EFFECT OF TREATMENT OF CUCUMBER SEEDS WITH GROWTH REGULATORS ON EMERGENCE AND YIELD OF PLANTS IN THE FIELD

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Abstract[1]

An experiment was conducted at three field locations to determine the effects on several horticulturally important characters in cucumber (Cucumis sativus L.) after growth regulator and nutrient solution seed treatment. Seeds were treated with Cytozyme, Cytex, Ergostim, Progib, $GA_{4/7}$ alone and in combination with ethephon using two infusion media, acetone and water. Rate and total emergence of seedlings, sex expression, maturity date and fruit yield were not affected by seed treatment or infusion media. Cytozyme, Cytex and Ergostim treatment in combination with acetone infusion was detrimental to the emergence of seedlings.

1. Introduction

Uniform emergence of crop plants in the field is extremely important. Variation resulting from non-uniform emergence in plant development can reduce crop yield. Stand uniformity is of particular concern in crops which are mechanically harvested only once. The survival and performance of seeds after sowing is affected by physical, mechanical, chemical, and biotic factors (Khan, 1979; Thomas, 1981; Hegarty, 1979). Super- or sub-optimal temperatures, unfavorable light conditions, drought and flooding, and unfavorable gaseous environments are physical factors which influence seedling emergence. In the northern United States, spring temperatures can fluctuate dramatically. Low temperatures after the sowing of many warm season vegetables can lead to non-uniform emergence of seedlings (Kotowski, 1926; Thompson, 1974a, 1974b). Stand uniformity can be enhanced by various seed treatments (Gray, 1981; Ells, 1963; Heydecker, 1973, 1974; Malnassy, 1971; Pollock, 1969; Salter, 1978; Sosa-Coronel, 1982). The germination of several

[1] Mention of a trademark, proprietary product or vendor does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of the other products or vendors that may also be suitable.

vegetable species under suboptimal temperatures increased after seed treatment with growth regulators and various osmotica (Nelson, 1980; Fieldhouse, 1975; Darby, 1976; Yaklich, 1975).

Cucurbit seed requires relatively high temperatures for successful germination and seedling emergence (Harrington, 1954; Hegarty, 1973). Improved germination of watermelon seeds (Citrullus lanatus (Thumb.) Matsum. and Nakai) has been observed at 15°C after priming with inorganic osmotica (Sachs, 1977). Likewise, infusion of gibberellic acid ($GA_{4/7}$) and ethephon by acetone, increased the percentage of germination of cucumber (Cucumis sativus L.) and muskmelon (Cucumis melo L.) seeds at 12 and 16°C, respectively (Nelson, 1980). Although GA_3 seed treatments have proved to be effective in increasing the low temperature germination of several crop species (Coats, 1967; Cole, 1974; Wittwer, 1957; Yen, 1972), it is less effective than $GA_{4/7}$ alone or in combination with ethephon in cucumber and muskmelon (Nelson, 1980).

Albeit cucumber seeds germinate rapidly at 20°C, the amount of time increases substantially at 14°C (Simon, 1976; Nienhuis, 1983). Below 11°C, only a small percentage of the seeds germinate (Simon, 1976). While germination and emergence are sequential processes, emergence in cucumber is predominately a function of the time required for radicle elongation and hypocotyl development at a given temperature (Simon, 1976). Moreover, seedling emergence at 15°C appears to be independent of the physiological processes which promote germination (Staub, 1985). Therefore, it was desirable to determine the efficacy of growth regulator seed treatments on the emergence of cucumber under cool field conditions and their effect on several horticulturally important characters.

2. Materials and methods

Seeds of the gynoecious USDA inbred line WI 1606 were aerated in either distilled water or reagent grade acetone for 6 hr. at 32°C and 16 hr. at 25°C, respectively. Infusion media contained either Cytozyme (10% v/v; Cytozyme, Inc., Salt Lake City, Utah), Cytex (10% v/v; Atlantic and Pacific Research, Inc., North Palm Beach, Florida), Ergostim (10% v/v; Montedison USA, Inc., New York, New York), Progib (7 ppm; Abbott Laboratories, North Chicago, Illinois), gibberellic acid ($GA_{4/7}$; 1.0 mM), or $GA_{4/7}$ in combination with ethephon (3.5 mM). Cytozyme and Cytex are cytokinin-containing compounds, while Progib contains gibberellic acid (GA_3). Ergostim is a nutrient solution whose active ingredients are folic acid (0.1%) and n-acetyl thiazolidin-4 carboxylic acid (5%).

Seeds aerated in either distilled water or acetone without growth regulators were used as controls. After treatment, seeds were air dried at 25°C and stored under laboratory conditions (20 ± 5°C and approximately 70% RH) for approximately 3 weeks prior to evaluation in this experiment.

Seeds of each treatment were planted twice in field nurseries at Hancock, Wisconsin; Napoleon, Ohio; and Clinton, North Carolina on 9/5, 23/5, 10/5, 16/5, and 18/4, 27/4/1984, respectively.

Treatments were arranged in a randomized complete block design with 3 replications. Fifty seeds of each treatment were sown about 0.12 m apart in rows 6.1 m long, spaced 1.5 m apart. Supplemental irrigation was used along with standard cultural practices.

Data were collected on seedling emergence, flowering date, sex expression, and fruit yield. For each treatment, percent emergence (PE) and the average number of days to emergence (DTE) were calculated using the following formulae:

$$PE = (T/50) \times 100, \text{ and}$$

$$DTE = \sum(E_i x D_i)/T$$

where T = total number of seedlings which emerged and 50 = total number of seeds planted per plot; E_i = number of seedlings emerged on the ith day after sowing; D_i = the number of days after sowing. Final emergence data were collected 18 days after sowing. Seedlings were considered emerged when the cotyledons were free from the soil surface (approximately 1 mm or more). Minimum and maximum daily temperatures were recorded at a soil depth of approximately 25 mm during the period of seedling emergence.

Sex expression was determined by counting the number of staminate flowers on the first 10 nodes of 10 plants in each treatment. Plants were classified as gynoecious (0 staminate flowers), predominately gynoecious (1-3 staminate flowers), or monoecious (more than 4 staminate flowers). At each location, fruits were harvested once and number of fruits per plant were counted. The percentage of oversized fruit was calculated for each treatment as a function of the number of fruits with a diameter greater than 51 mm.

Analyses of variances were performed separately for each trait over locations. Arcsine square root transformations of data percentages did not affect the results of the analyses, so the analyses of untransformed data are presented.

3. Results and discussion

3.1. Soil temperatures

Temperatures during seedling emergence ranged 7 to 30, 8 to 31, and 4 to 33°C in Wisconsin, Ohio, and North Carolina, respectively (Figure 1). Temperature minimums in Wisconsin were, on the average, lower than the other locations. In North Carolina, minimum and maximum temperatures were notably lower during the first 9 days than during subsequent days.

3.2. Percentage and rate of emergence

Since there were no significant planting date differences for percentage of emergence (PE), PE data were merged and are presented as location means (Table 1). While the PE of controls in North Carolina were similar regardless of infusion medium, Ohio controls were consistently higher than the other locations. Moreover, higher PE was recorded in water than in acetone controls. Cytozyme, Cytex or Ergostim treatment in combination with acetone infusion was detrimental to the emergence of seedlings. This effect was not observed when water was used as the infusion medium. No consistent differences were observed in PE among treatments. In Ohio, the PE of seeds treated with $GA_{4/7}$ in combination with either ethephon infused with acetone, or Progib infused with water were significantly lower than controls. However, regardless of infusion media, the PE of seed treated with either $GA_{4/7}$ or Progib and sown in Wisconsin was significantly higher than controls. The PE of seed which had undergone water infusion of Ergostim and Cytozyme was significantly higher than control in Ohio and Wisconsin, respectively. Likewise, a significantly higher PE was observed for seed which had water-infused with $GA_{4/7}$ alone and in combination with ethephon, and sown in North Carolina and Wisconsin, respectively.

With regard to infusion media, there were no differences in the average number of days to emergence (DTE) among controls within planting dates at the same location. There were, however, significant location differences in DTE among controls. Regardless of infusion medium, the DTE of control plots in the first plantings at Ohio and Wisconsin was higher when compared to other plantings. In contrast, seeds infused with either water or acetone and sown in the second planting at Wisconsin emerged more rapidly than controls in other plantings or locations. From the minimum and maximum temperatures recorded, it is difficult to interpret these differences as due to temperature alone. Although no obvious temperature trends can be identified which relate to the observed differences, the rapidity at which soils attain near maximum daily temperatures and the rate of decline of soil temperatures along with unfavorable edaphic conditions could have been contributing factors. Differences among treatments for DTE were observed among acetone but not water-infused seed. The DTE of seedlings from $GA_{4/7}$ + ethephon treated seed in the North Carolina second planting and the Ohio first planting was higher than other treatments. The DTE of seedlings derived from seed treated with $GA_{4/7}$ alone and in combination with ethephon in the Ohio second planting was less than other treatments. Compared to control, seedlings in the first Wisconsin planting emerged more rapidly when seed was treated with Progib and $GA_{4/7}$.

3.3. Sex expression

Neither infusion media nor growth regulator treatments significantly affected the gynoecious sex expression of WI 1606 (data not presented). Predominately gynoecious and monoecious plants were observed in the Ohio first planting at a frequency of 0.2 and 0.01%, respectively. Both plantings in North Carolina and Wisconsin yielded gynoecious plants only.

3.4. Fruit yields

Fruit yields in Ohio were typically lower than the other locations, and in some cases significantly so (Table 2). No significant differences in fruit yields were recorded among infusion media or chemical treatments, except in Wisconsin. Plants produced from seed which had undergone acetone infusion of $GA_{4/7}$ alone or in combination with ethephon bore significantly more fruit than comparable control plants.

3.5. Percentage of oversized fruit

The percentage of oversized fruits may indicate the relative effect on earliness of a treatment when compared to plants grown at the same location, during the same time period. Because of the interactions of factors such as photoperiod, temperature, moisture and other environmental parameters it is difficult to make comparisons between locations. However, if similar trends can be identified among locations, then this information can be used to lend support to the effect of a treatment on earliness. Although significant differences in the percentage of oversized fruits were observed, no pattern attrributable to a growth regulator treatment could be identified among locations and planting dates.

Previous studies have shown that germination percentage and speed for cucumber seeds incubated at 12°C was markedly increased by acetone infusion with $GA_{4/7}$ (Nelson, 1980). Data from this study indicate that, for the growth regulators used, there were no treatments which could be consistently associated with increasing the emergence percentage or speed. Although isolated fruit yield differences did occur between treatments, none of these differences could be attributed directly to increases in rate and total emergence. This could be partially attributed to the fact that the biochemical processes required for germination and hypocotyl elongation are dissimilar. It appears, from available information (Simon, 1976; Staub, 1985), that growth regulators which promote germination under prolonged exposure at suboptimal temperatures do not necessarily promote emergence in cool soil under field conditions.

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