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Germination and Seedling Development of Tomato in Hypobaric Atmospheres[1]

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Abstract. **Germination and seedling development of *Lycopersicon esculentum*. Mill 'C-28' was measured at 750 (atmospheric pressure), 375, and 250 torr. Germination percentage and rate along with seedling development to the first true leaf increased as pressure increased.**

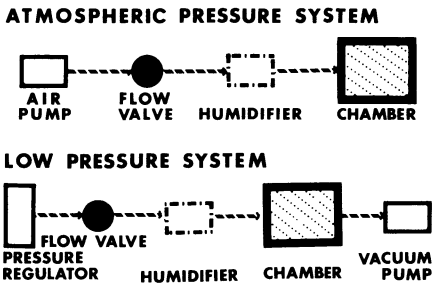

Fig. 1. Schematic diagrams of low pressure and atmospheric pressure systems. Arrows indicate direction of air flow.

Oxygen is necessary for the respiratory process in germinating seeds (2). Siegel and Rosen (11) reported that germination of 20 species in 2% or 5% O_2 was less than that in air. Several species functioned as facultative anaerobes, while germination of tomato seeds in 5% O_2 was only about 1/3 that observed in air. Heichel and Day (3) noted that most dicots tested failed to germinate in 2% O_2, while most monocots tested germinated nearly as well in 2% O_2 as in air.

Seedling development after germination may not respond to low oxygen in the same pattern as germination. Heichel and Day (3) showed that growth of C_3 monocots and dicots was severely inhibited by low O_2 while growth of C_4 monocots was least inhibited by low O_2. Siegel and Rosen (11) noted that early seedling growth was inhibited by 5% O_2 compared to air in 4 of 5 species tested. Growth of rice after germination in low O_2 (4,5,6,7,8) was abnormal and was characterized by absence of greening, abnormal root growth, and lack of vertical shoot orientation, but the abnormalities were corrected upon exposure to air.

The purpose of this research was to determine how reduced pressures affected seed germination and early seedling development since such pressures generally reduce respiration rates (1).

The low pressure apparatus (Fig. 1) consisted of a GCA/Precision Scientific Vac Torr 150 vacuum pump, Nupro Fine Metering Valves, and 10-liter vacuum desiccators fitted with 1.3 cm^2 metal screens across the bottom to keep the pots off the base of the chambers. Two-hole rubber stoppers covered the top of the desiccators, and connections were made with 1.0 cm diameter plastic tubing. A side-arm Erlenmeyer flask adjacent to the desiccator fitted with a fritted airstone in water was used to increase the relative humidity in the air and Matheson model 49 pressure regulators were used to regulate air pressure. In the atmospheric system (Fig. 1), a Universal Electric Model AB1F002 pump was used for air circulation.

The experiment was conducted in a temperature controlled cooler where the light intensity was 2.8 – 3.8 klux, using a Cool White fluorescent light source on a 7 am to 11 pm photoperiod regime. Temperature was 22° – 23°C(day) and 19° – 20°(night) with relative humidity maintained at 97 – 99%.

Fifty seeds of 'C-28' tomato were planted in each 7.6 cm^2 plastic pot in a medium of 1 sphagnum moss peat:1 vermiculite (by volume). Seeds were germinated at 250, 375, and 750 torr with air flow rates of 165, 250, and 500 ml/min, respectively, resulting in 3 air exchanges per hr for each pressure treatment. A randomized complete block design was used with 3 replications of each treatment.

Germination percentage was calculated by dividing the number of seeds which germinated, as detected by radicle emergence, by the number of seeds planted then multiplying by 100. Germination rate (GR) was calculated using Equation 1 (2),

$$\text{GR (Mean days)} = \frac{N_1T_1 + N_2T_2 \ldots + N_xT_x}{\text{Total number of germinating seeds}}$$

where N is the number of seeds germinating within each consecutive day and T indicates the time in days between the beginning of the experiment and the particular day of measurement.

Seed development percentage was calculated by dividing the number of seedlings with at lease 1 true leaf (minimum size – 1 x 3 mm.) by the total number of seedlings then multiplying by 100. Developmental rate (DR) was calculated by using Equation 2,

$$\text{DR (Mean days)} = \frac{N_1T_1 + N_2T_2 \ldots + N_xT_x}{\text{Total number of seedlings having at least 1 true leaf}}$$

where N is the number of seedlings on which the first true leaf developed within each consecutive day and T indicates the time in days from the beginning of the experiment to the particular day of measurement.

Developmental rate minus germination rate gives a value for the average length of time from seed germination to development of the first true leaf on a seedling.

Germination percentage of seeds was greatest at 750 torr (Fig. 2). At day 13, constant germination percentages were reached. Germination rate decreased as pressure increased (Table 1), so germination is faster at higher pressures. The storage of seeds and other plant materials at low pressure (1) results in an inhibition of dark respiration. This may be the reason for the germination results noted in this study. Since O_2 is necessary for seed germination (2), reduction of O_2 partial pressure may

Table 1. Germination, developmental, developmental minus germination rates and seed development percentage after 24 days of 'C-28' tomato seeds grown at 3 pressures.

Pressure (torr)	Germination rate (GR) (days)	Developmental rate (DR) (days)	DR – GR (days)	Seed development (%)
250	6.65	16.20	9.55	68.2
375	5.08	15.23	9.25	72.8
750	5.68	14.07	8.39	81.8
LSD, 10%	0.52	1.79	1.83	6.2

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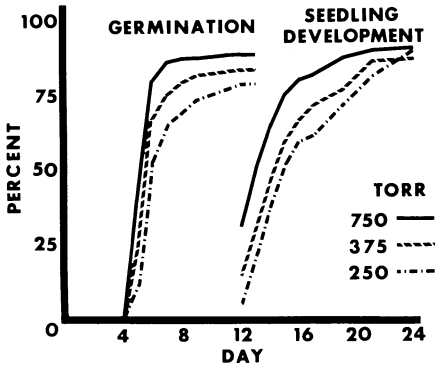

Fig. 2. Germination and seedling development percentages of 'C-28' tomato seeds at three pressures.

have inhibited germination and slowed the rate of germination. In general, results agree with those presented in previous literature (3,11) and show that the effects are duplicated when the low O_2 partial pressures are achieved by pressure instead of gas composition modifications at atmospheric pressure.

Seedling development percentages varied directly with pressure through day 21, but by day 24 no consistent trend was evident (Fig. 2). Seed development at day 24 varied directly with pressure (Table 1). Less evident was the trend of decreasing developmental rate minus germination rate as pressure was increased (Table 1), although the differences approximated that of germination rates. While final developmental percentages of seeds germinated do not seem to be affected by pressure, the delay at reduced pressures is evident. Since tomato is a C_3 dicot, results agree with published literature on the development of seeds germinated *in vacuo* (7) or at atmospheric pressure in reduced O_2 partial pressures (3,4,5,6,7, 9,11). The effect of inverse variation between pressure and developmental rates needs further investigation to determine if seedling size at germination in atmospheric pressure is different than seedling size at germination in lower pressures. Low pressure had an inhibitory effect on developmental percentage from seed, showing that if low pressure were used at some time during seedling production, the application of low pressure should begin at least after germination to obtain higher germination percentages (10).

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Effect of Soil Fumigation and Alternate-year Seeding on Weed Control, Bacterial Spot Incidence, and Yield of Pepper Transplants[1]

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Abstract. **In field tests conducted near Tifton, Georgia, soil fumigation with either a methyl bromide-chloropicrin mixture (67-33%, 480 kg/ha) or metham (748 liters/ha) decreased weed infestation and increased growth and marketable yields of pepper (*Capsicum annuum* L.) transplants, compared with pepper planted consecutively without fumigation. Alternate-year rotation of pepper with rye also reduced weed infestation and increased yield. Weed control accounted for 81% of marketable transplant yield. *Xanthomonas vesicatoria* (Doidge) Dows. overwintered in pepper debris incorporated fresh or dried. Bacterial spot occurred too erratically to permit any conclusions except that the methyl bromide-chloropicrin fumigation failed to provide any control.**

About 200 million field-grown pepper transplants are shipped each spring from southern Georgia to production areas of the eastern and midwestern United States and southern Canada. These transplants are produced under certification regulations of the Georgia Department of Agriculture (1). To be certified in Georgia, pepper transplants must be produced on land that has not been used for production of pepper transplants (except certified transplants) during the previous 3 years (1). Generally, fields used for pepper-transplant production are not fumigated, and weeds and soil-borne plant pathogens sometimes cause major losses. Although diphenamid (*N,N*-dimethyl-2,2-diphenylacetamide) is generally used, weed control is difficult because pepper seed germinate slowly (9).

Bacterial spot incited by *Xanthomonas vesicatoria* is one of the most serious diseases on pepper transplants. Primary inoculum for seedling infection may originate from contaminated seed (4) but apparently also may be present on overwintering plant residue (8, 11). Preventive applications of copper, streptomycin, or copper-streptomycin combinations may be hindered by adverse weather conditions and by the presence of antibiotic-resistant strains of *X. vesicatoria* (10).

In the spring of 1974, we observed (unpublished) a high incidence of bacterial spot on pepper transplants in part of a grower's field that had been fumigated with methyl bromide, where-

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