SOIL & CROP SCIENCES | RESEARCH ARTICLE

Evaluation of seed priming and coating on germination and early seedling growth of sesame (Sesamum indicum L.) under laboratory condition at Gondar, Ethiopia

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Abstract: The laboratory test was conducted in 2016 at Gondar seed laboratory with the objective of evaluating of seed priming, pesticide dressing and coating on germination of sesame (Sesamum indicum L.) on laboratory at Gondar, Ethiopia. Twelve treatments, untreated seed (T1), hydro-primed seed (T2), seed primed with CaCl₂ (T3), seed treated with dynamic (T4), hydro-primed seed + treated with dynamic (T5), seed primed with CaCl₂ + treated with dynamic (T6), seed treated with dynamic + disco (T7), hydro-primed seed + treated with dynamic + disco (T8), seed primed with CaCl₂ + treated with dynamic + disco (T9), seed treated with dynamic + disco + genius coating(T10), hydro-primed seed + treated with dynamic + disco + genius coating(T11) and seed primed with CaCl₂ + treated with dynamic + disco + genius coating (T12) were tested using completely randomized design (CRD) with four replications. Physiological quality data like germination percentage, root length, shoot length and vigor index were taken. Analysis of variance for all parameters was computed with SAS version 9.0 and mean separation was using the

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PUBLIC INTEREST STATEMENT

In Ethiopia, sesame grows well in the lowlands either as sole crop or intercropped with millet or sorghum. Within the low lands of Ethiopia in particular Amhara region, Metema and Gonder Zuria woreda is one of sesame producing area. Since sesame is widely utilized as oil crop by the people in world, its market price is much higher than all other crops. Despite the aforementioned importance of the crop, its current production is constrained by various problems in the country. Shattering of capsules at maturity, poor stand establishment, profuse branching, low harvest index and improper plant protection cover are among the main problems associated with low productivity of sesame production in Ethiopia. Hence, evaluation of seed priming and coating on germination and early seedling growth of sesame (Sesamum indicum L.) are necessary to enhance the productivity of sesame.
least significant difference test (LSD) at 5% and 1% level of significance. The study revealed that germination percentage, root length, shoot length and vigor index of sesame were significantly \( p < 0.01 \) affected by seed priming and coating treatments. From this experiment, higher germination percentage (91.50%) was recorded by primed seeds with water. However, the root length (4.78 cm), shoot length (6.33 cm) and vigor index (928.48) of sesame was higher for seeds coated with dynamic + disco.

Subjects: Environmental Sciences; Agriculture and Food; Agronomy

Keywords: Seed priming; seed coating; vigor index; dynamic; Disco genius coat

1. Introduction
Sesame \( (Sesamum indicum \text{ L.}) \) is an annual crop and one of the important oil crops of the world and belongs to the order Tubiflorae and family Pedaliaceae cultivated for seed \( (Raikwar & Srivastva, 2013) \). It was one of the first oil seeds from which oil was extracted by the ancient Hindus, which was used for certain ritual purposes \( (Arnon, 1972) \). Seegeler \( (1983) \) reported that it is an ancient oil seed, first recorded as a crop in Babylon and Assyria before 2050 BC.

Sesame is called as the “queen” of oilseeds in view of its oil \( (50–60\%) \), protein \( (18–25\%) \), carbohydrate and ash \( (El \text{ Khier, Ishag, & Yagoub, 2008}; Elleuch, Besbes, Roiseux, Blecker, & Attia, 2007) \). It is highly nutritive, medicinal value, Sesame seeds have digestive, rejuvenative, anti-aging and rich in vitamin E, minerals like calcium, phosphorus, iron (white seeds), copper, magnesium, zinc and potassium. This unique composition coupled with high-unsaturated fatty acid (Linolinic and Tocopherol) makes the sesame nearly perfect food \( (Lokesha & Theartha, 2006) \).

Sesame ranks first in total area and production from oil crops during 2013 and grown in an area of 7,062,237 ha with a production of 42,180,690 quintals in the world with a productivity of 597 kg/ha \( (CSA, 2014/2015) \). Due to its importance as a major export commodity, the area coverage and sesame seed production has increased through cultivation of additional new land in the last consecutive years in Ethiopia \( (Ayana, 2015) \). The area coverage of sesame crop in Ethiopia during 2013/14 \( (2006 \text{ E.C}) \) was 299,724 ha and about 2,202,161 quintals of productions with a productivity of 7.35 qt/Ha \( (CSA, 2014) \).

Sesame is a low yielder and worldwide average yields are low \( (Bedigian, Seigler, & Harlan, 1985) \). The major constraints in sesame production are shattering of capsules at maturity, poor stand establishment, profuse branching, low harvest index \( (Arora & Riley, 1994) \) and improper plant protection cover. Poor stand establishment generally results from poor and erratic germination \( (Hussain, Farooq, Basra, & Ahmad, 2006) \). However, early seedling emergence and uniform stand establishment are the major contributors for grain yield, quality and ultimately used for annual crops \( (Shehzad, Ayub, Ahmad, & Yaseen, 2012) \). This is particularly true in the semi-arid tropics where there is a delicate balance between supply and demand for water due to unpredictable rainfall conditions.

Conditions after sowing had a large influence on the emergence and seedling vigor and speed of germination and emergence was an important determinant of successful establishment. Rapidly germinating seedlings could emerge and produce deep root systems before the upper layers of the soil dry out, hardened or become dangerously hot \( (Murungu, 2011) \). For this, pre-farming seed treatments such as seed priming \( (Qadir, Khan, Khan, & Afzal, 2011) \) and coating \( (Gustafson, 2006) \) are known to improve seed performance under stressed environmental conditions. Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radical and generally enhances germination rate and plant performance \( (Bradford, 1986; Farooq, Basra, Rehman, & Saleem, 2008; Taylor & Harman, 1990) \). This decreases the time that the seed spends in the seedbed simply imbibing water. Therefore, by
reducing the imbibitions time through seed priming, germination rate of seed can be increased and seedlings emergence improved (Hartman, Kester, Davies, & Geneve, 2002). Primed seeds generally induce the establishment of more rapid and vigorous seedling than dry seeds (Musa, Harris, Johansen, & Kumar, 2001).

The result of some research has been shown that priming could increase germination traits, accelerate germination, improve seedling establishment and enhance plant growth (Anosheh et al., 2011). Seed priming also serves to maintain seed physical quality, like other treatments, yet it also has the potential to reduce farmers’ risk of poor seedling emergence under variable and uncertain moisture conditions (McGuire, 2005). Sridhar and Kumar (2013) reported that seed treatment helps to improve crop safety which in turn leads to good establishment of healthy and vigorous plants which results in better yields.

In helping the seed to germinate in a healthy and fertile environment, seeds are treated with coatings or other treatments, so that the emerging seedling is protected from pathogen attacks (Weiser, 1980). Seed coatings have been used to prevent insects (Nault, Straub, & Taylor, 2006) and incorporate beneficial microbes (Rice, Clayton, Lupwayi, & Olsen, 2001), enhance seed handling characteristics, and improve germination and seedling establishment (Peltonen-Sainio, Kontturi, & Peltonen, 2006). On the other hand, the seeds are so small and the rate of growth during the early phases is so slow so that important methods to enhance seed and seedling performance are through addition of chemicals to improve germination. Pesticide dressing and different techniques of seed coating are used for this. However, the beneficial effects of seed priming and coating on sesame are not well understood in Ethiopia. Hence, there is a need to evaluate the effect of seed priming, coating and integration of these techniques on germination and Early Seedling Growth of sesame in Laboratory at Gondar, Ethiopia.

2. Materials and methods

2.1. Description of the study area
The laboratory experiment was conducted in Gondar seed laboratory, Gondar town in 2016. Gondar is 50 km north of Lake Tana, 734 km north of Addis Ababa and nestles in the foothills of the Simien mountains at 2,200 m above sea level. The site is located at 12°N latitude and 37°E longitude. The mean annual temperature of the location is 26°C. Daily temperature becomes very high during the months of March to May, where it may get as high as 32°C. However, the experiment was conducted under controlled condition, having homogenous temperature, relative humidity and light.

2.2. Treatments and experimental design
In this experiment, Humera-1 which is an improved variety released from Humera Agricultural Research Center in 2011 and yet under production in the area was used as experimental material. Tap water and CaCl2 were used as seed priming materials and CaCl2 (2%) solution was prepared by dissolving 2gm CaCl2 in 100-mL tap water (Kumar, 2005; Yadav, Kumar, Kumar, Hussain, & Kumar, 2012). whereas Dynamic 400 FS which contains active ingredients of thiram and carbofuran was used as seed treatment material. DISCO AG Red L-256 (A liquid film coat for binding) and Genius coating were used as coating materials. Genius coat is a growth stimulator hormone used in yield increment under suboptimal conditions. Disco is a well-balanced novel blend of specific humic and fulvic acids incorporated in a specially developed film coat formulation for use on cereals. Dynamic 400 FS is a formulation of Thiram 20% and Carbofuran 20% which is used as a seed treatment to prevent diseases and pests. Twelve treatments were evaluated for their effects on physiological quality of bread wheat (Table 1). The treatments were consisted of two seed priming (hydro-primed and CaCl2), two seed coating (disco and genius coating) and one pesticide dressing (dynamic). The two seed priming, the two seed coating and one pesticide dressing were arranged in 2 × 2 × 1 factorials in completely randomized design (CRB) with four replication.
2.3. Experimental procedure

The seed weighed for each treatment was soaked with tap water and 2% CaCl2. For primed seeds with tap water, the seeds were soaked for 12 h in tap water while for the treatments having 2% CaCl2, the seeds were soaked for 12 h in cow urine. The seeds primed by tap water or 2% CaCl2 were dried under shade condition to attain its original weight. In the cases of seed coating, the seeds were coated just before planting with Dynamic FS 400 @ 5 mL kg$^{-1}$ of seed, Disco™ AG Red L-431 @ 2 mL kg$^{-1}$ of seed and Genius coat @ 5 mL kg$^{-1}$ of seed through mixing with water @ 6 mL kg$^{-1}$ of seed according to the treatments set up mentioned in Table 1 using rotating drum.

2.4. Data collected

- **Germination percentage experiments**: Four replicates of hundred seeds were sown in Petri-dishes inside a moistened filter paper under the test conditions of 25°C. After the test period of seven days the normal seedlings were counted and total germination percentage of normal seedlings was calculated based on the average of the four replications of 100 seeds (ISTA, 1999) according to the following formula:

  \[
  \text{Germination(%) = } \left( \frac{\text{Total number of normal germinated seedlings}}{\text{Total number of seeds planted}} \right) \times 100
  \]

- **Root and shoot length (cm)**: At the time of germination count, 10 normal seedlings were taken at random. The length between the collar and tip of the primary root was measured as root length and the mean length expressed in centimeter. From the 10 seedlings used for measuring the root length, the length between collar and tip of the primary shoot was measured as shoot length and the mean value expressed in centimeter.

- **Seedling vigor index**: The Vigor index values were computed, adopting the procedure of (Abdul-Baki & Anderson, 1973) as given below.

  \[
  \text{Seedling Vigor index} = \text{germination(%) } \times \text{total seedling length}
  \]

2.5. Statistical data analysis

Data was subjected to analysis of variance (ANOVA) using SAS software 9.0 (2009). All significant pairs of treatment means was compared using the least significant difference test (LSD) at 5% and 1% level of significance.
3. Results and discussion

3.1. Germination percentage

The effect of seed priming and coating on germination of sesame is presented in Figure 1. The analysis revealed highly significant differences ($P < 0.01$) in germination percentage due to different seed priming and coating techniques. The best germination result was observed for hydro-primed seeds. Regarding mean values of experimental results, the maximum germination percentage (91.5%) was recorded in seeds primed with water for 12 h followed by (88.75%) of seed germination in seed primed with CaCl2 (2%) solution. While, minimum germination percentage (64%) was observed in primed seed with water + Seed treated with dynamic + Disco ($T_8$).

The physiological basis for increasing germination percentage at 12 h priming duration might be the initiation of those metabolic events that normally occur during imbibitions and that are subsequently fixed by drying. These results are in conformity with previous findings by Ahmad and Lee (2011), which showed highest germination percentage of hydro primed sesame seeds for 12 h compared with non-primed seed. Similarly, Ghassemi-Golezani, Hosseinzadeh-Mahootchy, Zehtab-Salmosi, and Tourchi (2012) reported the highest germination percentage in chickpea with hydro priming for 12 h. On the other hand, Sadeghi and Robati (2015) studied that ascorbic acid priming on chicory seeds have shown the highest germination percentages, fastest germination rates and best seedling development under stress and non-stressed conditions (100%) while potassium chloride (KCl) enhanced germination only under non-stress condition.

Figure 1. Evaluation of seed priming and coating on germination percentage of sesame. Bars with different letters show significant differences at $p \leq 0.05$ (LSD).
3.2. Root and shoot length

Variance analysis and mean comparison results displayed that root and shoot length was highly significantly \((P < 0.01)\) affected by seed priming and coating techniques (Figure 2). The highest root length \((6.33 \text{ cm})\) and shoot length \((4.78 \text{ cm})\) were recorded from seeds having treated with dynamic + Disco \((T_7)\) whereas the lowest shoot length \((2.95 \text{ cm})\) was recorded from hydro-primed seed + treated with dynamic + Disco \((T_8)\). Similarly, the lowest root lengths \((4.05 \text{ cm} \text{ and } 4.11 \text{ cm})\) were recorded on hydro-primed seed + treated with dynamic + Disco \((T_8)\) and seed primed with CaCl2 treated with dynamic + Disco \((T_9)\), respectively. These results agree with the findings of Basavaraj et al. \((2010)\) who recorded significantly higher seed quality parameters from onion seeds treated with different colored polymers coupled with fungicide. His result revealed that seeds coated with polymer yellow + thiram recorded higher root and shoot length.

3.3. Seedling vigor index

Seed priming, pesticide dressing and coating treatments showed highly significant \((p < 0.01)\) difference on the number of capsules per plant (Figure 3). The highest seedling vigor index \((928.48)\) was recorded from \(T_7\) (treated with dynamic + Disco). On the other hand, \(T_8\) (hydro-primed seed + treated with Dynamic + Disco) showed lower seedling vigor index \((447.5)\). In line with these finding, Kumar et al. \((2014)\) reported that deltamethrin + vitavax power + polymer seed coating was found to be significantly superior seedling vigor index as compared to untreated control. On the other hand, Sharma, Rathore, Srinivasan, and Tyagi \((2014)\) reported in okra \((Abelmoschus esculentus L. Moench)\) that significantly higher vigor index was observed in the hydroprimed \((2044.0)\) and solid matrix \((SM)\) primed seeds with calcium aluminum silicate \((2121.0)\) for \(24 \text{ h}\) in comparison to other treatment \([\text{Osmopriming (1821.0) and Halo priming (1402.0)]}\) as well as non-primed seeds \((983.5)\).

4. Conclusion

In conclusion, results of the present study indicate that sesame variety is significantly affected by seed treated with priming, dynamic, Disco and Genius coating under laboratory conditions.

Seed priming and coating is working in improving vigor, speed of germination and germination percentage of sesame. Primed seeds with water alone and in combination with Dynamic, Disco and genius coat improved the percentage and speed of seed germination. The root length, shoot length and vigor index of bread wheat was higher for seeds treated with Dynamic + Disco. Primed seed with water was found to be promising for early emergence otherwise Dynamic + Disco coated seed is better.
to improve bread wheat seed vigor. Hence, we recommended Seed priming in water because it performed better than all treatments and enhancing emergence and better seedling growth. However, as the study was done in evaluating the effect of seed priming, coating and integration of these techniques on germination and Early Seedling Growth of sesame the study should be repeated to investigating the effect of water priming duration to determine the best optimum time.

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Figure 3. Evaluation of seed priming and coating on seedling vigor index of sesame. Bars with different letters show significant differences at $p \leq 0.05$ (LSD).

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