EDITORIAL

Seed Priming: an Efficient Farmers' Technology to Improve Seedling Vigour, Seedling Establishment and Crop Productivity

COLUMN

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1. Introduction

Poor seedling emergence and seedling vigour affect crop productivity in farmers' field. This urgez the necessity of simple, feasible and viable technology to improve seedling vigour and seedling establishment of crops under all environmental conditions. Rapid and uniform field emergence are two essential prerequisites to increase yield and quality in crops. Uniformity and increased seedling emergence of direct-seeded crops have major impact on final yield and quality (Gupta et al., 2008). Seed priming is a pre-sowing seed treatment that involves the controlled hydration of seeds, sufficient to allow pre-germinative metabolic events to take place, but radical emergence does not occur (Heydecker, 1937, Bradford, 1986). Priming allows the metabolic processes necessary for germination without protrusion of radicle. Priming is an enhancement method that accelerates germination and emergence (Khan, 1992; Taylor, 1998). Increased germination rate and uniformity have been attained due to metabolic repair during imbibitions.

2. What is Seed Priming?

Seed priming is defined as controlling hydration level within seeds so that the metabolic activity necessary for germination can occur, but radical emergence is prevented. During this phase, different physiological activities occur within the seed at different moisture levels (Leopold and Vertucci, 1989, Taylor, 1997).

Seed priming is a commercially used technique for improving seed germination and vigour. It involves imbibitions of seeds in water under controlled conditions up to the point of radical emergence followed by drying the seed back to the initial moisture content of the seeds (Basu, 1994, Mathews and Powel, 1988. McDonald, 2000). This treatment induces rapid, uniform and increased germination, improved seedling emergence, vigour and growth under diverse environmental conditions resulting in better stand establishment and the alleviation of phyotochrome-induced dormancy in some crops (Varier et al., 2010).

3. Techniques of Priming

The following types of seed priming are commonly used.

1. Hydropriming: It is undertaken in limited amount of water to the seeds. On farm steeping is the cheap and useful technique used in practice.

2. Osmopriming: Polyethylene glycol is commonly used as osmotic priming material. Other osmotic priming agents include glycerol, mannitol, specialized vermiculite compounds are used.

3. Matrix priming: It is the incubation of seeds in a solid, insoluble matrix (vermiculite, water absorbent polymer) with a limited amount of water.

Pregerminated seeds: Seeds are allowed to perform radical protrusion. The use of pregerminated seeds causes rapid and uniform seedling development.

The main objectives of priming seeds include

- To alleviate phytochrome-induced secondary dormancy (Vlades et al., 1985)
- To enhance germination and subsequent crop establishment
- To maintain uniformity in seed emergence
- To shorten the metabolic phase (Bewley and Black, 1978) so that emergence occurs before crusting thus crops can compete with weeds for water, space and light.

4. Beneficial Effects of Seed Priming on Seedling Establishment, Crop Growth and Productivity

a. Pre-soaking of seeds causes the hydration of membranes, proteins and the initiation of several metabolic functions (Bewley, 1982).
b. Hydro-priming enhaces germination and later growth of different species such as in wheat, maize, rice and chickpea (Harris et al., 1999).
c. Seed priming improves rapid and uniform germination and increases seed tolerance to adverse conditions (Heydecker et al., 1975; Harris et al*.,* 1999).
d. Seed priming resulted in yield improvement in cereals (Bradford, 1986).
e. Priming decreases longevity (Taylor, 1998).
f. Priming of seeds of different crops can alleviate the adverse effects of salinity stress and enhance crop yield (Ahmed, 1998; Harris et al., 1999; Pill and Kilan, 2000). *S*eed priming with KNO_3 (0.2%) increases significantly germination, root and shoot length and seedling vigour in maize. Osmopriming of seeds with NaCl nullify the adverse effects of salt stress.

5. Effect of Seed Priming on Some Crops

Recently Gupta et al*.,* (2008) made an extensive review on seed priming and its effects on crops. Seed priming benefits have been confirmed in different countries in various crops like wheat, barley, upland rice, maize, sorghum, pearl millet and chickpea. Therefore this innovative technology can be recommended to the farmers in different countries (ASA, 2003).

5.1. Field crops

5.1.1. Wheat

Harris et al., (2001) reported that that priming wheat seed overnight resulted in rapid emergence, more vigorous early growth, earlier flowering, earlier maturity and higher yield advantage. Many farmers reported that foliage in primed plots was darker than non-primed.

5.1.2 .Chickpea

Seed priming resulted in early emergence and better seedling establishment and improvement in yield components. Mukundam et al., (2008) reported that chickpea seed priming in water for 4 hrs is sufficient to have better germination, more number of pods plant^{-1} and higher yield (497 kg ha^{-1}) over control (456 kg ha^{-1}). It has been observed in chickpea that primed seeds exhibited higher germination speed. Priming by PEG 6000 at -1.0 MPa for 4 days was found to be the most beneficial treatment to improve chickpea seed performance (Kumar Chaudhary et al., 2008).
In on-farm trials in eastern India, it has been reported that seed priming increases the yields of chickpea and other rain-fed crops (Harris et al., 1999). It has been reported that priming of seeds resulted in 47% improvement in grain yield in chickpea. Arif et al*.*, (2007) reported that the seeds primed in 0.05% Zn solution (Zn SO4) gave the highest emergence, grain and biological yields in chickpea and wheat. Ali and Kamel (2009) studied the effects of seed priming on growth and yield of chickpea under saline soil. They observed that though there was no difference in total dry matter between halo (NaCl: - 0.67 MPa) and hydro-priming up to 80 days after sowing, but the highest dry matter and yield were obtained from halopriming.

5.1.3. Rice

Harris et al., 2001 evaluated on-farm seed priming in upland rice and rainfed crops in different trials in Africa. Overnight soaking followed by surface drying for several hours improved seedling emergence and stand establishment resulting in vigorous early growth, early maturity and higher yields. Lee et al. (1998) recommended priming of rice seeds to ensure better seedling establishment under adverse conditions. Osmopriming ($CaCl_2$ and $CaCl_2^+$ NaCl) improved seedling vigour index in flooded soil in rice.

5.1.4. Maize

On-farming seed priming can lead to better establishment in tropical crops such as maize, sorghum, rice and chickpea (Harris, 1996). In a study by Clark et al*.,* (2001), the results revealed that simple overnight soaking of seeds in water before sowing increased the rate of germination. According to Dezfuli et al., (2008), priming with water for 36 hrs was superior than other priming media. Maize seeds soaked in 20 ppm GA3 for 30 min improved few germination traits, but not yield (Subedi and Ma, 2005). Significant improvement in seedling emergence and high synchronization of silking and anthesis for maize genotypes have been achieved through hydropriming for 24 hrs (Nagar et al*.*, 1998). Seed priming with KNO_3 (0.2%) improved significantly germination percentage, seedling vigour index and electrical conductivity in maize. It is concluded that seeds may be treated with KNO_3 (0.2%) and hydropriming + thiram for 14 hrs for better seed quality and stand establishment.

5.1.5. Cotton

On farm seed priming is found to be effective in improving crop yield. Soaking duration plays a considerable role in improving cotton yield. In cotton, priming with water for 12 hrs appeared to be the most promising duration.

5.1.6. Soybean

Mohammed (2009) reported that primed seeds with potassium nitrate showed the highest values for all traits. Among the priming treatments, the lowest values of the traits were obtained with seeds primed with sodium nitrate. Primed seeds produced higher germination, greater seedling storage. Germination and seedling dry weight decreased with increase in duration in seed priming.

5.2. Vegetable crops

Seed soaking followed by drying of seeds has been demonstrated to improve germination of several vegetable seeds (Bradford, 1986). The priming technique has been employed in vegetable crop species to increase germination rate, total germination and seedling uniformity mainly under unfavourable conditions. Two studies have been conducted on the effect of priming on seedling vigour and productivity in vegetable crops (Maiti, 2006, Maiti et al, 2009; Maiti et al., 2011) by adopting the methods mentioned below:

Methodology: Seeds are soaked in three different methods viz. water for hydropriming, KNO_3 for halopriming and polythelene glycol (PEG) for osmotic priming and then the treated seeds are allowed to shade dry for 4-5 days. In this study, different priming techniques are adopted on hybrids of few vegetable crops such as tomato, chilli, cucumber and cabbage. The time required for treatment is standardized in the preliminary experiments. For example, in the case of hydropriming the time required for each species to initiate germination was noted based on which two times viz., suboptimum near to the initiation of germination (for eg., 20 hrs) and half of suboptimum (10 hours) in case of tomato. The selection of time varies according to the species and cultivars.

Four vegetable crops were used in this experiment under laboratory conditions. Seeds were sown in plastic pots using coco peat (coir peat) at room temperature and artificial light was provided to maintain light up to 15 days and room temperature was maintained at about 27°C. The time required for each treatment for each vegetable species have been selected varying among species as mentioned below crop wise.

5.2.1. Tomato

The hybrids showed variability in different priming treatments with respect to different variables. In general, hydropriming and halopriming gave favourable response in respect of agronomic traits and yield. Cheng and Bradford (1999) did not get remarkable response to osmopriming and hydropriming on germination time in the case of tomato. In general, it is observed that emergence percentage was greater in both hydropriming treatments. In case of shoot length, both hydropriming treatments achieved greater shoot length compared to the control. With respect to root length, the responses varied in different hybrids and treatments.

5.2.2. Chillies

It was reported that all priming treatments improved agronomic traits. In general, days to flowering and fruiting were earlier than the control. Hydropriming-1 gave about 67% increase in yield as compared to control. Kumar Choudhary et al., (2008) studied the effect of priming and ageing on seed quality parameters of chilli. Maximum increase in germination and other seedling parameters was witnessed in halopriming and in osmopriming.

5.2.3. Cucumber

The response of cucumber to different priming treatments reveal that priming treatments showed beneficial effects of some agronomic variables such as plant height, number of leaves, early fruiting and number of fruits.

5.2.4. Cabbage

The response of cabbage to different priming treatments. Priming treatments showed beneficial effects of some agronomic variables such as emergence percentage, plant height, number of leaves, and leaf length. In all the treatments mentioned above cabbage showed remarkably greater growth specially in hydropriming-I and halopriming compared to control.

6. Conclusion

A comparative study on the effects of priming techniques revealed that in all the crops studied, the priming techniques improved growth and yield of all the crops although the hybrids showed variation in responses to different treatments. In almost all the cases, improvement in seedling vigour and agronomic traits specially yield with special reference to tomato and chilli was observed.

7. References

Ahmed, S., Anwar, M., Ullah, H., 1989. Wet and pre-soaking by improved germination. Crop Science 1181, 125-127.

Ali, E., Kamel, S.G., 2009. Effects of seed priming on growth and yield of chickpea under saline soil. Recent Research in Science and Technology 1(6), 282-286.

Arif, M., Waqas, M., Nawab, K., Shahid, U., 2007. Effect of seed priming in Zn solution in chickpea and wheat. In: Proceeding of the Africa Crop Science Conference 8, 27-31 October 2007, Egypt, 237-240.

ASA., 2003. Innovative technologies-On farm seed priming. A low-risk and low cost activity for farmers. Action for Social Advancement , Sahyog Nagar Dahood, Gujrat, India.

Basu, R.N., 1994. An appraisal of research on wet and dry physiological seed treatment and their applicability with special reference to tropical and subtropical countries. Seed Science and Technology 22, 107-126

Bewley, J.D., Black, M., 1978. Physiology and Biochemistry of seeds. 1(1), The Haworth Press, Inc., New York.

Bewley, J. D., A., Black, M., 1982. Physiology and biochemistry of seeds in relation to germination. Springer Verlag, Berlin, Germany.

Bradford, K.J., 1986. Manipulation of seed water relations via osmotic priming to improve germination under stress conditions. Horticulture Science 21, 1105-1112.

Cheng, Z.Y., Bradford, K.J., 1999. Hydrothermal time analysis of tomato seed germination responses to priming treat-

ments. Journal of Experimental Botany 50, 89-99.

Clark, L.J., Whalley, W.R., Ellis-Jones, J., Dent, K., Rouse, H.R., Savage, F., 2001. On-Farm seed priming in maize: A Physiological evaluation. In: Seventh Eastern and Southern Africa Regional Maize Conference. 11-15th January, 268-273.

Dezfuli, P.M., Sharif-zadeh, F., Jammohammadi, M., 2008. Influence of priming techniques on seed germination behaviour of maize inbred lines (*Zea mays* L.). ARPN Journal of Agricultural and Biological Science 1(4), 22-25.

Gupta, A., Kumar, A., Roy, M.B., Naseem, M., Chaudhary, V.K., Maiti, R.K., 2008. Seed Priming: Aftermath. International Journal of Agriculture, Environment and Biotechnology 1, 219-212.

Gupta, A., Kumar, A., Roy, M., Naseem, M., Choudhury, V.K., Maiti, R.K., 2008. Seed Priming: International Journal of Agriculture, Environment and Biotechnology 1(4), 199-209.

Harris, D., 1996. The effects of manure, genotype and priming and depth and date of sowing on the emergence and early growth of *Sorghum bicolour* (L) Moench in semi-arid hotwarm. Soil and Tillage Research 40, 71-88.

Harris, D., Joshi, A., Khan, P.A., Gothkar, P., Sodhi, P.S., 1999. On farm seed priming in semi-arid agriculture. Development and evaluation in maize, rice and chickpea. Extension Agriculture 35, 15-29.

Harris, D., Raghuvanshi, B.S., Gangwar, S.C., Singh, S.C., Joshi, K.D., Rashid, A., Hollington, P.A., 2001, Participatory evaluation by farmers of on-farm priming in wheat in India, Nepal and Pakistan. Experimental Agriculture 37, 403-415.

Heydecker, W., Higgins, J., Turner, Y.J., 1975. Invigoration of seeds. Seed Science and Technology 3, 881-888.

Hill, H.J., Taylor, A.G., Min, T.G., 1989. Density separation of imbibed and priming vegetable seeds. Journal of American Society of Horticultural Science 114, 661-665.

Khan, A.A., 1992. Preplant physiological and seed conditioning. In: Janik, J. (Ed.), Horticultural Reviews. John Wiley and Sons, New York, 131-181.

Kumar Chaudhury, V., Shubhan Kumari, Chaurasia, Naseem, M., Arnab Gupta, and Maiti, R.K. 2008. Effect of priming and ageing on seed quality parameters of chilli (*Capscicum annuum*). International Journal of Agriculture, Environment and Biotechnology 1, 111-116.

Kumar Chaudhury, V., Cauasia, S.K., Gupta, A., Naseem, M., 2008. Effect of priming on germination and vigour of chickpea seed. International Journal of Agriculture, Environment and Biotechnology 1, 196-198.

Lee, S.S., Kim, J.H., Hong, S.B., Kim, M.K., Yun, S.H., Park, E.H., 1998. Priming effect of rice seeds on seedling establishment under adverse conditions. Korean Journal of Crop Science 43(3), 194-198.

Leopold, A.C., Vertucci, C.W., 1989. Moisture as a regulator of physiological reactions in seeds. In: Stanwood, P.C. and McDonald, M.B. (Eds.), Seed moisture. Crop Science Society of America Special publication number 14, Madison, WI, 51-69.

Maiti, R.K., Gupta, A., Umasahankar, P., Raj Kumar, D., Vidyasagar, P., 2009. Effect of priming on seedling vigour and growth and productivity of few vegetable species: Tomato, Chilli, Cucumber and Cabbage. International Journal of Agriculture, Environment and Biotechnology 2 (4), 368-374.

Maiti, R.K., Sarkar, N.C., Singh, V.P., 2006. Principles of post harvest seed physiology and technology. Agrobios India, 226.

Maiti, R.K., Vidyasagar, P., Rajkumar, D., Ramaswamy, A., Rodriguez, H.G., 2011. Seed priming improves seedling vigor and yield of few vegetable crops. International Journal of Bio-Resource and Stress Management 2(1), 125-130.

Mukundam, B., Venkata Ramana, M.V., Ramanjaneyulu, A.V., Raja, V., 2008. Effect of seed priming and tillage practices on growth parameters, yield attributes and yield of chickpea grown in rice fallows. Crop Research 35 (1&2), 151-152.

Pill, W.G., Kilan, E.A., 2000. Germination and emergence of parseley in response to osmotic or matric seed priming and treatment with gibberellins. Horticultural Science 35, 907-909.

Mathews, S., Powell, A.A., 1988. Seed treatments, developments and prospects. Outlook Agriculture 17, 97-103.

McDonald, M.B., 2000. Seed priming. In: Black, M. and Bewelly, J.D. (Eds.), Seed Technology and its biological basis. CRC Press, Florida, 287-325.

Mohammed, G.R., 2009. The effect of seed priming on plant traits of late spring seeded Soybean (*Glycine max* L.). American-Eusian Journal of Agriculture & Environment Science 5(3), 322-326.

Nagar, R.P., Dadlani, M., Sharma, S.P., 1998. Effect of hydropriming on field emergence and crop growth of maize genotypes. Seed Research 26, 1-5.

Subedi, K.D., Ma, B.L., 2005. Seed priming does not improve corn yield in a humid temperate environment. Agronomy Journal 97, 211-218.

Taylor, A.G., 1997. Seed Storage, germination and quality. In: Wien, H.C. (Ed), The physiology of Vegetable Crops, CAB International, Wallingford, UK, 1-36.

Taylor, A.P., Allen, P.S., Bennet, M.A., Bradford, K.J., Burns, J.S., Misra, M.K., 1998. Seed characteristics. Seed Science Research 8, 245-256.

Varier, A., Vari, A.K., Dadlani, M., 2010. The cellular basis of seed priming. Current Science 99 (4), 450-456.