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# Usefulness of hydro-matrix seed priming in cumin (*Cuminum cyminum* L.) for hastening germination

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## Abstract

An experiment was conducted to address the seed germination and seedling establishment problem in cumin during 2012-13 at NRCSS, Ajmer. Seeds of two popular genotypes of cumin viz. GC 4 and RZ 209 were taken. hydro-matrix seed priming was done for hastening the germination under laboratory and field conditions. Six hours hydro priming followed by 72 hours matrix priming with synthetic soil proved best in hastening the germination in which more than 90% seeds have been germinated on 4$^{th}$ day after inoculation as compare to 8$^{th}$ day under control conditions. Genotype GC 4 is more responsive to priming than RZ 209. Similar results were obtained under field conditions. However, time taken in 90% germination was 6$^{th}$ day after sowing as compared to 10 days in non primed seeds. This method of seed priming is not only hastening the germination but cost effective also and can be performed by farmer himself. It is not include any chemical treatment thus may be used in organic cumin production. This also save one irrigation which otherwise required before germination of cumin seeds under normal conditions.

**Key words:** Cumin, germination, hydro priming and matrix priming

## Introduction

Seeds must germinate and seedlings emerge, quickly and uniformly throughout the field so that light, water and soil nutrients may be used for maximum efficiency. Unfortunately, this seldom occurs in the marginal environments of the semi-arid tropics. Poor quality soils, inferior quality seeds and limited input resources all contribute to a situation where good crop establishment is often difficult. Sparse crops need to be re-sown, which is expensive and resource consuming. If farmers are to improve their livelihoods, solutions must be found, however simple, for better germination and establishment of crops. Once sown, seeds spend significant amounts of time just absorbing water from the soil. By reducing this time to a minimum seeds can be made to germinate, and seedlings emerge, more quickly. The easiest way to do this is to soak seeds in water before sowing. This is not a new idea, however, soaking was only ever done when conditions were poor - to "catch up" on time lost to drought. Soaking was never done on a regular basis and the duration of soaking was highly variable. Thus results had been mixed. The three early phases of germination are: (i) imbibition, (ii) lag phase, and (iii) protrusion of the radical through the testa (Simon, 20). Priming is a procedure that partially hydrates seed, followed by drying of seed, so that germination processes begin, but radical emergence does not occur. Methods of seed priming have been described in detail by Bradford (2) and Khan (9) and include soaking seed in water or osmotic solution, and intermixture with porous matrix material.

Cumin is one of the major seed spices crop of India mainly grown in Rajasthan, Gujarat and some part of Madhya Pradesh and Haryana. Seed germination and poor seedling establishment is a major problem in cumin cultivation. It requires 10 to 15 days in seedling emergence and one pre germination irrigation for successful seedling establishment. Moist soil condition during seedling establishment is congenial for wilt disease caused by *Fusarium oxysporum* f. sp. *cumini.* This disease is sometimes so severe up to the level of destroying the whole crop stand. To address this problem various seed priming experiments have been conducted at NRCSS, Ajmer. Present communication provide a simple, cost effective and non chemical seed priming protocol for hastening germination in cumin by reducing the days to germination by 7-8 days as compared to non primed seeds.

## Material and methods

Seeds of two genotypes GC 4 and RZ 209 were taken and soaked with shaking for 3, 6 and 9 hrs. The seed exudates was collected and analyzed for total phenol and flavonoid contents and seed germination percentage was recorded for each treatment. After soaking treatment seeds were intermixed with Diatomaceous earth and synthetic soil (mixture of



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perlite, coco peat and organic material). Mixture of matrix material and seeds were moistened with distilled water. Counted seeds were taken from the mixture after 48, 72 and 96 hrs and inoculated in BOD incubators at 25 °C. Observations were recorded on number of seeds germinated after inoculation. The best treatment was selected for replication under field conditions.

***Thermo-priming and combination of hydro-thermo priming***

Seeds of both the genotypes (GC 4 and RZ 209) were soaked in distilled water for 0, 6 and 9 hrs. After soaking one set of seeds was dried using blotting paper and another set of seeds was dried at room temperature up to complete dryness. These seeds were place at 4°C in a refrigerator. Fifteen seeds per replication were inoculated in a petri dish after 0, 8, 13, 18, 25, 32 days of low temperature treatment. Days to 90% germination of germineable seeds were counted to know the treatment effect.

## Results and discussion

Table 1 showed Total phenolic and total flavonoid content in seed exudates of genotypes GC 4 and RZ 209 after soaking and shaking the seeds for 3, 6 and 12 hrs. Soaking with shaking for 12 hrs resulted in highest phenolics and flavonoids in both the genotypes. Maximum leaching of phenolic and flavonoids from seeds was taking place during 3 to 6 hrs in both the genotypes. The seeds from these treatments were inoculated in petri dishes containing moist filter paper and placed in BOD incubator for germination. The germination of seeds were observed daily and number of germinated seeds were counted. Number of days in 90% germination of viable seeds was calculated. The results revealed that genotype GC 4 showed 90% germination after 7 days of inoculation where seeds were soaked and shacked for 6 hrs and phenolic and flavonoid content were 45.42 and 15.73 ppm in 1000 ppm seed exudates while control or untreated seeds contained 58.96 and 24.98 ppm phenolic and flavonoid content respectively. Similarly genotype RZ 209 showed 90% germination after 6 days of inoculation in the treatment of 6 hrs soaking and shaking where phenolic and flavonoid content were 46.14 and 22.23 ppm in 1000 ppm seed exudates as compared to control or untreated seeds which showed 51.06 and 23.73 ppm phenolic and flavonoid content respectively.

Phenolic compounds are secondary metabolites of plants generally involved in defense against ultraviolet radiation or aggression by pathogens. Several thousands of phenolic compounds have been described in plants and can be grouped into different classes according to their basic chemical structure (such as type and number of phenol rings), and into different subclasses, according to specific substitutions in the basic structure, association with carbohydrates and polymerized forms (Manach *et al.*, 2011). These compounds are also of great significance in plant development. They are involved in diverse processes such as rhizogenesis (Curir *et al.*, 3), vitrification (Kevers *et al.*, 8), resistance to biotic and abiotic stress (Delalonde *et al.*, 4), and redox reactions in soils (Takalama and Oniki, 23). Additionally, they serve as flower pigments, act as constitutive protection agents against invading organisms, function as signal molecules, act as allelopathic compounds, and affect cell and plant growth (Ndakidemi and Dakora, 13). They have also been recognized as allelochemicals for weed control (Putnam and Tang, 17) and plant defence molecules (Vidhyasekaran, 25). Some of the phenolic

**Table 1** Total phenolic, flavonoid and antioxidant content in distilled water extract from seeds of cumin genotypes

| Genotypes | Total Phenolic Content (ppm GAE/1000 ppm seed exudates) | Total Flavonoid Content (ppm QE/1000 ppm seed exudates) | Number of days in 90% germination |
|---|---|---|---|
| GC-4 Control | 58.96 | 24.98 | 14 |
| GC-4 3hr | 44.60 | 07.23 | 08 |
| GC-4 6hr | 45.42 | 15.73 | 07 |
| GC-4 12hr | 47.17 | 25.09 | 11 |
| RZ-209 Control | 51.06 | 23.73 | 12 |
| RZ-209 3hr | 43.99 | 9.40 | 10 |
| RZ -209 6hr | 46.14 | 22.23 | 06 |
| RZ-209 12hr | 52.76 | 24.18 | 11 |

compounds play important role in several physiological responses in plants, e.g. salicylic acid has a direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It also affects ethylene biosynthesis, stomatal movement and reverses the effects of ABA on leaf abscission. Enhancement of the level of chlorophyll and carotenoid pigments, photosynthetic rate and modifying the activity of some of the important enzymes are other roles assigned to this and its structurly related phenolic compounds (Hayat *et al.*, 7).

The inhibitory effect of these compounds on germination and early growth is not surprising since phenolic acids are potent germination and growth inhibitors (Einhellig, 5; and Mizutani, 12). For example, phenolics from barley affect the growth of other plants (Liu and Lovett, 10). Such inhibitory impact of phenolics has also been reported in mung bean (Batish *et al.*,1).

Table 2 and 3 showed the effect of hydro-matrix seed priming of cumin genotypes GC 4 and RZ 209 on number of days to 90% germination. Diatomaceous earth and synthetic soil (mixture of perlite, vermiculite and peat) were used as matrix material while seeds were pre soaked in distilled water for 0 and 6 hrs. These seeds were intermixing with porous matrix material i.e. diatomaceous earth and synthetic soil and moistened with distilled water. This mixture was kept for 48, 72 and 96 hrs at room temperature. After that 45 seeds from each treatment were inoculated in three replication at 25 °C. When the seeds were primed with matrix material without pre soaking both the genotypes responded at par and best results were obtained with synthetic soil where 90% seeds were germinated after 6.0 days of inoculation. Effect of priming duration was not significant as all three treatments showed same results. However, matrix priming when preceded with hydro-priming of 6 hrs further reduced the time taken in germination. Ninety percent germination was noticed in genotype GC 4 after 4 days of inoculation in the treatment of 72 hrs matrix priming with synthetic soil. Genotype RZ 209 took however, 5 days to achieve 90% germination.

Similar experiment was repeated under field conditions by keeping 72 and 96 hrs matrix priming with or without hydro-priming. Table 3 revealed the data of field experiment. Genotype RZ 209 was more responsive than GC 4 under field experiment. Both the matrix materials were found suitable as well as the effect of duration of priming was not seen. However, 90% germination was observed in 6-7 DAS in RZ 209 and 8 DAS in genotype GC 4.

**Table 2** Effect of seed priming on time taken in germination (*in vitro*)

| Duration of matrix priming | Without soaking (Matrix priming) | | | | 6 hr soaking (Hydro-matrix priming) | | | |
|---|---|---|---|---|---|---|---|---|
| | GC 4 | | RZ 209 | | GC 4 | | RZ 209 | |
| | Days to 90% germination | | | | | | | |
| | DE | SS | DE | SS | DE | SS | DE | SS |
| 48 hrs | 7.0 | 6.0 | 7.0 | 7.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 72 hrs | 7.0 | 6.0 | 8.0 | 6.0 | 6.0 | 4.0 | 6.0 | 5.0 |
| 96 hrs | 8.0 | 6.0 | 9.0 | 6.0 | 7.0 | 6.0 | 7.0 | 6.0 |

**Table 3** Effect of matrix priming on time taken in germination (*in vivo*)

| Duration of matrix priming | GC-4 | | RZ-209 | | GC-4 | RZ-209 |
|---|---|---|---|---|---|---|
| | Time taken in germination in 90% lines | | | | | |
| | DE | SS | DE | SS | Control | Control |
| 72 hrs with soaking | 7 | 8 | 7 | 7 | 8 | 8 |
| 72 hrs without soaking | 10 | 10 | 9 | 9 | 10 | 11 |
| 96 hrs with soaking | 8 | 8 | 7 | 6 | 8 | 8 |
| 96 hrs with w/o soaking | 10 | 10 | 10 | 8 | 11 | 12 |

DE: Diatomaceous Earth, SS: Synthetic Soil

***Thermo-priming and combination of hydro-thermo priming***

Effect of the combination of hydro-thermo and hydro-matrix priming was significant on number of days to germination. Analysis of variance showed that both the genotypes (V) respond equally to hydro-thermo priming. Drying technique (D) has significant effect on germination as blotting paper dried seeds showed better results as compared to completely dried seeds. Time of seed soaking has significant effect irrespective of the genotype as 9hrs soaking gave best results. Combined effect of drying technique and soaking time also showed significant effect of germination. Similarly combined effect of drying technique and low temperature treatment time showed significant effect irrespective of

**Analysis of variance**

| Source | df | mss | CD | cv % |
|---|---|---|---|---|
| Treatment | 71 | 15.307** | 1.821 | 10.881 |
| V | 1 | 0.116 | 0.303 | |
| D | 1 | 135.375** | 0.303 | |
| VxD | 1 | 3.375 | 0.429 | |
| TT | 2 | 40.394** | 0.372 | |
| VxTT | 2 | 0.921 | 0.526 | |
| DxTT | 2 | 31.097** | 0.526 | |
| DU | 5 | 101.66** | 0.526 | |
| VxDU | 5 | 1.260 | 0.743 | |
| DxDU | 5 | 22.275** | 0.743 | |
| TTxDU | 10 | 5.11** | 0.910 | |
| Error | 144 | 1.273 | | |

**Significant at 0.5 and 0.1 % level of significance

genotype. Genotype + 9 hrs soaking + Blotting dry + 32 days low temperature treatment resulted in germination just after 5 days of inoculation while genotype + without soaking + 32 days low temperature treatment resulted in seed germination after 8 days of sowing in GC 4 and 9.0 days in RZ 209.

Results suggested that synthetic soil is suitable for matrix priming in both the genotypes. Combination of 6 hrs pre soaking and 72 hrs matrix priming with synthetic soil proved best in hastening the germination in which more than 90% seeds have been germinated on 4th day after inoculation as compare to 8th day under control conditions. Genotype GC 4 is more responsive to priming than RZ 209. Similar results were obtained under field conditions. However, time taken in 90% germination was 6th day after sowing as compared to 10 days in non primed seeds.

Seed priming has been found a double technology to enhance rapid and uniform emergence and to achieve high vigour and better yield in cumin (Nematollahi *et al.*, 14). Apart from this seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly seeds of vegetables and small seeded grasses (Bradford 2).

The beneficial effects of priming have also been demonstrated for many field crops such as wheat, sugar beet, maize, soybean and sunflower (Powell and Bingham 16; Parera and Cantliffe 15; Sadeghian and Yavari 19; Singh and Rao 21). Rao *et. al.*, 18 reports that primed brassica seeds may reduce the risk of poor stand establishment in cold and moist soils. Hydropriming resulted in increase of normal germination. The results are in line with the findings of Thornton and Powell 24 in Brassica and Srinivasan *et. al.*, 22 in mustard.

Fujikura *et. al.*, 6 also indicated the beneficial effects of hydro priming on aged or unaged seeds with respect to germination and percentage of normal seedlings in cauliflower.

This method of seed priming is not only hastening the germination but cost effective also and can be performed by farmer himself. It is not include any chemical treatment thus may be used in organic cumin production. This also save one irrigation which otherwise required before germination of cumin seeds under normal conditions.

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