AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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Batch #28

1. SUBJECT CLASSIFICATION

A. PRIMARY: Serials — Y-AC00-0000-0000

B. SECONDARY: Agriculture--Education,extension,and advisory work

2. TITLE AND SUBTITLE

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(101) Pa.State Univ. Dept.of Agronomy

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Pa.State

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(Activity summary)

9. ABSTRACT

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12. DESCRIPTORS	**13. PROJECT NUMBER**
Education,higher	
	14. CONTRACT NUMBER CSD-1932 211(d)
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AID 590-1 (4-74)

THE PENNSYLVANIA STATE UNIVERSITY

COLLEGE OF AGRICULTURE

DEPARTMENT OF AGRONOMY

JUNE 1, 1968 to MAY 31, 1969

TECHNICAL REPORT

211(d) International Program

The Pennsylvania State University

Major Accomplishments

This contract has not been in operation long enough to catalog any real major accomplishments. However the following actions have been taken:

1. Appointment of Dr. R. P. Pfeifer as 211(d) Professor on October 1, 1968 (Subsequently resigned February 28, 1969).

2. Appointment of Michael Colegrove as Graduate Assistant on September 15, 1968.

3. Appointment of Wayne Hoag as Graduate Assistant on June 15, 1969.

4. Arrangements are in progress to send Michael A. Colegrove to India to carry out part of his thesis research from September 15 through March 15, 1969.

5. A second candidate for the 211(d) professorship has been interviewed.

6. Arrangements have been made to study uptake and its effect on grain production under basic soils of India. Similar studies on acid to neutral soils in the United States are already underway. Laboratory experiments using the two soils, acid and basic to study plant response as well as physical and chemical processes in P fixation will be carried out in an attempt to develop fertilizer application recommendations which are most effective for sorghum grain production in Maharashtra, India and Pennsylvania.

7. A small library on Indian research in grain and seed production is being developed.

8. Planning is in progress on a program of instruction with an international aspect to be incorporated in Agronomy curricula.

Evaluation of Progress

No data has yet been collected for this project. However, experimental plantings of sorghum have been made in the field in Pennsylvania and in the miniature Jordan Soil Plots. Plantings are planned this year in June near Poona, Maharashtra, India. The first graduate student was expected to go to India in June but because of academic course conflicts he will delay his trip to India until September to gather his first data from there.

Recommendations and Conclusions

Continuation of the project is recommended with the first student going to India in 1969. Further, the newly appointed professor should be sent to India as early as possible after appointment to gain maximum information on production of food grain and seed crops to support the 211(d) program.

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International program in crop production; annual report,1972/1973

3. AUTHOR(S)
(101) Pa.State Univ. Dept.of Agronomy

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1973	15p.	ARC 631.5.P415

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Pa.State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(Activity summary)

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAB-640	
12. DESCRIPTORS	**13. PROJECT NUMBER**
Education,higher	
	14. CONTRACT NUMBER CSD-1932 211(d)
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Annual Report for the Period Ending May 31, 1973

211(d) International Program in Crop Production

Agronomy Department, The Pennsylvania State University

University Park, Pennsylvania 16802

211(d) Annual Report

Date September 1, 1973

Title: Crop Production in India and Other Developing Nations

Grantee: The Pennsylvania State University, University Park, PA 16802

Director: Agronomy Department (119 Tyson Building)
Dr. Richard H. Cole, Project Leader

A. Statistical Summary:

Grant Period June 1, 1968 to May 31, 1975 Grant Amount $200,000.00
Expenditures for Report Year $37,539.53 Accumulated $154,159.83
Anticipated for Next Year $28,000.00

B. Narrative Summary:

The Agronomy Department continues to be the most internationally involved department in the College of Agriculture. Over the past year, the faculty have become very actively involved in both the Argentina and Bahama Island programs. Major leadership has been provided by our Department Heads, the 211(d) Professor, and several Professors of Crop and Soil Science.

As the contracts have been phased out in India, lines of communication have been maintained by the international agronomy faculty and the 211(d) students. The continued interest of the 211(d) Professor and the international students has been extremely beneficial. Because of the lack of an active Indian program, it has been suggested that cooperation with the Bahamian Project would be acceptable. Grant support through May of 1978 has been requested without increasing the amount of the grant.

The greatest impact of this grant has been within the Department. Teaching, advising and consulting capabilities have been drastically improved. Two former 211(d) students have been employed by international foundations and started careers in international agricultural development. In the future, advanced training should be a part of the total programs of the College of Agriculture. Cooperation among departments and other U. S. institutions, as well as program flexibility, has proved essential for departmental international projects.

I. GENERAL BACKGROUND AND PURPOSE OF THE GRANT

This project is one of six conducted at the universities that coordinated their work in India through CUSURDI (the Council of United States Universities for Rural Development in India). Each project was designed to encourage the employment of a full-time faculty member to conduct research, supervise graduate students, and carry out other activities to increase the university's competence in the international dimension of a chosen discipline. Inter university and inter-disciplinary exchange of information and knowledge has been encouraged, and joint reviews of work plans and progress have been conducted by CUSURDI.

Because of the crop production needs and interests in Central India and the competence in agronomy at The Pennsylvania State University, the area of specialization ultimately selected for this project was "Crop Production." This proved to be an excellent area of specialization because it has been broad enough to gain wide faculty and student support while stimulating more specialized areas of international interest in agronomy at the University.

II. OBJECTIVES

The major objectives of the 211(d) project at The Pennsylvania State University are as follows:

1. To increase interest in and knowledge about the agricultural problems of India and other developing nations, and improve the capabilities of The Pennsylvania State University to become associated with international programs in crop production;
2. To increase the pool of scientists interested in and capable of assisting in agricultural development outside the United States;
3. To provide an opportunity for graduate students to obtain research experience in crop production involving problems relevant to India and other less developed countries;
4. To create an awareness and stimulate interest of plant and soil scientists in international assignments and careers; and;
5. To encourage youth to seek training leading to careers in international agriculture.

All of the project objectives were considered in selecting the work priorities for this past year. Agronomists were actively involved in Indian, Argentinian and Bahamian programs. Because of the termination of our university contracts in India, considerable time was spent by the 211(d) staff supporting the work in Argentina and assisting in organizing the new program being developed in the Bahama Islands. Agronomy students may now receive international experience on Andros Island in the Bahamas. Because of the competences of our staff and the programs being conducted in the College of Agriculture, the international agronomic speciality area has included the production of forage and grain crops as well as food grain crop production.

III. ACCOMPLISHMENTS

A. Increasing interest in and knowledge about the agricultural problems of India and other developing nations and improving the capabilities of PSU to become associated with international programs in crop production.

Active committees interested in problems in India, Argentina and the Bahamas have been maintained in the Agronomy Department. The 211(d) professor has taken major leadership roles in the Indian and Bahamian programs and the department head has served as coordinator of the Argentina Crop Production program.

Faculty participation has been the greatest this past year in the Argentina program. Future involvement in Argentina will likely be dependent upon stabilization of the political situation in that nation.

It is hoped that the Indian involvement, terminated in 1973, will become modified and activated again within the next two or three years. The faculty continues to make frequent contact with associates in India and have been encouraged by the Indians to propose programs that may become activated in the future. The 211(d) professor continues to serve on Indian graduate theses review committees and maintaines contact with past participants. Associates in Maharashtra include Dr. V. S. Khuspe (formally Agronomy Head and now Dean of Agriculture, Rahuri), Dr. N. D. Patil (Soil Science Head, Rahuri), Dr. B. D. Khot (Professor of Agronomy, Poona), and Dr. P. N. Kalbhor (Associate Professor of Agronomy, Poona). The major cooperator at IARI, Dehli, is Dr. Rajat De. Active cooperative research this past year involved work with corn hybrids, phosphorus fertility in sorghum, corn grain and fodder production, soybean varieties, and alfalfa varieties and persistance. All the work is presently being continued by Indian associates and their students. Early personal contact in India would be desirable.

Penn State's involvement in the Bahamian program was developed during the latter part of the fiscal year. The University's role has been expanding rapidly. Professional experience for applied agronomists with limited international experience can be provided through this project. The contract allows PSU to expand its interest in international forage crop-grain crop-livestock programs.

An estimated 25% of this years expenditures have been used to meet this objective.

B. Increasing the pool of scientists interested in and capable of assisting in agricultural development outside the United States.

This past year was an involvement year for the agronomy faculty in international programs. In the Argentine program one agronomist, Dr. Daniel P. Knievel, served the entire year and four faculty (Doctors Cunningham, Hill, Hartwig and McKee) each taught in the program for three months. Three other professors (Jung, Petersen and Washko) were removed from the program on short notice. Dr. J. L. Starling, Agronomy Head, also attended a coordinating meeting in Argentina.

Only Dr. Cole, 211(d) professor, and Dr. Pennock, 5 year team member at Poona, were actively involved in India this past year.

The agronomy input in the Bahama program has been primarily the responsibility of the agronomy extension professors Eakin, Baylor and McClellan. A major role has been played by the 211(d) professors extension associate, Professor James H. Eakin. Fortunately he has had experience with island agriculture and developing soils with similar characteristics. The 211(d) professor has served as chairman of the college committee for the project.

Three Indian students participants departed from the University during the past year (Patil, Somowanshi, and Desai). Their programs were completed with very little difficulty. The 211(d) professor served as chairman of the programs for both one year participants, and as a committee member of the student that received the Ph.D. in Agronomy, Dr. S. N. Desai. While they have received excellent training to fill specific positions in their home state, one man has been improperly placed and there is some question about the final placement of the others. After being trained to attack applied problems, it appears undesirable to place a man in a position where problem solving is not encouraged. Continued guidance to help students adjust to these problems is necessary.

Two additional 211(d) International Agronomy students with considerable international experience graduated during the past year. Wayne L. Haag completed his Ph.D. and was employed by the Rockefeller Foundation in Mexico. J. Harold Stern completed his M.S. and remained at Pena State for further studies. While Mr. Stern has 5 1/2 years of international experience, he expects to expand his research experience through employment in the Bahama project in 1974. Abstracts of both their theses are attached.

An estimated 30% of this years expenditures were used to meet this objective.

C. Providing opportunity for graduate students to obtain research experience in crop production involving problems relevant to India and other less developed nations.

Only one student, Mr. Wayne L. Haag, received international experience in India at project expense this past year. He was primarily responsible to conduct a special problem and carry out the programs previously established by the 211(d) professor. One other student, J. Harold Stern, studied for a four-week period at his own expense in Africa.

Provision has been made for two Ph.D. candidates to obtain international experience in the Bahama program in the next two years. If this grant can be extended as suggested in later chapters, one additional 211(d) student can be supported within the next 5 years.

Five students have received grant support since the project was initiated in 1968. Three (Colegrove, Haag and Stern) received full stipend support. Only Colegrove, the first student in the program, was solely supported by the project. Colegrove conducted a major portion of his thesis work in India and Haag a short-term special problem. Both are employed by the Ford and Rockefeller Foundation, respectively. Stern conducted all his M.S. thesis work in Pennsylvania, but will obtain international research experience before completing the Ph.D. A fourth student (A. David Wilson) was scheduled to leave for India at the time student involvement in India was terminated. Since that time he has been supported by departmental funds and is doing a US based multi-state thesis. He expects to

seek international employment, and because of prior international work experience should have little problem obtaining a position. James Bergman received stipend support for about 14 months and provided self-support for the remainder of his tenure. Although offered an international position in Africa, he elected the opportunity to join the New York Extension Service. Ronald Gayton, a future student employee on the Bahama project, received full departmental support.

International employers have indicated the characteristic desired of potential candidates as follows:

(1) Come from an applied background;
(2) Have international experience;
(3) Have a graduate degree or speciality; and
(4) Desire international work.

The 211(d) international agronomy professor has also been active as chairman or member of graduate committees of three Indian and several other international graduate students. Applied problems have been utilized for all students programs of those enrolled since 1970.

About 25% of the expenditures have been needed to meet this objective.

D. Creating awareness and stimulating interest of plan and soil scientists in international assignments and careers.

Only an estimated 10% of this years expenditures have been utilized to promote awareness and stimulate interest in international assignments. The Indian program was drastically reduced, needing little professional help, and the Argentina program had the spade work completed before the start of the project year.

More people were available for assignments at PSU then could have been utilized without jeopardizing domestic programs. Because of the previous stimulating international programs, no difficulty was encountered in recruitment for the Bahama project.

E. Encouraging youth to seek training leading to careers in international agriculture.

The need to motivate students early in their undergraduate programs was again emphasized when a College of Agriculture course in international agriculture was offered for the first time in 1973. Forty-nine enthusiastic students enrolled.

Because of the need for on-the-job experience, several students were encouraged to seek their first international employment in volunteer organizations. The 211(d) professor was continuously available for student advisement. A major problem is the need for a clearing house to list international opportunities and the lack of a continuous, consistant manpower need. Ten per cent of this years expenditures were used to meet this objective.

IV. IMPACT OF GRANT ON THE UNIVERSITY

The major impact of the grant has been felt within the Agronomy Department. It has drastically improved our international teaching and advising capabilities. Undergraduates are exposed to international crops and soils problems. International agronomy graduate students are assigned appropriate applied problems.

Research specialists are available for international assignments and consulting. This has not been confined to the area of grain and forage crop production. Specialists have also worked in corn and alfalfa improvement, soil resources and land use management, soil analysis and fertility, crop quality analysis, weed control, crop ecology and physiology, and soil and water management.

The need for cooperation with other U. S. institutions has been realized in our College of Agriculture projects in India, Argentina, Uruguay, and the Bahamas. The greater the number of institutions involved, the greater the number of productive new ideas. Recruitment of specialists from associated institutions is not difficult as they are already familiar with the program being conducted.

The active participation of agronomists in international programs also has a stimulating effect on other disciplines within the College. Very few problems can be solved by an agronomist alone. The willingness to take the leadership role and work with associates in other departments, will likely encourage cooperation on domestic projects in the future.

The flexibility of programs cannot be overlooked. The India contracts were terminated this past year. It now appears that the Argentina contract may not continue as expected. New involvement must always be under consideration if we are to maintain continuous international programs. Diverse funding would be desirable. The stability of programs should receive greater importance when considering future projects.

Student training should be part of the Universities active projects. Problems conducted in a foreign nation must not be a project of interest only to the student and his major professors. Local country support is essential. It is doubtful if international training can be designed without some risk of the work being suspended, but when conducted within a viable University program, problems should be minimized.

The experience gained through the work promoted by this grant has been very valuable. The 211(d) professor and students have been called upon to do many tasks that could not have been considered without this type of support. The placement of these funds within the Department of Agronomy has had an effect on all College programs. When this support is primarily removed at the end of this next year, its value should become quite evident.

V. UTILIZATION OF INSTITUTIONAL RESOURCES IN DEVELOPMENT

Because of the expertise developed within the Department through international assignments and study made possible by the grant, the Agronomy Department has been in a position to assume major roles in three of five of the College of Agriculture's recent international contracts. Crop production was the major subject matter area in the Indian and Argentinian contracts. Forage and grain production, along with soil and water management are vital to our Bahamian program.

The activities supported by this grant, i.e. seminars, student advisement, graduate study, etc., have helped to promote an interest in international development throughout the College. U. S. graduates are making major contributions in Rockefeller and Ford Foundation Projects. Extensive use has been made of our soil and forage testing facilities as well as the Dr. J. S. Shenk's vole colony located at the University. Departmental facilities often supplement visits to the USDA Regional Pasture Laboratory located at University Park.

In the future, contributions to international programs within the agronomic area could be increased because of the continued interest within the Department. This must not be at the expense of domestic programs. Greater involvement should be self-supporting when possible.

VI. OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

The Pennsylvania State University continues to supply the facilities as well as supervisory, technical, clerical and accounting services required by the project. It has encouraged faculty and students not assigned to this project or paid from other international contracts to contribute time freely to international projects. An estimate of this support is found in Table 1.

These estimates do not include the contributions of professional associates in other nations or that of cooperating institutions. As Bahamian-American associations are actively developed, it is hoped that the Indian-American associations can be maintained.

Table 1. Estimated contributions from departmental sources of funding for the period June 1, 1973 through May 31, 1974.

Activities	Departmental Funds
International Teaching	$ 5,500.00
Student Advising	4,500.00
International Research	750.00
International Service	3,750.00
International Consulting	7,000.00
Program Organization	3,000.00
Other	5,000.00
Total	**$29,500.00**

VII. BUDGETS AND EXPENDITURES

The original and revised budgets and expenditures for the project are reported in Table 2. Less than 19% of the total budget was spent in fiscal 72-73. Five-year expenditures were about 77% of the total grant; however, only 9% of the grant funds are expected to be available for program use after June 1, 1974 (Table 3).

Salaries and wages in 1972-73 included the full salary of the 211(d) professor, Dr. Richard H. Cole, and the assistantships of three 211(d) students. Dr. Wayne L. Haag graduated and was employed by the Rockefeller Foundation in Mexico in December, 1973. Mr. A. David Wilson was transferred to departmental funds in October of 1972 when it was learned he could not complete his thesis in India. A third international student, Mr. J. Harold Stern, received his M.S. in March of 1973 and is continuing his international agronomy studies supported by grant funds. One student not previously supported by grant funds, Mr. Ronald F. Guyton, is presently conducting an international thesis that will require minimal grant support in the future. Wages were also paid undergraduate students for part-time direct assistance of the 211(d) professor and students.

Other expenditures were minimal with a few exceptions. Travel expenses to India were paid in 72-73 for Dr. Richard H. Cole, the 211(d) professor, and Mr. Wayne L. Haag, a 211(d) student. Greenhouse moisture pumps and a pressure moisture chamber were purchased for international student studies at a cost of $2,111.70 and $770.00 respectively. Suppliers were Cole-Palmer and PMS Instruments (an Oregon firm).

The expenditures over the past year were slightly less than projected because of the reduced activity of the Indian programs. Future programs must be dependent upon the PSU contracts or likely contracts with other nations.

The lack of significant documentation of research and developmental activities is a major problem within the agronomic area. A considerable portion of the work conducted in India by the faculty and students remains unpublished. Some of the cooperative data collected or being collected has been or is being utilized by our Indian associates, but the reporting of this work should be a cooperative venture. A plan to report this information will soon be finalized.

VIII. PLAN OF WORK AND BUDGET FOR SUBSEQUENT YEARS

The proposed budget for 1973-74 is $28,000.00 (Table 3). This includes a major portion of the salary of the 211(d) professor and one graduate assistant. Beyond promoting the international programs already established, the 211(d) professor will be responsible to work out the details of the graduate programs of two students in the Bahamas. He will also maintain liaison with his agronomic associates in India. There is an outside chance that a data collecting trip to India may be proposed in 1974. An effort will be

renewed to publish the data available before the end of the project year. The only 211(d) supported Ph.D. student will be employed on contract funds through March of 1971.

The projected budget for subsequent years is based on the following assumptions:

(1) Cooperative student study programs will not be conducted in India, but will be replaced by agronomic student projects established on Andros Island in the Bahama Islands.

(2) Graduate stipends and minimal logistic support will be supplied three agronomy graduate students for not more than a six-month period on their return from the Bahamas.

(3) The 211(d) professor will not be paid by grant funds after June 30, 1971, with the exception that a one-month salary is budgeted for 77-78 when a final report will be prepared.

(4) Travel funds will be allowed for graduate students committee chairman to make one trip to Andros Island each year to evaluate the student project progress.

(5) The Bahama Islands can be utilized as the "laboratory" for international agronomy students, and a grant extension can be approved through May 30, 1978.

A Ph.D. student is expected to complete his work in 1975-76, another in 76-77 and a final student in 77-78. Their involvement will insure an active international interest within the Agronomy Department. The students will be well-trained and will be expected to seek full-time international agricultural development employment.

It must be expected that international program promotion by the 211(d) professor will be drastically reduced after June 30, 1971. While primarily assigned to domestic projects, a continued interest can be expected by many of the faculty in the Agronomy Department.

Table 2. Budgets and expenditures for the 211(d) International Agronomy Project at The Pennsylvania State University.

Category	Original Five-Year Budget	Revised Seven-Year Budget	Revised Ten-Year Budget	Expenditures Recorded 6/1/72-5/31/73	Total Expenditures Through 5/31/73
Salary and Wages	$146,000.00	$136,500.00	$141,548.63	$27,069.00	[illegible]
Travel and Transportation	21,000.00	44,500.00	36,183.95	5,486.15	[illegible]*
Equipment and Supplies	22,000.00	13,000.00	14,991.93	3,765.84	[illegible]
Other Direct Costs	11,000.00	6,000.00	7,275.49	1,218.54	[illegible]
Totals	**$200,000.00**	**$200,000.00**	$200,000.00	$37,538.53	$154,[illegible]

* Includes an estimated $3,000.00 for travel not charged to the project to date.

ıle 3. Revised budget for the 211(d) International Agronomy Project at The Pennsylvania State University.

Category	Five-Year Project Expenditures	1973-74 Budget	1974-75 Budget	1975-76 Budget	1976-77 Budget	1977-78 Budget
ary and Wages	$107,548.63	$24,000.00	$1,500.00	$2,000.00	$2,000.00	$4,500.00
ıvel and Transportation	30,683.95*	2,000.00	1,000.00	1,000.00	1,000.00	500.00
ıipment and Supplies	11,991.93	1,000.00	500.00	500.00	500.00	500.00
ıer Direct Costs	3,935.32	1,000.00	500.00	500.00	500.00	840.17
als	$154,159.83	$28,000.00	$3,500.00	$4,000.00	$4,000.00	$6,340.17

Includes an estimated $3,000.00 for travel not charged to the project to date.

March, 1973

Department of Agronomy
119 Tyson Building
University Park, Pa. 16802

Summary of the thesis by Wayne L. Haag

"Evaluating methods of selection for disease resistance in alfalfa, Medicago sativa L."

I. Theoretical

The relative effectiveness of self progeny test, selfed family, polycross progeny test, polycross family, full-sib family, and individual selection were compared theoretically. Initial gene frequency, level of environmental variance, and genetic models were variables in the comparisons. The comparisons were based on theoretical change in gene frequency with one cycle of selection in a two-allele autotetraploid population in random mating equilibrium.

Theoretical responses with selfed progeny test and selfed family selection were equal, and were always greater than the other methods. Polycross progeny test selection was the second most effective method, and polycross family selection was the least effective method. Full-sib family and individual selection were intermediate between polycross progeny test and polycross family selection. Full-sib family selection was more effective than individual selection when environmentalal variance was large, but individual selection was more effective for some gene frequencies when environmental variance was small.

II. Experimental

One generation each of selfed progeny test, selfed family, polycross progeny test, polycross family, and individual selection was conducted for resistance to Uromyces striatus Schroet. var. medicaginis (Pass.) Arth., Phoma herbarum West f. medicaginis West ex. Rab., and Stemphylium botryosum Wallr. in alfalfa, Medicago sativa L. Selected individuals from each method with each pathogen were intermated separately. The improved populations were compared experimentally to evaluate relative effectiveness of the selection methods.

Each method of selection produced a significant increase in resistance to U. striatus. Selfed progeny test and selfed family gave similar responses and were the most effective methods. Polycross progeny test and polycross family selection also gave similar reponses, but were the least effective methods for U. striatus resistance. Response with individual selection was intermediate between selfed and polycross methods. Each of the progeny test and family methods produced similar and significant increases in resistance to P. herbarum. Individual selection for resistance to P. herbarum was not effective. No method of selection produced a significant increase in resistance to S. botryosum.

March, 1973

Department of Agronomy
119 Tyson Building
University Park, Pa. 16802

Summary of the thesis by J. Harold Stern

"Trickle irrigation and media effects on growth of Chrysanthemum morifolium Ramat."

Factors limiting growth in gravel culture are oxygen, nutrients and water. These factors are dependent on gravel diameter, nutrient solution composition, and irrigation frequency. This study evaluated combinations of trickel irrigation frequencies and particle sizes on growth of Chrysanthemum morifolium Ramat. irrigated with complete nutrient solution. Plant height, fresh weight, dry weight, and flower diameter were used to measure chrysanthemum growth. Media used were: Coarse incinerated anthracite refuse (73%>2mm), fine incinerated anthracite refuse (40%>2mm), and soil from the B21 horizon of Gatesburg sand (3%>2mm) (Entic Haplorthod, sandy, siliceous, mesic). Irrigation frequencies were: once per day, four times per day at 4-hr. intervals, and constantly during the 13 light hours. Fine incinerated anthracite refuse irrigated constantly or every 4 hours produced Chrysanthemums with significantly greater height, fresh weight and flower diameter than other treatments, while Gatesburg sand irrigated daily resulted in less growth than other treatments.