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Response of Sesame (*Sesamum indicum*) Cultivars to Hydropriming of Seeds

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ABSTRACT

Laboratory tests and a field experiment were carried out to evaluate the effects of hydro priming (P_2, P_3 and P_4: hydropriming of 8, 12 and 16 hours, respectively) on seed invigoration and field performance of three sesame cultivars (TS_3, TN_{238} and Yellow white). The field experiment was arranged as factorial based on RCB design in three replicates. Hydropriming increased germination percentage, germination rate and seedling size, compared with non-primed seeds. Improving seedling establishment of sesame cultivars by priming resulted in increasing their grain yield. However, the grain yield of sesame cultivars were differentially affected by seed priming where grain yield of TS_3 cultivar was improved more compared to other sesame cultivars. The highest yield increase was obtained with 16 h hydropriming. Thus, it is conceivable to suggest that this priming duration is the best treatment for invigoration of sesame seeds.

KEY WORDS: grain yield, hydropriming, seed germination, seedling emergence, sesame.

INTRODUCTION

Sesame (*Sesamum indicum* L.) which is usually planted in arid and semi-arid regions ia an annual oilseed crop cultivated for centuries, particularly in the developing countries of Asia and Africa, for its high content of both excellent quality edible oil (42-54%) and protein (22- 25%) (Desphande *et al.,* 1996). Rapid and uniform field emergence is an essential prerequisite to reach the yield potential, quality and ultimately profit in annual crops (Parera and Cantliffe, 1994). Out of many constraints regarding low production of oilseeds, seed quality is the prime importance. Oilseeds are deteriorated more rapidly during storage, which reduces the quality of seeds (Afzal *et al.,* 2004).

Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pregermination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance (Bradford, 1986; Taylor and Harman,1990). Primingallows seed hydration to initiate the early events of germination, but not permit radicle emergence, followed by drying to initial moisture (McDonald, 2000; Ashraf and Foolad, 2005). There are reports that seed priming permits early DNA replication, increase RNA and protein synthesis, enhances embryo growth, repairs deteriorated seed parts and reduces leakage of metabolites (McDonald, 2000). Seed priming is seen as a viable technology to enhance rapid and uniform emergence, high vigor and better yields in some field crops (Chiu *et al.,* 2002; Murungu *et al.,* 2004). Methods of seed priming include osmo-priming, salt-priming, hydropriming, matrix-priming and thermo-priming (Khan, 1992; McDonald, 2000). Hydropriming is a very simple, pre-sowing treatment in which seeds are soaked in water for a certain time and dried before sowing (Thornton and Powell, 1992). Similar to other priming techniques, hydropriming generally enhances seed germination and seedling emergence, although there are exceptions.

It is reported that when seeds of maize and chickpea are primed with water (hydropriming) the growing stages of plant (seedling development, flowering and maturity) are faster passed because of improved early establishment which finally increased grain yield of crop (Harris et al 1999). Hydropriming is a low-cost pre-sowing seed treatment which has proved highly popular with farmers (Harris *et al.,* 2001). Its value has already been shown for many crops, for example wheat (Harris *et al.,* 2001; Rajpar *et al.,* 2006); chickpea (Musa *et al.,* 2001 ;), maize (Ashraf and Rauf, 2001), mungbean (Rashid *et al.,* 2004), sunflower (Kaya *et al.,* 2006) and Barley (Abdulrahmani *et al.,* 2007).

Since the beneficial effects of hydropriming on field performance of sesame are not well documented, this research was carried out to investigate the effects of hydropriming on seed invigoration, seedling emergence and grain yield of sesame cultivars.

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MATERIALS AND METHODS

Seeds of three sesame cultivars including TS_3, TN_{238} and Yellow White were obtained from Safiabad Agricultural Research Center of Dezful, Iran. These seeds were divided into four sub–samples. A sub–sample was kept as control (unprimed) and the three other sub–samples were prepared for priming treatments. Seeds of a sub–sample were soaked in water for 8 (P_1), 12 (P_2) and 16 (P_3) hours. Priming treatments were performed in an incubator adjusted on 20±1°C under dark conditions. After priming, seeds were dried back to primary moisture at room temperature of 20 -22°C. All the seeds were treated with Mankozeb at a rate of 2 g kg-1 before testing. Laboratory tests were carried out as factorial with CR design at Seed Technology Laboratory of the Ahwaz Payame-Noor University, Iran. Four replicates of 25 seeds were placed between moist filter papers and germinated in an incubator at 10°C for 10 days. Germination (protrusion of radicle by 2 mm) was recorded in daily intervals. Mean germination time for each treatment was calculated according to Ellis and Roberts (1980). The field experiment was conducted in a farm located at the north of Ramhormoz (46º36´ N, 31º16´ E, altitude 150 m above sea level), Iran. The seeds were sown at high density to ensure adequate emergence. After seedling establishment, subplots were thinned to 40 plants/m^2. Each plot consisted of 8 rows with 2 cm length, spaced 50 cm apart. The experiment was arranged as factorial based on RCB design with three replications. All plots were irrigated immediately after sowing. Weeds were controlled by hand weeding during crop growth and development. The number of emerged seedlings in an area of 1 m^2 within each plot was counted in daily intervals until seedling establishment stabilized. Method of Ellis and Roberts (1980) was applied to calculate mean emergence time. At maturity, 20 plants in the middle part of each plot were harvested and the number of capsule per plant, grain per plant, 1000 grain weight and grain yield per unit area were recorded. Analysis of variance of the data appropriate to the experimental design and comparison of means at $p \leq 0.05$ were done using MSATAC software.

RESULT AND DISCUSSIONS

Effects of hydropriming priming on germination percentage, germination rate and seedling dry weight was significant ($P \leq 0.05$). The seeds primed with P_3 germinated earlier than those primed with P_2 and P_1 and non-primed, and it was statistically significant. Hydro primed seeds of P_1 (hydropriming duration of 8 hours) also produced larger seedlings, compared with non-primed seeds (Table 1), but its seedling dry weight was significantly lower than that of P_2 and P_3. Germination percentage, germination time and seedling dry weights of sesame were significantly affected by cultivar ($P \leq 0.01$). The highest germination percentage was obtained for TS_3 which was not significantly different from TN_{238}. Germination percentage of Yellow white was significantly lower than that of TS_3 and TN_{238}. Seeds of TS_3 and TN_{238} germinated faster than those of Yellow white. Mean germination time of TS_3 and TN_{238} cultivars was statistically similar. The highest and the lowest seedling dry weight were recorded for TS_3 and Yellow white, respectively (Table1). Priming × cultivar interaction was only significant for seedling dry weight ($P \leq 0.01$). Seedling weight of all cultivars improved as a result of salt priming (Figure 1).

Table 1: Effect of hydropriming and cultivar on germination percentage, germination time and seedling dry weight of sesame cultivars.

Treatments	Germination (%)	Germination rate (day)	Seedling dry weight (mg)
Cultivar			
TS_3	98.0 a	4.01 a	5.18 a
TN_{238}	96.0 a	4.20 a	4.66 b
Yellow white	92.0 b	3.7 b	3.06 c
Priming			
Non-primed	92.0 b	3.8 c	4.13 c
P_1	93.0 b	3.4 c	4.80 b
P_2	97.0 a	4.8b	5.23 a
P_3	98.0 a	5.6 a	5.41 a
LSD at $P \leq 0.05$ for cultivar	5.2	0.28	0.33
LSD at $P \leq 0.05$ for priming	3.1	0.63	0.42

Different letters indicating significant difference at $P \leq 0.05$. P_1, P_2 and P_3: Hydropriming duration of 8, 12 and 16 hours, respectively.

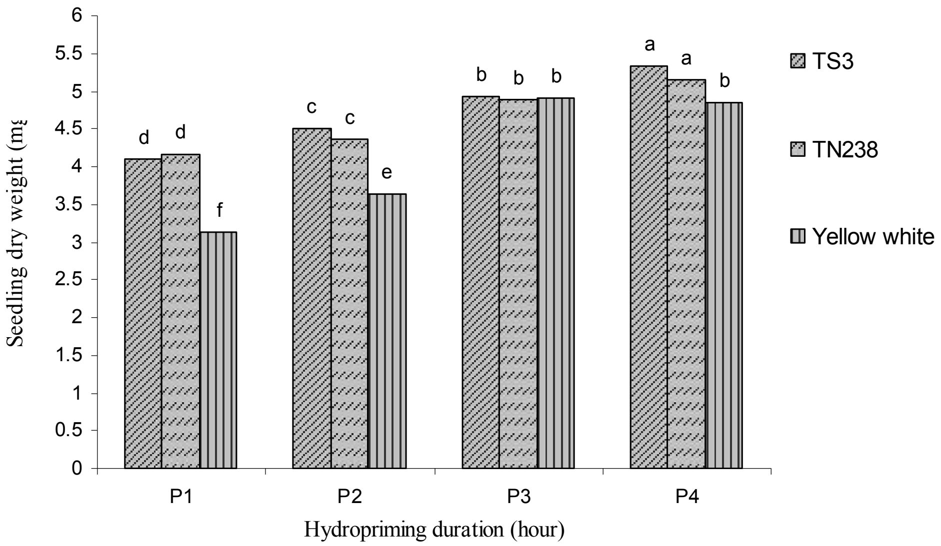

Figure 1: Mean seedling dry weight of sesame cultivars affected by hydropriming in the laboratory. Different letters indicating significant difference at P≤0.05. P_2, P_3 and P_4: hydropriming duration of 8, 12 and 16 hours. P_1: non-primed

Analysis of variance of the field data showed that seedling emergence percentage was significantly affected by cultivar and hydropriming (P≤0.05). The effect of hydropriming on emergence time was also significant (P≤0.05), but cultivar had no significant effect on this trait (P≤0.05). Cultivar and hydropriming significantly influenced the number grains per plant. The effects of cultivar and hydropriming on 1000 grain weight were not significant (Table 2). In contrast, grain yield was significantly affected by priming treatment. The interaction of hydropriming × cultivar was only significant for grains per plant. However, the other interactions of the treatments were not significant for any traits (Table 2). Mean emergence percentage for TS_3 was significantly higher than that for TN_{238} and Yellow white, but differences in mean emergence time among cultivars were not statistically significant. The highest emergence percentage and the emergence time were achieved by hydropriming with 16 hours duration (P_3). Seedlings from non-primed seeds emerged later and were less than those from salt-primed seeds (Table 2). TS_3 produced the highest number grains per plant, but there was no significant difference among cultivars for 1000-grain weight. Mean number grains per plant and grain yield per unit area increased due to hydropriming. Enhancement in number of grains per plant, due to hydropriming, was observed for all cultivars (Figure 2). The highest improvement in grain yield per unit area was achieved by TS_3 (23%).

Table 3: Means of field traits for sesame affected by hydropriming and cultivar.

treatment	Seedling emergence (%)	Emergence rate (day)	Grain per plant	1000-grain weight (g)	Grain yield (kg. ha^{-1})
Cultivar					
TS_3	63.32 a	5.5 a	1100 a	3.17 a	1200 a
TN_{238}	56.18 b	5.6 a	950 b	3.17 a	1080 b
Yellow white	54.12 b	5.9 a	765 c	3.13 a	882 c
Priming					
Non-primed	57.82 b	4.75 c	871 c	3.15 a	871 c
P_1	58.11 ab	4.86 c	891 a	3.17 a	894 c
P_2	60.19 ab	5.50 b	932 b	3.17 a	972 b
P_3	62.71 a	6.78 a	974 a	3.17 a	1100 a
LSD at P≤0.05 for cultivar	4.1	1.5	44.6	1.1	88.4
LSD at P≤0.05 for priming	4.1	0.51	33.4	1.2	40.5

Different letters indicating significant difference at P≤0.05. P_1, P_2 and P_3: Hydropriming duration of 8, 12 and 16 hours, respectively.

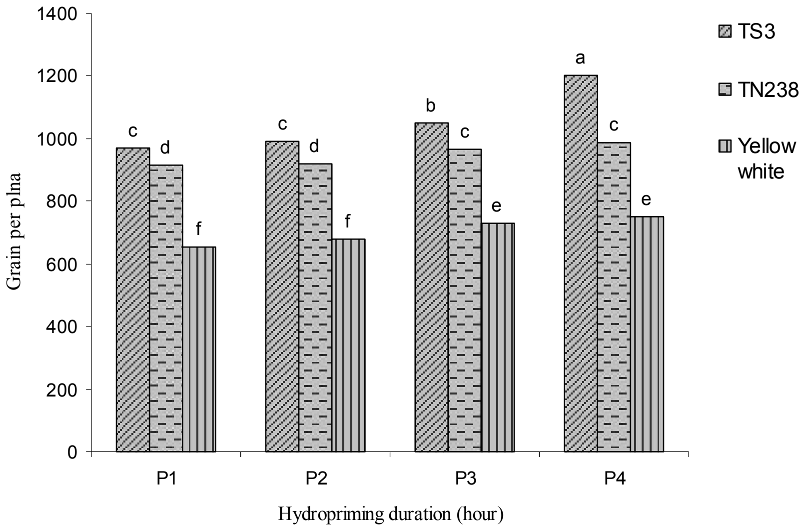

Figure 2: Mean grains per plant of sesame cultivars affected by hydropriming. Different letters indicating significant difference at P≤0.05.

Hydro-priming improved seed germination and seedling vigor of sesame cultivars as indicated by rapid germination and high seedling dry weight in the laboratory (Table 1). According to McDonald (2000), primed seeds can rapidly imbibe and revive the seed metabolism, enhancing germination rate and uniformity. Enhancement in seedling size due to hydropriming was more evident in TS_3 and TN_{238}, compared with Yellow white (Figure 1). This indicates that sesame cultivars respond differently to hydropriming. Rapid germination of hydro primed seeds led to early and enhanced emergence of sesame seedlings in the field. The highest benefit of priming was observed for seeds primed with P_4 (16 hours) (Table 2). Therefore, hydro priming can ensure satisfactory stand establishment of sesame cultivars in the field. Kibite and Harker, (1991) reported seed hydration of wheat, barley and oat seeds improved the uniformity of seedling emergence**.** Variations in grain yield among sesame cultivars (Table 2) are closely associated with differences in seedling emergence percentage seed lots (Table 1). TS_3 cultivar had more stand establishment, thus, it had higher potential for production of more grain per plant. In other word, the effects of hydropriming on increasing seedling establishment and production grains per plant led to considerable improvement in grain yield per unit area (Table 2). The beneficial effects of hydropriming on yield were reported (Kahlon et al., 1992; Hussain et al., 2006 and Farooq et al., 2006). In current study, superiorities of hydroprimed seeds in stimulation of seedling emergence and establishment continued to improve grain yield. These results are in line with the findings of Kathiresan and Gnanarethinam (1985) in sunflower. This means that during priming, seeds would be simultaneously subjected to processes of repair and deterioration and force between the two determined the success or failure of the treatment (McDonald, 2000).

CONCLUSION

Hydropriming generally increased grain yield of sesame cultivars by improving seed germination rate, seedling emergence rate and percentage, and grains per plant. The highest yield increase was obtained with 16 h hydropriming. Thus, it is conceivable to suggest that this priming duration is the best treatment for invigoration of sesame seeds. The highest benefit of hydropriming can be obtained from TS_3 cultivar.

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