**NEW BOOK!**

***Develop successful strategies for managing potato production with the help of this practical guide!***

**MANAGING THE POTATO PRODUCTION SYSTEM**

**Bill B. Dean, PhD**
Associate Horticulturist and Extension Specialist, Washington State University, Prosser

***"THE BEST COMPREHENSIVE TEXT AVAILABLE ON POTATO CROP MANAGEMENT. An invaluable aid for students, producers, crop consultants, and especially those laboratory scientists who don't know beans about spuds. . . . This is the first reference I've seen that can serve as a complete textbook for this class. I intend to use it."***
Robert B. Dwelle, PhD, Professor of Crop Physiology, University of Idaho

***"A good reference for growers, technical advisors, teachers, and all those interested in potato production."***
Joseph B. Sieczka, Associate Professor/Coordinator, Cornell University, Long Island Horticultural Research Lab, Riverhead, New York

**$49.95 hard. ISBN: 1-56022-025-2.**
**(Outside US/Canada/Mexico: $60.00)**
Text price (5+ copies): $24.95.
(Outside US/Canada/Mexico: $30.00)
1994. 183 pp. with Index.

This important book on the culture of the potato presents the latest scientific information for potato growers in an easily accessible format and clear language. **Managing the Potato Production System** contains all the current information needed to harvest a bountiful crop. The book is written specifically for field production-oriented technicians and growers and makes the knowledge of production systems easy for readers to apply by providing essential background information, suggestions for incorporating the information into a total production system, and sample forms for collecting data to assist proper and timely decision making.

**Contents**

Foreword (R.E. Gough) • Preface • History and Marketing • Potato Breeding • Potato Seed • Anatomy and Morphology: Growth and Development • Cultivation, Fertilization, and Irrigation • Insect Pests • Diseases • Physiological Disorders • Harvesting, Handling, and Storage • Potato Quality • References • Additional Reading • Appendix • Index

*VISA, MASTERCARD, DISCOVER & AMERICAN EXPRESS WELCOME!*

**CALL OUR TOLL-FREE NUMBER: 1-800-342-9678**
US & Canada only / 8am-5pm ET/Mon-Fri

**FAX YOUR ORDER TO US: 1-800-895-0582**
Outside US/Canada: + 607-722-6362

**E-MAIL YOUR ORDER TO US: getinfo@haworth.com**

- Orders outside USA, Canada and Mexico must be prepaid by check or credit card.
- Postage and handling: US orders, $3.00 for first book, $1.25 for each additional book. Outside US, $4.75 for first book; $1.75 for each additional book.
- NY and Minnesota residents: add appropriate local tax after postage and handling.
- Canadian residents: add 7% G&S Tax before postage and handling.
- If paying in Canadian funds, please use the current exchange rate to convert total to your currency.
- Discounts not good in conjunction with any other offer.
- Prices subject to change without notice.
- 5+ price is not available to library jobbers or wholesalers.

**Food Products Press,**
an imprint of the Haworth Press, Inc.
10 Alice Street, Binghamton, New York USA

EAD96

20

# Growth Response of Cucumber to Hydrophilic Polymer Application Under Different Soil Moisture Levels

A. R. Al-Harbi
A. M. Al-Omran
A. Shalaby
H. Wahdan
M. I. Choudhary

**ABSTRACT.** The effect of hydrophilic polymer addition on the growth of cucumber (*Cucumis sativus* L., cv. Dina) was investigated under different levels of soil moisture. The plants were grown in pots filled with 7 kg of moderately calcareous loam soil. The soil was mixed with five concentrations of hydrophilic polymer Broad Leaf (P-4). These concentrations were 0.0% (control), 0.1, 0.2, 0.3, and 0.4% on a dry-weight basis. Three levels of soil moisture, namely, 25, 50, and 75% of field capacity of untreated soil (control), were used in this study. The results showed a significant increase in the vegetative growth with increasing polymer concentration up to 0.3%. Further increase to 0.4% of P-4 had no significant effect on plant growth. A significant interaction was observed between polymer concentration and soil moisture level. Growing plants under 50% of field capacity with 0.2% polymer concentration resulted in more vegetative growth than did other treatments. Addition of hydrophilic polymers was most effective when the plants were grown

A. R. Al-Harbi is affiliated with the Department of Plant Production, A. M. Al-Omran and A. Shalaby are affiliated with the Department of Soil Science, H. Wahdan is affiliated with the Department of Plant Production, and M. I. Choudhary is affiliated with the Department of Soil Science, College of Agriculture, King Saud University, P.O. Box 2460, Riyadh 11451, Kingdom of Saudi Arabia.

The financial support of the Agricultural Research Center, College of Agriculture, King Saud University is gratefully acknowledged.


© 1996 by The Haworth Press, Inc. All rights reserved.

under the lowest soil moisture treatment level (25% of field capacity). Soil surface, subsoil, and plant temperatures were reduced significantly when soil was treated with higher concentrations of polymer. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworth.com]*

**KEYWORDS.** *Cucumis sativus* L., hydrophilic polymer, soil moisture, soil temperature

## *INTRODUCTION*

Hydrophilic polymers are high-molecular-weight materials that can absorb as much as several hundred times their weight of water (Wallace, 1988). The use of these materials in soil for improving the physical properties and plant growth has attracted considerable interest. The main effects of the hydrophilic polymers are increased water-holding capacity and suppression of evaporation losses, leading to increased water use efficiency (WUE) by the plants (Johnson, 1984; Choudhary et al., 1995). Al-Omran et al. (1987) reported an increase in water-holding capacity and a decrease in evaporation from various soils with addition of hydrophilic polymers. The improvement in soil structure resulted in an increase in plant growth and water use efficiency (El-Kommos et al., 1989; Al-Harbi et al., 1994). The polymers also advanced flowering of tomato plants and enhanced the uptake of N, P, and K by the plants (Ouchi et al., 1990).

The use of polymers in agricultural land is mainly targeted to reduce the frequency and the amount of irrigation, especially in arid regions, where the scarcity of water is a limiting factor for agriculture productivity. Crop response to the addition of polymers in the root medium appeared to be greatest when incorporated into sand or media with low organic matter, and plant response to polymer addition was affected by the crop sensitivity to water stress (Orzolek, 1993).

Saudi Arabia is classified as an arid region, and most of the agricultural land is sandy (Bashour et al., 1983). Crop production relies mainly upon irrigation from suitable groundwater. Reducing the total amount of irrigation water would have a significant impact on agriculture productivity, especially for sensitive crops such as cucumber. In this study we investigated the effect of different concentrations of hydrophilic polymers on the growth of cucumber plants grown under different levels of soil moisture.



## *MATERIALS AND METHODS*

A surface sample (0-15 cm) of moderately calcareous sandy loam (torripsamments) was used in this experiment. The soil contained a very low level of organic matter (0.75%), a high level of $CaCO_3$ (28%), a low level of soluble salts (ECe 0.76 dS $m^{-1}$), a pH of 7.8, and a very low sodium adsorption ratio (SAR 0.81). It was air-dried and passed through a 2-mm sieve. Commercial cross-linked hydrophilic polymers called Broad Leaf (P-4), produced by Agricultural Polymers Ltd. UK, were applied to the soil at five concentrations: 0 (control), 0.1, 0.2, 0.3, and 0.4% (on a dry-weight basis). The corresponding amounts of soil conditioner were thoroughly hand-mixed with air-dried soil.

Field capacity (FC) of the treated and untreated soil samples was determined at 0.01 MPa using a pressure-plate apparatus (Black, 1965). The soil samples were packed in 10-kg plastic pots to a bulk density equal to 1.5 g $cm^{-3}$ with 7 kg of soil per pot. The pots were placed in a greenhouse at day and night temperatures of 25 and 18°C, respectively. The pots were irrigated to field capacity using tap water (EC = 0.4 dS $m^{-1}$ and SAR = 0.9). The amount of water added was 1360 $cm^3$ for control, 1868 $cm^3$ for 0.1, 2640 $cm^3$ for 0.2, 3290 $cm^3$ for 0.3, and 4090 $cm^3$ for 0.4% polymer concentration.

Five seeds of cucumber (*Cucumis sativus* L., cv. Dina) were sown in each pot, 48 hours after wetting, on 27 April 1994. A fixed amount of irrigation water (550 $cm^3$) was added to each pot during germination and early seedling growth, about 100 $cm^3$ every four days for two weeks. At the second leaf stage the seedlings were thinned to one per pot and irrigation treatments were initiated. The irrigation treatments consisted of three soil moisture levels. Irrigation water was added when soil moisture in the pots reached 25, 50, and 75% of the field capacity of untreated soil (control). At each irrigation the soil moisture of the pots was brought up to field capacity. The treatments were replicated four times in a completely randomized design (CRD). A fixed amount of nutrient solution was added to each pot, as recommended by Collin and Jensen (1983).

Plant height and stem diameter at the fourth node were measured at two days, interval for two weeks after imposing the treatments. The plants were harvested after 45 days, and the retained soil water in pots was determined. Vegetative growth parameters, including plant height, stem diameter, leaf number, total leaf area, and fresh and dry weight of the shoots, were determined. Temperatures of the soil surface and plants were determined before and 24 h after irrigation. Subsurface soil temperature at

TABLE 1. Plant growth as affected by hydrophilic polymer concentration.

| Polymer concentration (%) | Plant height (cm) | Stem diameter (cm) | Leaf number (L/P) | Leaf area ($cm^2$) | Shoot fresh weight (g/P) | Shoot dry weight (g/P) |
|---|---|---|---|---|---|---|
| 0 (Control) | 24.4 | 0.62 | 7.1 | 386 | 17.3 | 2.26 |
| 0.1 | 35.4 | 0.77 | 8.9 | 671 | 31.2 | 4.32 |
| 0.2 | 43.8 | 0.73 | 9.6 | 765 | 36.0 | 4.79 |
| 0.3 | 49.8 | 0.82 | 10.0 | 816 | 42.9 | 6.10 |
| 0.4 | 43.6 | 0.79 | 9.6 | 734 | 37.3 | 5.32 |
| $LSD_{0.05}$ | 5.2 | 0.11 | 0.9 | 114 | 5.2 | 0.78 |

10-cm depth was determined using thermal cell temperature from Soil MC-372, Soil Test, Inc.

## RESULTS AND DISCUSSION

Effects of polymer concentration on plant growth parameters are presented in Table 1. Addition of polymers has improved the plant growth. Plant height, stem diameter, leaf number and area, and fresh and dry weight were significantly greater with 0.1% polymer treatment in comparison to the control. Plant vegetative growth was slightly greater at increased polymer concentrations up to 0.3%. A significant decrease in plant height and fresh and dry weight was measured at 0.4% concentration in comparison to 0.3% concentration of polymer. Stem diameter, and leaf number and area were also decreased, but the difference was nonsignificant. It is very obvious that 0.3% concentration of polymer gave the most vegetative growth of all treatments. Growth response to polymer addition varied with plant species and number of irrigations (Dehgan et al., 1994). Al-Harbi et al. (1994), in their study of tomatoes found a significant increase in the plant height and leaf area with addition of polymer of up to 0.4% concentration, and a marginal decrease when the polymer concentration was increased to 0.6%. El-Kommos et al. (1989) also found the most vegetative growth and dry-matter production of wheat with the addition of soil conditioner (Boligrow) at the rate of



0.25%. Higher application concentrations caused a decrease in plant height and dry-matter production.

The results showed a significant interaction between polymer addition and soil moisture level on plant height, leaf area, and fresh and dry weight of the plants (Table 2). The application of lower concentrations of hydrophilic polymer seemed to be more effective under low soil moisture levels. The effect of 0.1% polymer concentration was more pronounced at 25% FC, 0.2% at 50% FC, and 0.3% at 75% FC. No significant difference was observed at the highest rate of polymer at each level of FC. Plants grown under 50% FC with 0.2% polymer concentration gave the greatest vegetative growth. At the same level of FC the shoot dry weight was slightly higher at 0.3% than 0.2% polymer concentration, but the difference was

TABLE 2. Effect of soil moisture level and hydrophilic polymer on plant height, leaf area, and fresh and dry weight of cucumber plants.

| Soil moisture level (FC) (%) | Polymer concentration (%) | Plant height (cm) | Leaf area ($cm^2$) | Shoot fresh wt. (g/p) | Shoot dry wt. (g/p) |
|---|---|---|---|---|---|
| 25 | 0 (Control) | 13.0 | 211 | 8.7 | 1.26 |
| 50 | 0 (Control) | 30.5 | 426 | 18.7 | 2.25 |
| 75 | 0 (Control) | 29.7 | 513 | 24.3 | 3.29 |
| 25 | 0.1 | 35.0 | 677 | 30.6 | 4.12 |
| 50 | 0.1 | 31.0 | 703 | 32.7 | 4.41 |
| 75 | 0.1 | 40.7 | 596 | 27.2 | 3.82 |
| 25 | 0.2 | 35.7 | 674 | 31.0 | 4.14 |
| 50 | 0.2 | 55.7 | 1022 | 50.2 | 6.45 |
| 75 | 0.2 | 39.7 | 635 | 29.9 | 4.42 |
| 25 | 0.3 | 40.0 | 753 | 38.4 | 5.36 |
| 50 | 0.3 | 53.7 | 906 | 48.1 | 6.97 |
| 75 | 0.3 | 55.3 | 788 | 42.2 | 5.97 |
| 25 | 0.4 | 38.7 | 683 | 34.2 | 4.83 |
| 50 | 0.4 | 47.7 | 826 | 42.5 | 6.05 |
| 75 | 0.4 | 44.3 | 694 | 35.3 | 5.07 |
| $LSD_{0.05}$ | | 8.9 | 198 | 9.0 | 1.35 |

nonsignificant. At 75% FC, the leaf area of plants at 0.3% polymer concentration was 54% greater than the control, while at 25% FC, the percentage of increase was 257% greater than the control. Similar results were observed for fresh and dry weight. Bres and Weston (1993) reported that polymer application did not strongly affect the growth of tomato seedlings when water was not a limiting factor.

The positive effect of application of hydrophilic polymers might be due to improved water-holding capacity and nutrient availability in the root medium (Orzolek, 1993). Vegetative growth reduction at higher rates could result from reduced availability of water. The results presented here indicate that the optimum application rate depends on the moisture level in the root medium. This finding concurs with those of Sabrah et al. (1993), who reported that the promotive effect of applied soil conditioner on plant growth depends on the irrigation regimes used.

Results presented in Table 3 show a significant reduction in subsoil temperature with increasing polymer concentrations of up to 0.2%, while the soil surface and plant temperatures were significantly decreased with increasing polymer concentrations of up to 0.3%. This reduction could be attributed to the evaporative cooling of the retained water and the shading effect of the large vegetative growth resulting from polymer addition. Higher concentration (0.4%) caused a significant increase in subsoil temperature, while no changes were observed in the temperatures of the soil surface and plants.

TABLE 3. Effect of hydrophilic polymer concentrations on soil and plant temperatures.

| Polymer concentration (%) | Temperature (C°) | | |
|---|---|---|---|
| | Subsoil | Soil surface | Plant |
| 0 (Control) | 28.3 | 29.3 | 27.1 |
| 0.1 | 25.7 | 27.7 | 25.9 |
| 0.2 | 24.9 | 26.7 | 25.1 |
| 0.3 | 24.5 | 25.7 | 24.1 |
| 0.4 | 25.7 | 25.7 | 23.9 |
| $LSD_{0.05}$ | 0.774 | 0.81 | 0.42 |



## CONCLUSION

Over the short duration of this experiment, it was found that hydrophilic polymers can be used to decrease the irrigation water requirement. The promotive effect of polymer application is very obvious when the moisture level in the root medium is below the optimum level. Low concentrations of polymer improved the plant growth by increasing water-holding capacity and perhaps promoted the aeration of the root medium. Reduction in vegetative growth with addition of higher polymer concentrations may be due to the natural characteristic of polymer, which retained water and thus competed with the plant, especially under low levels of soil moisture. Reduced soil and plant temperatures due to polymer addition might have contributed to the improvement in plant growth.

## LITERATURE CITED


Al-Harbi, A.R., A.M. Al-Omran, H. Wahdan, and A.A. Shalaby. 1994. Impact of irrigation regime and addition of a soil conditioner on tomato seedling growth. Arid Soil Res. Rehab. 8:285-290.

Al-Omran, A.M., M.A. Mustafa, and A.A. Shalaby. 1987. Intermittent evaporation from soil columns as affected by gel-forming conditioner. Soil Sci. Soc. Am. J. 51:1593-1599.

Bashour, I., A.S. Mashhady, D.J. Parasad, T. Miller, and M. Mazroa. 1983. Morphology and composition of some soil under cultivation in Saudi Arabia. Geoderma. 29:327-340.

Black, C.A. (ed.). 1965. Methods of soil analysis, Parts 1 and 2. American Society of Agronomy, Madison, Wisconsin.

Bres, W. and L.A. Weston.1993. Influence of gel additives on nitrate, ammonium and water retention, and tomato growth in a soilless medium. HortScience 28(10):1005-1007.

Choudhary, M.I., A.A. Shalaby, and A.M. Al-Omran. 1995. Water holding capacity and evaporation of calcareous soil as affected by four synthetic polymers. Commun. Soil Sci. Plant Anal. 26:2205-2215.

Collin, W.L. and M.H. Jensen. 1983. Hydroponics: A 1983 technology overview. Environmental Research Laboratory, University of Arizona, Tucson.

Dehgan, B., T.H. Yeager, and F.C. Almira. 1994. Photinia and Podocarpus growth response to a hydrophilic polymer-amended medium. HortScience 29(6):641-644.

El-Kommos, F., A.A. Dahroug, and Y. Nour El-Din. 1989. Evapotranspiration, water use efficiency and dry matter of wheat as affected by some soil conditioner at different soil moisture level. Egypt. J. Soil Sci. 29(4):387-400.

Johnson, M.S. 1984. Effect of soluble salts on water absorption by gel-forming soil conditioners. J. Sci. Food Agric. 35:1063-1066.

Orzolek, M.D. 1993. Use of hydrophylic polymer in horticulture. HortTechnology 3(1):41-44.

Ouchi, S., A. Nishikawa, and E. Kamada. 1990. Soil improving effect of super water absorbent polymer (Part 2). Japanese J. of Soil Sci. and Plant Nutrition 61(6):606-613.

Sabrah, R.E.A., M.F. Ghoneim, R.K. Rabie, and H.M. Abdel-Magid. 1993. Effect of soil conditioners and irrigation regimes on growth and nutrient uptake by alfalfa plants. Egypt. J. Soil Sci. 33(1):73-84.

Wallace, G.P. 1988. Granular gel as growth media for tomato seedlings. HortScience 23(6):998-1000.

*for faculty/professionals with journal subscription recommendation authority for their institutional library . . .*

If you have read a reprint or photocopy of this article, would you like to make sure that your library also subscribes to this journal? If you have the authority to recommend subscriptions to your library, we will send you a free sample copy for review with your librarian. Just fill out the form below–**and make sure that you type or write out clearly both the name of the journal and your own name and address.**

( ) Yes, please send me a complimentary sample copy of this journal:

(please write in complete journal title here–do not leave blank)

I will show this journal to our institutional or agency library for a possible subscription.
The name of my institutional/agency library is:

NAME: ______

INSTITUTION: ______

ADDRESS: ______

CITY: ______ STATE: ______ ZIP: ______

Return to: Sample Copy Department, The Haworth Press, Inc., 10 Alice Street, Binghamton, NY 13904-1580

# Plant and Row Spacing for Southern Pea and Snap Bean

Richard L. Parish
Christopher M. LaBorde
Timothy J. Raiford

**ABSTRACT.** Row configuration and seed spacing within the row were evaluated with southern pea (*Vigna unguiculata* [L.] Walp.) and snap bean (*Phaseolus vulgaris* L.). The row configurations used were single drills on 1.22 m (48 in) rows and twin drills 0.30 m (12 in) apart on 1.22 m (48 in) rows. Nominal seed spacings were 69, 102, and 137 mm (2.7, 4.0, and 5.4 in) for southern pea and 91, 117, and 137 mm (3.6, 4.6, and 5.4 in) for snap bean. Three plantings were made in 1995.

Snap bean showed sensitivity to single- and twin-drill configurations in yield response. Twin-drill plots of snap bean yielded over twice as much as single-drilled beans. Southern pea did not differ in yield as a result of row configuration or in-row spacing. Mechanical harvest of twin drills was not efficient; thus, the machine-harvested yields were lower than hand-harvested yields. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworth.com]*

**KEYWORDS.** Plant spacing, row spacing, row configuration, twin drill, southern pea, snap bean

Richard L. Parish is Professor, and Christopher M. LaBorde is Research Associate, Department of Biological and Agricultural Engineering, Hammond Research Station, Hammond, LA 70403.

Timothy J. Raiford is Instructor, Burden Research Plantation, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803.

Use of specific brand names does not imply endorsement by the Louisiana Agricultural Experiment Station.

Approved for publication by the Director of the Louisiana Agricultural Experiment Station as manuscript number 96-07-0126.

Journal of Vegetable Crop Production, Vol. 2(2) 1996
© 1996 by The Haworth Press, Inc. All rights reserved.