth regulator treatments on daily germination of hybrid maize in cold test



Emergence. Seedling emergence started after nine days of sowing in all the treated seeds except osmoconditioned seeds under field conditions (Fig. 2). All the treated seeds showed higher emergence percentage than that of control. On ninth day of sowing, highest emergence was recorded in seeds treated with GA_3 (36.25%). After 12 days of sowing, highest emergence was recorded in seeds treated with press mud (100%) while other treated seeds also showed higher seedling emergence. Minimal seedling emergence was recorded in seeds treated with PEG (85.83%). Similar results were reported by Kim *et al.* (1993), Coale (1991) and Hays (1992) who indicated seed soaking in GA_3 solution increased the emergence rate in rice. But these results are not in line with the findings of Hardegree (2000) who reported that osmotic priming of wheat seeds improved the germination rate, while GA_3 had no effect on the emergence rate.

Fig. 2. Effect of priming and growth regulator treatments on daily emergence of hybrid maize cv. Monsanto-7878

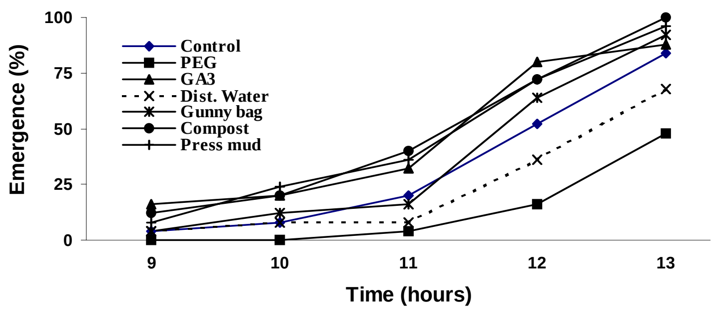
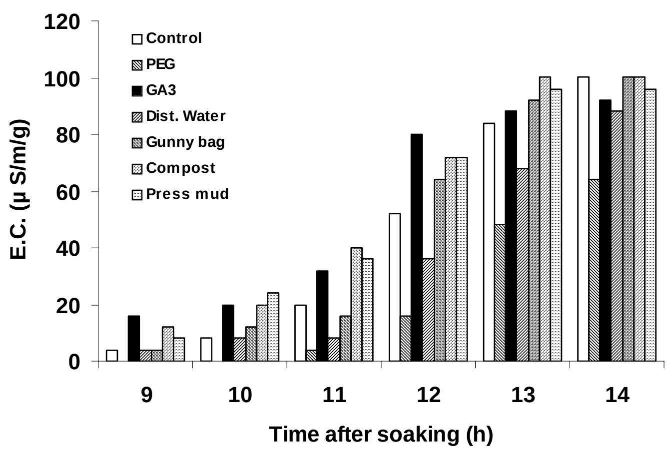


Fig. 3. Effect of priming and growth regulator treatments on EC seed leachates of hybrid maize cv. Monsanto-7878



Root and shoot length. Different seed priming techniques had highly significant effect on root and shoot length (Table I). The seeds treated with GA_3 had maximum root length, however, it remained statistically at par with all other treatments except that of osmoconditioning. Minimum root and shoot length were recorded from osmoconditioned seeds. An increase in root length might be the result of higher embryo-cell wall extensibility. Increased root length by GA_3 indicates that GA_3 stimulated hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle. These results are in lined with the work done by Jett *et al.* (1996) who reported that root growth rates of matric primed seeds were significantly higher than either osmotic or non primed seedlings at most temperatures. Rapid growth of hybrids is associated with increased content of endogenous GA_3, which promote seedling vigour, increase shoot height and weight and enhance grain yield as reported by Rood *et al.* (1990).

Root/shoot ratio. Priming techniques significantly affected root to shoot ratio (Table I). Maximum root to shoot ratio was recorded in seeds treated with compost, which was statistically at par with those of GA_3 soaking, hydropriming, matriconditioning with gunny bag, and control. Minimum root to shoot ratio was observed from osmoconditioning treatment and was statistically at par with those of seeds subjected to hydro or matripriming with press mud or gunny bag. The increase in root to shoot ratio by priming may be due to the result of higher cell wall extensibility and higher metabolic processes during lower imbibitional rate by hydro- or matri priming. While GA_3 has been reported to stimulate storage degradation in cereals and also hydrolysis the cell material that covers the radicle and thus promotes germination (Rood *et al*., 1990).

Electrical conductivity of seed leachates. The electrical conductivity (EC) of leachate from non-primed and matriconditioned (press mud) seeds increased rapidly during the first 30 min of imbibition and maintained the increasing trend upto 12 h of imbibition. Hydroprimed and GA_3 soaked seed leachates showed lowest EC during imbibition while highest value of EC was observed in seeds treated with PEG after 24 h. Electrolyte leakage from hydroprimed, matriconditioned with compost and gunny bag and GA_3 soaked seeds was consistently less than non-primed and matriconditioned seeds with press mud during the imbibition (Fig. 3). The low EC for other primed seed may be due to better plasma membrane structure by slow hydration while increased seed leachates conductivity of osmoconditioning and matriconditioning with press mud was probably due to the loss of ability to reorganize cellular membranes rapidly and completely (McDonald, 1980). EC is considered as an effective indicator of seed germination in sweet corn (Waters & Blanchette, 1983) but the results related to seeds matriconditioned with press mud were unexpected. Seeds treated with press mud showed maximum field emergence but EC of seed leachates was increased. The possible reason for this may be the

Table I. Priming and growth regulator treatments influencing root, shoot length and root/shoot ratio of hybrid maize cv. Monsanto-7878

Treatments	Root length (cm)	Shoot length (cm)	Root/shoot ratio
Control	9.303 a	9.303 a	1.430 a
Osmotic Priming	4.387 b	4.387 b	0.9833 b
GA_3	10.16 a	10.16 a	1.433 a
Hydropriming	8.287 a	8.287 a	1.313 ab
MC with gunny bag	9.933 a	9.933 a	1.327 ab
MC with compost	9.923 a	9.923 a	1.457 a
MC with press mud	7.893 a	7.893 a	1.027 b
LSD at 5%	***2.65***	***2.65***	***0.35***

MC = Matriconditioning; Means sharing common letters do not differ significantly from each other at 5% probability contributing of some mineral nutrients by press mud even after post priming washing (Jett *et al*., 1996).

CONCLUSIONS

The results suggest that hybrid maize seed vigour can be enhanced to some extent when treated with different priming techniques except osmotic priming. The failure of invigoration of maize seeds by osmotic priming confirms the findings of Bennett and Waters (1987) who reported that it is not successful with large seeded crops such as soybean and corn. The present results also confirm that cold test is a suitable vigour test for maize as compared to electrical conductivity test because it is inexpensive and correlated highly with field emergence.

REFERENCES

AOSA, 1991. Rules for Testing Seed. *J. Seed Tech*., 12: 18–9.

Bennett, M.A. and L. Waters, Jr., 1987. Seed hydration treatments for improved sweet maize germination and stand establishment. *J. Amer. Soc. Hort. Sci*., 112: 45–9.

Bradford, K.J., 1986. Manipulation of seed water relations via osmotic priming to improve germination under stress conditions. *Hort. Sci*., 21: 1105–12

Bray, C.M., P.A. Davison, M. Ashraf and R.M. Taylor, 1989. Biochemical changes during osmopriming of leek seeds. *Ann. Bot*., 63: 185–93.

Cantliffe, D.G., 1997. Industrial processing of vegetable seeds. *J. Korean Soc. Hort. Sci.,* 38: 441–5.

Coale, F.J., 1991. Performance of gibberellic acid treated seed in the EAA. Belle Glade EREC Res. Rep. EV Fla. Univ. Agric. Res. Educ. Cent. (Feb.): 40-49.

Ellis, R.H., T.D. Hong and E.H. Roberts, 1985. *Handbook of Seed Technology for Genebanks. Vol. I. Principles and Methodology*. International Board for Plant Genetic Resources, Rome, Italy.

Hardegree, S.P. and S.S. Van Vactor, 2000. Germination and emergence of primed grass seeds under field and simulated-field temperature regimes. *Ann. Bot*., 85: 379–90.

Hays, S.M., 1992. A botanical body builder strengthens rice. Agri. Res., (August), 10–12.

Heydecker, W. and P. Coolbear, 1977. Seed treatments for improved performance - survey and attempted prognosis. *Seed Sci. & Tech*., 5: 353–425.

Jett, L.W., G.E. Welbaum and R.D. Morse, 1996. Effect of matric and osmotic priming treatments on Broccoli seed germination. *J. Amer. Soc. Hort. Sci*., 121: 423–9.

Khan, A.A., 1993. Preplant physiological seed conditioning. *Hort. Rev*., 13: 131–81.

Khan, A.A., J.D. Maguire, G.S. Abawi and S. Illas, 1992. Matriconditioning of vegetable seed to improve stand establishment in early field planting. *J. Amer. Soc. Hort. Sci*., 117: 41–7.

Khan, A.A., 1992. Preplant physiological seed conditioning. *Hort. Rev*., 14: 131-181

Kim, J.K., M.H. Lee and Y.J. Oh., 1993. Effect of gibberellin seed spray on seedling emergence and growth in dry seeded rice. *Korean J. Crop Sci*., 34: 297–303.

Kubik, K.K., J.A. Eastin, J.D. Eastin and K.M. Eskridge, 1989. Solid matrix priming of tomato and pepper. Proc. Intl. Conf. Stand Establishment for Hort. Crops, p. 86.

Matthews, S., 1980. Controlled deterioration: a new vigour test for crop seeds. In: Hebblethwaite PD, ed. *Seed production*. London: Butterworths, 513-526.

McDonald, Jr. M.B., 1980. Assessment of seed quality. *Hort. Sci.,* 15: 784–8.

Nakamura, S., T. Teranishi and M. Aoki, 1982. Promoting effect of polyethylene glycol on the germinaiton of celery and Spinach seeds. *J. Japan. Soc. Hort. Sci*., 50: 461–7.

Rood, S.B., R.I. Buzzell, D.J. Major and R.P. Pharis, 1990. Gibberellins and heterosis in maize: quantitative relationship. *Crop Sci*., 30: 281–6.

Steel, R.G.D. and J.H. Torrie, 1984. *Principles and Procedures of Statistics. A bimaterical approach.* pp: 172–8. McGraw Hill International Company London.

Sundstrom, F.J., R.B. Reader and R.L. Edwards, 1987. Effect of seed treatment and planting method on Tabasco pepper. *J. Amer. Soc. Hort. Sci*., 112: 641–4.

Tekrony, D.M. and D.B. Egli, 1977. Relationship between laborato+ry indices of soybean and seed vigour and field emergence. *Crop Sci.,* 17: 573–7.

Waters, Jr. L. and B.L. Blanchette, 1983. Prediction of sweet maize field emergence by conductivity and cold tests*. J. Amer. Soc. Hort. Sci.,* 108: 778–81.

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