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Short communication

The efficacy of different seed priming osmotica on the establishment of maize (*Zea mays* L.) caryopses

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Abstract

The purpose of this Communication is to compare the efficacy of different seed priming osmotica on the germination and emergence of maize caryopses. First, a laboratory experiment was carried out to determine the effects of different seed priming osmotica on germination. The osmotica used are 0.1% copper sulphate, 0.1% zinc sulphate and 0.1% sodium sulphate. A control of unprimed caryopses was used for comparative analysis. In general, seed priming significantly increased the final caryopses germination. Caryopses primed in copper sulphate, however, gave the highest final germination. Then, field trials to determine the final seedling emergence of caryopsis in the field were carried out in a semi-arid area in southern Zimbabwe. Results testify that priming in copper sulphate and zinc sulphate significantly increased seed emergence by 43% and 29%, respectively, while priming in sodium sulphate did not significantly increase emergence. The study thus recommends copper sulphate as the most suitable seed priming osmotica.

Keywords: Seed emergence; Osmotic potential; Drought tolerance; Seedling vigour; Water stress

Good crop establishment is a major constraint to crop production in the semi-arid tropics (Matarira et al., 2004). Seeds and seedlings often experience adverse physical conditions in the seedbed such as high temperatures, rapid soil drying and crust formation (Parera and Cantliffe, 1994). Slow asynchronous, unreliable germination, emergence, and insufficient stand establishment of maize are major problems in low-precipitation areas. High temperatures and soil crusting may adversely affect germination and post-germination growth. Semi-arid tropics face major challenges when it comes to soil structure management. Soils are vulnerable to compaction, crusting and erosion due to their low organic matter status and unstable aggregates (Nerson and Govers, 1986).

In Zimbabwe, most maize production is rain fed, and according to Rowland (1993), rain-fed crop production systems in the dry lands of Africa operate in a risky environment. The risks are related to moisture

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deficiency and are of several distinct types. The first risk is related to inadequate and uneven distribution of rainfall. In general, rainfall in semi-arid Zimbabwe is very low and highly variable resulting in highly uncertain yield levels. Furthermore, the distribution of the rainfall during cropping periods is uneven, with high amounts of rain when it is not needed and lack of it when the crop needs it most. Secondly, the late onset and early cessation of rains result in severe shortening of the rainy season. When the rains set in late, the sowings of the crop are delayed resulting in poor yields. At times, the rains may tail off very early in the season exposing the crop to drought during the critical flowering and maturity stages, thus reducing crop yields considerably. Farmers are too familiar with early rains that peter out early resulting in poor germination and hence the need to re-plant. Not only does this lead to increased seed and labour costs but also crop establishment is delayed and the prospects of an adequate harvest diminish.

Crop scientists and other technocrats have responded to the plight of semi-arid farmers in a number of ways. These include breeding for drought tolerance, irrigation, and the promotion of water conservation technologies among others. Breeding for drought tolerance is not easy; the search for germination-specific genes has been laborious and time consuming (Maiti et al., 2006). Irrigation is too expensive for the resource poor farmers in the semi-arid areas while the labour and equipment intensiveness associated with the majority of water harvesting techniques make them unattractive to farmers.

Osmotic seed priming, which does not require sophisticated equipment, produces quicker and easier to see results and is far less expensive than most water conservation techniques, and offers farmers with a highly attractive alternative for improving crop establishment and yields. Seed priming is a physiologically based, seed-enhancement process for improving the germination characteristics of seeds. It is accomplished by partially hydrating seeds and maintaining them under defined moisture, temperature and aeration conditions for a prescribed period of time. Heydecker et al. (1973) defined osmotic seed priming as a pre-sowing treatment in an osmotic solution that allows seeds to imbibe water to proceed to the first stage of germination but prevent radicle protrusion through the seed coat. Recently Taylor et al. (1998) used a broader term "seed enhancement" which includes pre-soaking hydration, coating technologies and seed conditioning. It is seen as a viable technology to enhance rapid and uniform emergence, higher vigour and better yields mostly in vegetable and flower species and some field crops.

Different osmotica can be used in seed priming and these, according to Taylor et al. (1998), have got different characteristics and levels of efficacy. Some of the osmotica that can be used include potassium nitrate, calcium chloride, boron agrosan, cycocel, sodium chloride, sodium sulphate, magnesium sulphate, citric, furamic, succinic, malic acid, purines, pyrimidines, caffeine, uracil, xanthine, uridine diphosphate (De Chandra, 1999).

This short communication describes results of experiments that were carried out to compare the efficacy of different seed priming osmotica on maize in semi-arid areas of Zimbabwe. The experiment was done in two parts. The first part was a laboratory test to compare germination percentages of seed subjected to different osmotica treatments. The second part was a field trial to test the caryopsis emergence efficacy of the different osmotica in a low-rainfall area in southern Zimbabwe.

Firstly, three seed lots of maize variety Pan 413 were primed at 25 °C for 24 h in three different aerated osmotic solutions (0.1% copper sulphate, 0.1% zinc sulphate and 0.1% sodium sulphate). The water potentials of these solutions were approximately the same at an average of -1.5 MPa. During priming, containers were kept well aerated, because sufficient oxygen is a requirement for seed respiration in osmotic seed priming. Constant stirring was done to avoid development of anaerobic conditions. After the 24-h priming period, seeds were rinsed in deionized water for 2 min and then air dried for 24-h at room temperature (25 °C).

After priming, seeds were firstly surface sterilized using 0.05% sodium hypochlorite to remove microbes. The experiment had four treatments, which are seeds primed in copper sulphate, seeds primed in sodium sulphate, seeds primed in zinc sulphate and the unprimed seeds as the control. Three replications of each treatment were placed in Petri dishes containing two germination papers and 10 ml of deionized water and incubated in a germination chamber at 25 °C. The complete randomized design (CRD) was used in the experiment, since the experimental unit was homogenous. The treatments were assigned to the experimental unit at random. Radicle protrusion was scored at 24-h intervals for 7 days. Data were collected on the following parameters: days to start germination, mean germination time, days to 50% germination and the final germination percentage.