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SEEDS FROM FRESH CONVENTIONALLY-GROWN TOMATOES GERMINATE FASTER THAN DRIED OR ORGANIC SEEDS

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ABSTRACT

Conventionally-grown and organically-grown tomato seeds sourced from both fresh tomatoes and store-bought packages were germinated for seven days to evaluate the effect of seed source on germination rates. Seeds from fresh Roma tomatoes were prepared by allowing them to ferment in their own pulp for 24 hours, while commercially packaged dry seeds did not require any preparation. Once prepared, the seeds were spaced evenly on wet paper towels and stored in resealable plastic bags in groups of 10 for a total sample size of 100 seeds in each of four treatments. The number of germinated seeds and the length of their roots were measured daily for seven days. 82.5% of the seeds from fresh tomatoes germinated—91% of the conventional and 74% of the organic—while only 49% of the commercially dried seeds germinated—35% of the conventional and 63% of the organic. Conventionally-grown seeds germinated on average one day faster than organically-grown seeds. In addition, the seeds from fresh tomatoes experienced significantly faster germination rates by 0.78 days and longer average growth. Our data indicate potentially higher germination success for seeds sourced from fresh tomatoes, but only when conventionally-grown.

Keywords: germination, growth, organic, conventional, fresh, dried, tomatoes, seeds

INTRODUCTION

In response to a growing world population, organic farming, in contrast to conventional methods, has recently been emphasized as a more sustainable solution for increased crop production (Pacini et al. 2003; Foley et al. 2011). Organic practices are intended to foster growth by maintaining natural ecosystems without introducing foreign pesticides (Rigby and Cáceres 2001). Unfortunately the term *organic* has not been applied consistently across products and regulation can be inadequate (Liu 2011). In addition, consumers often mistake foods labeled as organic to be richer in nutrients and therefore heathier (Olson 2017). However studies do not support the health advantages of organic products (Smith-Spangler et al. 2012). For example, Ordóñez-Santos et al. (2011) found no significant differences in levels of potassium, lycopene, and β-carotene among other macronutrients between organically-grown and conventionally-grown tomatoes. Even the impact on the environment is highly dependent on the plants cultivated, soil type, and watering tendencies (Pacini et al. 2003). Seufert et al. (2012)

found organic farming leads to nearly 25% lower yields than conventional methods, thus requiring more water use and causing higher stresses on farmland (Tuomisto et al. 2012).

In this study, we test the benefits of organic growing methods on seed germination and seedling development in both fresh and prepackaged seeds. We hypothesize that organically-grown tomatoes will have higher germination rates and grow faster than conventionally-grown seeds, as Brainard et al. (2006) found in the grain amaranth. Seeds are often dried for storage and mass marketing, and drying greatly reduces the overall preparation workload for planting (McCormack 2004). However, drying can lower seed viability over time (e.g., Nienhuis and Lower 1981). Alternatively, the germination rates of fresh seeds might be slower than prepackaged dry seeds, as seeds within fresh fruit possess natural, chemical germination inhibitors as an adaptive quality to prevent seed germination while inside the aqueous environment of the fruit (Bradford et al. 2013). We compare the germination and initial growth of seeds grown using organic and conventional methods that are both prepackaged and from fresh tomatoes.

MATERIALS & METHODS

Seeds from conventionally-grown and USDA organic-labeled tomatoes were derived from both dried commercial packets and fresh tomatoes (from which seeds were subsequently dried). The Roma variety of tomato (*Solanum lycopersicum*) was selected due to its wide availability as fresh fruit and dried seeds (Cook and Calvin 2005). All seed packets and fruits were purchased from a local chain store and their history prior to purchase is unknown. To prepare seeds from fresh tomato fruits, the seeds along with the pulp were removed and allowed to ferment in jars for approximately 24 hours. Fermenting removes germination-inhibiting substances from the seed coats (McCormack 2004). After fermentation, seeds were separated from the pulp, rinsed with water, and air dried. Prepackaged dried seeds did not require any additional preparation.

Prepared seeds were placed on water-saturated paper towels. The towels were carefully rolled to completely cover the seeds, and then placed in separate resealable plastic bags. Water was added as needed to keep the paper thoroughly saturated. All bags of the four seed types were kept in environments receiving 8–10 hours of daily sunlight and a temperature between 20 and 25 °C. Ten groups of 10 seeds for each of the four seed types were prepared for germination. This provided a total of one hundred replicates for each treatment.

Each day for seven days, the paper towels were removed from their bags, unrolled, and the number of germinated seeds was recorded. Percent germination was analyzed using chi-square. Mean difference in rate of germination and length of growth were analyzed by ANOVA with Tukey-Kramer post hoc tests to evaluate pairwise significant differences between treatments. Statistical significance was defined with a p-value of 0.05 or less. Analysis was performed using JMP 13 (SAS Institute Inc.).

RESULTS

A multifactorial ANOVA on length grown by day 7 shows a significant effect of both packaging and growing method, with a significant interaction between these treatments (Table I). However, differences are most likely driven solely by higher growth in conventionally-grown fresh seeds. Seeds from fresh, conventionally-grown tomatoes were more likely to germinate (Figure 1*A*), germinated faster (Figure 2*A*), and grew longer during the experimental period (Figure 1*B* and 2*B*) than seeds from other treatments. In contrast, dried conventionally-grown seeds were less likely to germinate and grew less than seeds from other treatments (Figures 1 and 2). Therefore, organically-grown seeds showed intermediate germination and growth rates (Figures 1 and 2).

Table I. Multifactorial ANOVA on seedling length at day 7

Source	df	Sum of Squares	Mean Squares	F	*p*
Growing method	1	880	880	6.67	0.0104
Packaging type	1	1896	1896	14.4	0.0002
Growing method x packaging type	1	698	698	5.29	0.0223
Model	3	4531	1510	11.4	<0.0001
Error	262	34614	132		
Corrected total	265	39145			

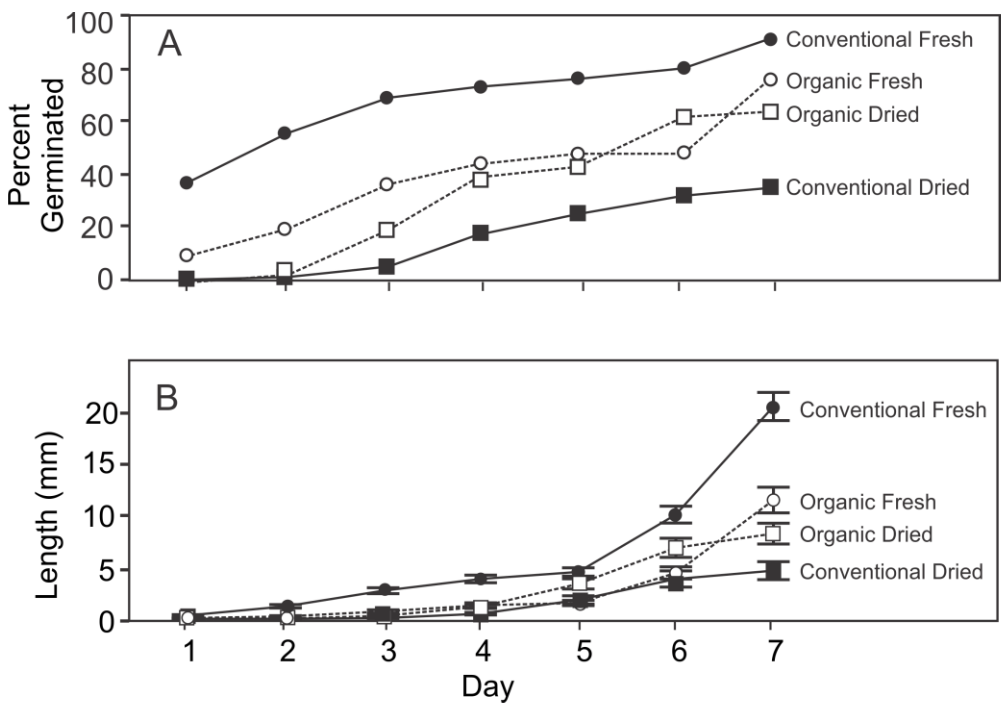

Figure 1. (A) Cumulative percentage of seeds germinated out of all seeds tested (n = 100) over time. (B) Length of roots of all seeds tested, including those not germinated for which length = 0 mm (n = 100). Average +/- standard error.

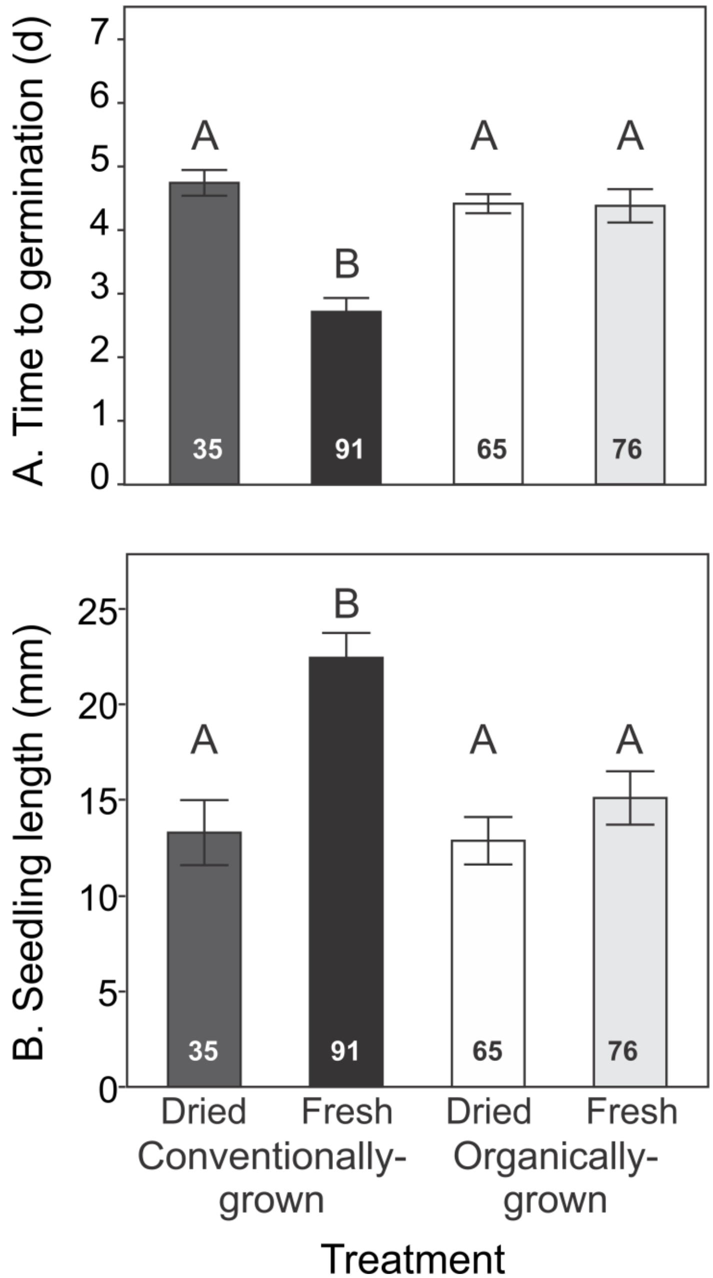

Figure 2. A. Time to germination in days. B. Seedling length in millimeters on day 7 (i.e., maximum growth during the experimental period.). Averages +/- standard error are shown for those seeds that germinated only. Sample sizes are inset in the bars. Different letters within a graph indicate statistical differences based on one-factor ANOVA with Tukey-Kramer post hoc tests.

DISCUSSION

Fresh seeds from conventionally-grown tomatoes had the highest germination rate, the shortest time to germination, and the greatest length of growth compared to conventionally-grown dried seeds from packages, or organically-grown seeds from either source. Fresh seeds showed higher germination rates (only 49% of the prepackaged dry seeds germinated, while 82.5% of the fresh seeds germinated) and length of growth (dried seeds grew an average of 6.45 mm over seven days; fresh seeds grew 15.95 mm) compared to dried seeds. These results are not unusual given the stress of drying and storage on seed viability (Harris 2001; Ajouri et al. 2004; Farooq et al. 2008; Filho et al. 2016). For example, Filho et al. (2016) found that soybean seed germination and seedling growth decline with increased drying temperature and time in storage. However, the difference here is driven only by the higher seed success of fresh conventionally-grown seeds, while freshness made no difference in organic seeds. Brainard et al. (2006) found that amaranth seeds that were cultivated using organic methods, rather than conventional methods, had significantly higher germination rates both in petri dishes and in the field. We found no such benefits of organic growing methods on germination efficiency in tomato and must reject our hypothesis that organic seeds have higher germination rates. Lower germination success could further reduce the perceived benefits of buying organic products given their typically higher prices (Aschemann-Witzel and Zielke 2017). While the results indicate that fresh seeds are a preferred alternative to dried seeds, fresh seeds require far more initial preparation to remove germination inhibitors and prepare the seedlings for planting compared to the traditionally-used dried seeds (McCormack 2004). Fresh seeds must also be planted shortly after harvesting (Nienhuis and Lower 1981). Unfortunately, interpretation of these results might be hindered by the inconsistent use of organic labels on products (Adam 2005; Liu 2011) and a normal decline in seed viability due to drying and storage (Ajouri et al. 2004; Filho et al. 2016). Further studies investigating more varieties and sources might help elucidate the effects of growth and storage history on germination rate and seedling development and perhaps indicate that a genetic factor is involved.

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