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Control of Rhizoctonia Damping-Off in Seedlings Grown from True Potato Seed[1]

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Traditionally, farmers around the world have used seed tubers to produce potatoes for food as well as for planting. This practice, however, is a major limitation to potato production in the tropics where seed tubers are highly perishable and expensive to store and transport. For some time, the International Potato Center (CIP), along with other research institutions, has been studying the use of true potato seed (TPS) (botanical seed) as an alternative method for potato production. The two methods of growing potatoes from TPS that have been broadly accepted are 1) sowing TPS directly in the field, and 2) sowing TPS in seedbeds and transplanting seedlings to the field. Potatoes produced by either method can be used for food or as seed tubers, but the latter method has shown to be the most effective in establishing a good plant stand.

At the nursery stage, when seedlings are grown in seedbeds, several soilborne pathogens may affect seed germination if nonsterilized soil is used. *Rhizoctonia solani*, a fungus that causes damping-off in potatoes and other crops such as beans, cotton, tomato, cabbage and eggplant, is one of the most serious pathogens that damages seedlings. It attacks the growing, tender seedlings whose tissue is composed mostly of cells that have not yet developed thick secondary walls. Under low soil temperatures and high moisture levels, the disease develops rapidly in the roots and hypocotyl, killing seedlings shortly before or after emergence.

Approximately 75 Third World researchers, extensionists, and educators have received training from CIP in production of potatoes from TPS since 1982. There are now 21 national experimental stations worldwide—17 from developing countries—conducting research on TPS. In addition, CIP is collaborating in 12 research projects, which are part of graduate study programs, that are underway in Colombia, India, Peru, and Nepal.

The current interest in TPS and the recognition that farmers in most countries lack the resources to sterilize soil for seedbed preparation—they must rely on fungicides for eliminating soilborne diseases such as *R. solani*—formed the basis for CIP's preliminary trials on 14 commercial fungicides. The trials were conducted at the Institute of Plant Protection (IPO) at Wageningen in the Netherlands, from July to December 1982, and at CIP headquarters in Lima, Peru, from February to September 1983.

General Methodology

A study was done on the effect that different fungicides had on controlling *Rhizoctonia* damping-off in TPS seedlings in the seedbeds and after transplanting. The presence of *R. solani* in the soil was established by obtaining a uniform soil infestation for all experiments. The procedure used was to inoculate sterilized wheat kernels with a fresh isolate of *R. solani*. These were allowed to incubate for 15 to 20 days at room temperature. After incubation, 7 g of infected wheat was mixed with each kilogram of soil. This mixture of soil and wheat was then allowed to stabilize for four days before TPS were sown or before seedlings were transplanted. A non-inoculated sterilized soil was used as a control to calculate the percent TPS germination; this figure was then considered as 100% survival for all calculations.

Fourteen fungicides were tested at various dose levels in many different trials. The trials were necessary because most of the fungicides used in this study have been commercially recommended to control *R. solani* in crops other than the potato. Although fungicides are sometimes recommended for treating potato seed tubers, none have been used on seedlings coming from TPS. Because of this, and because the trials were conducted at two different locations using two different soil types, no statistical analysis was performed on the results. The principal intent was to gain insight on the effect the fungicides would have on controlling *R. solani* in TPS seedlings and to make this information available to potential users as quickly as possible.

TPS from the cultivar Desirée was used for all trials conducted in Wageningen, and TPS from CIP clone DTO-33 was used for the trials in Lima. The temperature under which experiments were carried out at both locations fluctuated between 22°-28°C.

Control in seedbeds. When fungicides are applied to the soil, the dose, and time and method of application are essential to obtain good control of any soilborne disease. It is essential that fungicides be distributed uniformly throughout the soil. In this study, the procedure for all seedbed experiments was to mix fungicides with the water of the first irrigation and apply immediately after sowing TPS.

TPS were sown in plastic trays (flats) containing inoculated and non-inoculated

[1] Results presented in this article do not imply an endorsement by the International Potato Center of the fungicides tested. Verification of results under specific local conditions and in conformity with local food and drug laws is recommended.

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Linda W. Peterson, Editor

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Table 1. Fungicides used for control of *Rhizoctonia* damping-off in true potato seed (TPS) seedbeds under screenhouse conditions (22°-28°C).

Fungicide	Dose/m² (commercial product)	% seedling survival
Campogran (furmecyclos 40% WP)	5.5 g	97.0
Iprodione 1861 (iprodione 25% EL)	8.5 ml	96.0
Monceren (pencycuron 25% WP)	8.0 g	95.0
Solacol (validamycin 3% L)	350.0 ml[a]	90.0
Benlate (benomyl 50% WP)	8.4 g	88.8
Rizolex (tolclofos methyl 50% WP)	7.5 g	87.0
Vitavax (carboxamide 40% WP)	1.4 g	85.0
Ronilan (vinchlozoline 50% WP)	5.5 g	70.5
Brassicol (PCNB 75% WP)	5.0 g	68.8
Tecto (thiabendazole 45% EL)	7.0 ml	43.0
Control (sterilized soil + *R. solani*)	–	13.6

[a]Standard 3% solution diluted 1:20.

soils. One hundred TPS were sown in each tray with three trays used for each fungicide treatment. Immediately after TPS were sown, trays were irrigated with the fungicide and water solution. The percent TPS germination was taken every five days following emergence for up to 30 days.

Those fungicides that gave the best control of *Rhizoctonia* damping-off are listed in Table 1. From this group, Brassicol, Vitavax, and Tecto retarded germination and seedling development by five to seven days, but still achieved an acceptable level of disease control as compared to the TPS sown in inoculated soils without fungicide treatment. On the other hand, the seedlings grown from soil treated with Rizolex, Iprodione 1861, Campogran, and Monceren were more vigorous than those treated with other fungicides.

Control in transplants. Control of *Rhizoctonia* damping-off in transplants was based on experiments carried out in pots under screenhouse conditions. TPS were first sown in plastic trays containing sterilized soil. When seedlings were 35 days old, they were transplanted to pots (2 seedlings/pot) containing the inoculated soil, which was treated with each of the different fungicides. Fungicides were hand-mixed with the infested soil the same day as transplanting. The data on the number of surviving seedlings were collected every five days after transplanting for up to 20 days. At the end of each experiment, seedlings were cut at the soil level and their fresh weight recorded. Each treatment included 40 seedlings, and each experiment was repeated a minimum of three times.

The fungicides giving the best control of *Rhizoctonia* damping-off in transplants are presented in Table 2. From this group, Rizolex gave 100% disease control and the highest seedling fresh weight. Under the experimental conditions used, Tecto, and Solacol were the least effective in controlling damping-off and also yielded seedlings with the lowest fresh weight. The recorded fresh weight of all seedlings

Table 2. Fungicides used for control of *Rhizoctonia* damping-off in transplants coming from TPS under screenhouse conditions (22°-28°C).

Fungicide	Dose per kg/soil (commercial product)	% seedling survival	Avg. seedling weight (g)
Rizolex	1.5 g	100	5.01
Sterilized soil	–	100	3.22
Iprodione 1861	2.7 ml	100	2.54
Campogran	1.5 g	100	2.45
Demosan	1.5 g	100	2.20
Vitavax	0.25 g	100	2.15
Brassicol	1.5 g	100	1.49
Monceren	1.5 g	95	2.86
Benlate	2.0 g	90	1.98
Solacol	35.0 ml[a]	70	0.74
Tecto	2.0 ml	65	0.73
Control (sterilized soil + *R. solani*)	–	15	0.58

[a]Standard 3% solution diluted 1:20.

was in agreement with general visual observations on plant vigor. Seedlings grown in soil treated with Rizolex (Fig. 1), Iprodione 1861, Campogran, Demosan, and Monceren were visually larger and more vigorous than those grown on soil treated with the other fungicides. An additional observation was that Tecto, Vitavax, and Brassicol were extremely phytotoxic when applied at a dose level slightly higher than those used in Table 2.

Conclusions

Results have shown that by using different fungicides, an effective control of *Rhizoctonia* damping-off can be obtained in the seedbed and in the soil after transplanting seedlings grown from TPS. This wide variety of fungicides provides an opportunity for scientists and farmers around the world to choose a product that is locally available and thus less expensive. Researchers and breeders working with valuable TPS progenies could also benefit from these fungicides when *Rhizoctonia* damping-off is killing their seedlings.

To control damping-off in the seedbed, the mixing of fungicides with the irrigation water proved to be a cost- and labor-efficient method of application that also assured uniform distribution in the seedbed soil.

Although transplanting experiments were done in pots, the results obtained from the experiments gave a good indication of what to expect when transplanting is done in the field. This particular phase of research, which needs more work, is now in progress in field trials at CIP headquarters.

Precautions must be taken when using fungicides such as Tecto, Vitavax, and Brassicol because, as mentioned earlier in the paper, they were phytotoxic when used in doses above those shown in Tables 1 and 2.

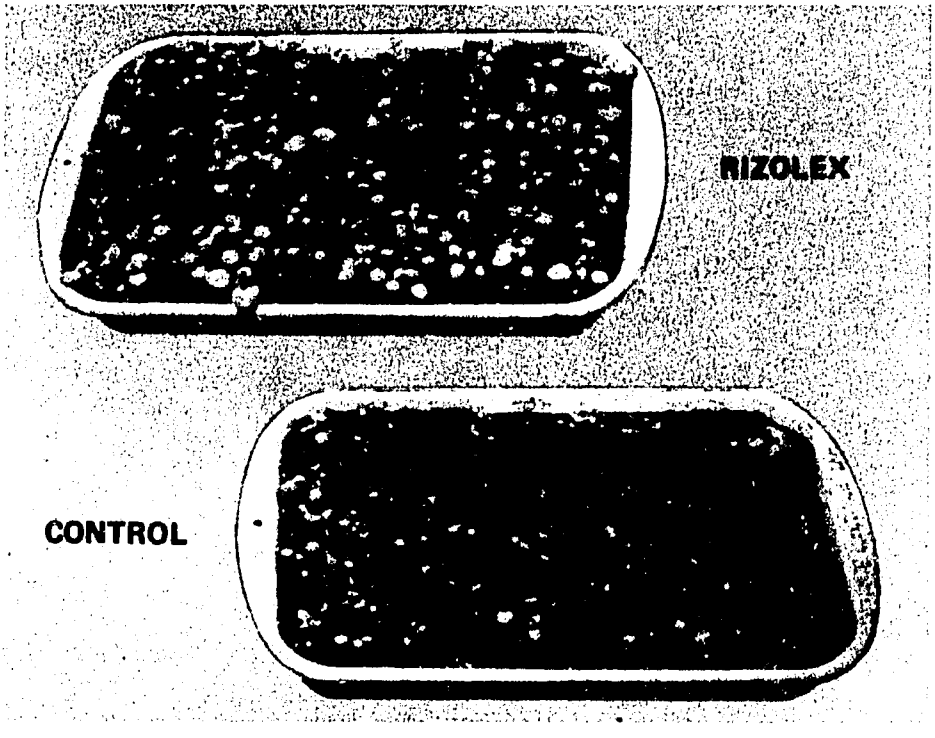

Fig. 1. Control of *Rhizoctonia* damping-off in seedbeds of true potato seed. *Top*: seedling stand in inoculated soil treated with the fungicide Rizolex. *Bottom*: seedling stand in inoculated, untreated soil.

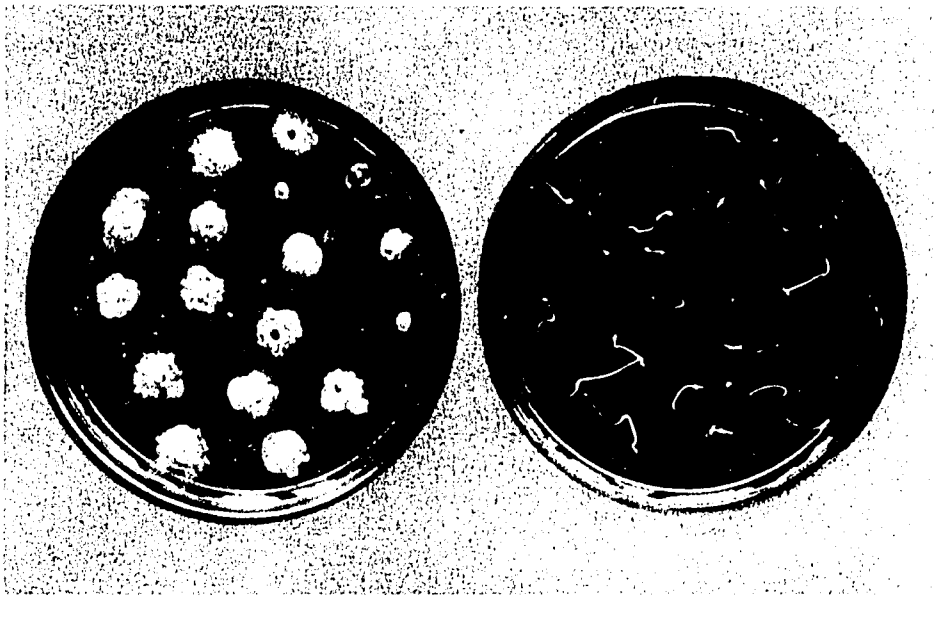

Fig. 2. *Left*: contaminated true potato seed (TPS). *Right*: germination of TPS after treatment with 0.5% sodium hypochlorite solution for ten minutes.

Related Note

Disinfection of TPS

Even when damping-off is controlled by fungicides or soil sterilization, the quality of the TPS must still be considered as an important factor when establishing a seedbed. Normally, TPS inside the berry are free of pathogens that can cause losses in seedling stand; however, during the process of berry ripening or extraction and processing, TPS may become highly contaminated with bacterial or fungal saprophytes and pathogens. Observations on germination of different TPS sets during the past year at CIP have shown that many TPS did not germinate because of high bacterial contamination on the surface of the seed.

Different treatments using chemicals, antibiotics, and fungicides were tested to disinfect TPS and to assure at the same time that germination was not affected. Of all the treatments tested, a ten-minute dipping in a 0.5% sodium hypochlorite solution gave the most effective control of all TPS surface contaminants (Fig. 2). This treatment is now being used on all true potato seed produced at the International Potato Center. This seed is being distributed to the regions for further experiments with national programs.

CALENDAR OF EVENTS

January 23 - February 17
Third International Course on Potato Production with Emphasis on Seed Production
Peru (Headquarters)

January 30 - February 3
Workshop on Nematology
Panama

February 16 - 23
Workshop on Tissue Culture and Rapid Multiplication Techniques
Vietnam (Region VII)

March (3 days)
In-Country Production Course
Rwanda (Region III)

March (2 weeks)
Seed Production Course
Bangladesh (Region VI)

March 26 - April 6
In-Country Production Course
Senegal (Region V)

April 2 - 7
In-Country Production Course
Burma (Region VII)

April 9 - 27
International Course on Potato Tuber Moth, Peru (Headquarters)

May 7 - 20
Germplasm Management Course
Tunisia (Region V)

May 21 - 24
In-Country Seed Production Course
Burundi (Region III)

May 25 - 26
Workshop on Bacterial Wilt
Burundi (Region III)

June 4 - 15
Germplasm Management Course
Kenya (Region III)

June 18 - 23
Storage Course
Kenya (Region III)

June 25 - 29
Storage Course
Thailand (Region VII)

Training Activities

Course Highlights

The National Agrarian University at La Molina, Lima, is organizing and conducting the *Third International Potato Production Course with Emphasis on Seed Production*, funded by the United Nations Development Program (UNDP). The course will again be under the direction of Dr. Ulises Moreno with the assistance of Mr. Carlos Alvarez as coordinator. Eight of the 16 participating scientists will be from other countries in Central and South America.

The one-week *Workshop on Nematology* will be held in Panama, which is a member country of the regional network PRECODEPA. This is a follow-up meeting of scientists from Central and South America who attended the nematology course at CIP headquarters in September 1982. The workshop will focus on research progress made during the past 18 months and will assess the impact of training received.

The *Workshop on Tissue Culture and Rapid Multiplication Techniques* is scheduled for the second half of February in Vietnam. The participants will come from different countries in Asia to observe the in-vitro multiplication method used by Vietnamese farmers. Through this method the farmers can rapidly multiply and produce sufficient quantities of disease-free planting materials for their own use and to sell to neighboring farmers. If this system is adopted by farmers in other Southeast Asian countries, it could assist in the rapid production of large quantities of high-quality rooted cuttings and tubers.

Training Courses Held

CIP Headquarters—The *International Course on Potato Production from True Seed*, funded by the German Foundation for International Development (DSE), was held in Lima from October 5 to 28. Part of the agenda included a six-day visit to CIP's research stations at Huancayo (highlands) and San Ramon (low-altitude tropical zone) where there are ongoing TPS research projects. Mr. Rainer Willingshofer, First Secretary for Technical Cooperation and Finance in the Embassy of the Federal Republic of Germany in

Peru, attended the opening session and addressed the meeting on the role of the DSE in technical cooperation in developing countries. Eight scientists from Chile, Cuba, Mexico, Kenya, Sri Lanka, Philippines, South Korea, and Thailand attended the course, which emphasized laboratory, nursery, and practical field work. The course also included a case study devised to develop the scientists' ability to solve problems using certain agroecological and socioeconomic data. The scientists also prepared research and training work plans for use in their own countries.

Region I—There were 14 participants from 10 Latin American countries in the DSE-sponsored course on *Pathological Problems in Seed Production*, held at the Instituto Colombiano Agropecuario (ICA), Bogota, and at the La Selva experimental station, Medellin, Colombia, from October 31 to November 12. The countries represented were Argentina, Bolivia, Colombia, Costa Rica, Chile, Ecuador, Mexico, Peru, Dominican Republic, and Venezuela. The course covered a wide range of subjects including symptomatology, detection methods, prevention, and control of diseases caused by viruses, fungi, bacteria, and mycoplasma, as well as damage caused by nematodes and insects.

Region II – The *Potato Production Course*, funded by DSE, was held in Brazil from October 24 to November 12 in collaboration with the Centro Nacional de Pesquisa de Hortaliças (CNPH) of Brazil's Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA). There were 14 participants from Brazil and 2 each from Argentina and Uruguay attending the course, which was taught in Portuguese and Spanish. CIP's new production manual, which integrates production technologies with socioeconomic analyses, was used for the first time in this course. The participants learned about the social and technical aspects of farm-level problems by visiting farms and interviewing farmers. The visits were followed by lectures, and field and laboratory work that would enable them to develop practical solutions to these problems. The course began in Brasilia with lectures on production technology and then moved to the potato-growing districts of Maria da Fe and Canoinhas for field work and on-farm studies. Instruction was done by Brazilian and Peruvian scientists.

The Instituto de Investigaciones Agropecuarias (INIA) of Chile organized an *International Course on Production and Storage of Certified Seed* at its Remehue Experimental Station, Osorno, from November 28 to December 16. The UNDP-sponsored course was attended by 10 participants from Chile, 2 each from Argentina and Brazil, and one each from Costa Rica, Panama, Peru, and the Dominican Republic. The basic idea of the course was to teach the participants through the experience and knowledge gained from the certified seed program of Chile. All of the instructors were from the Chilean national potato program, except for one from the National Agrarian University in Lima.

Region III—The national potato program (PNAP) of Rwanda organized its last in-country *Production Course* of the year at Ruhengeri from October 17 to 21 in collaboration with CIP scientists working in Rwanda. The course, which concentrated mainly on seed production, was attended by 17 extension staff from rural development projects in different parts of Rwanda.

Rwandese farmers and their families participate in on-farm research with trainees attending in-country production courses.

Trainees in TPS technology select flowers for seed production and inspect the crop grown from true seed

Visiting Scientists

Danilo Ernesto Farfán and **Carlos Hernán Santos** from the Centro de Investigación y Promoción Agropecuaria (CIPA), Puno, Peru, and **Gregoria Meza** of the University of San Antonio Abad, Cuzco, Peru, spent two weeks at CIP headquarters studying general production methods with the Physiology Department staff. **José Elizondo** from Chihuahua spent one month in October learning the different types of rapid multiplication techniques that he will use in seed potato production in Mexico. FAO sponsored **Ernesto Vargas Manzanares**, who works in the Potato Seed Production Program of Honduras, for one month's training in seed production during November.

Three scientists worked for two weeks in the virology laboratory learning techniques for the serological determination of viruses: **Mateo Cadena** from the Mexican potato program at the National Institute of Agricultural Research, Toluca; **Mirtha Beresiarte** from Agronomía Balcarce S.R.L., Buenos Aires, Argentina; and **María Verónica Tapia** from the Chilean national potato program at the Remehue Experimental Station, Osorno.

Arnoldo A. García Soto from ICTA/INCAP, Guatemala, was trained for four weeks during October and November on simple processing methods. His training was sponsored by PRECODEPA, of which Guatemala is a member country. **Abdul Zafar Iqbal**, Chief Publications Officer, Bangladesh Agricultural Research Council, Dhaka, studied communications methods for two months at the University of Missouri before coming to CIP headquarters to receive one month of training in communications. **Jahangir Hossain**, also from Bangladesh, received training for two months on in vitro techniques for potato propagation and on serological methods for virus detection. This training supports the program development of the Potato Research Center, Bangladesh Agricultural Research Institute at Dhaka.

Two senior scientists from China arrived at CIP headquarters in mid-November to do six months of research with CIP scientists. **Mr. Song Eo-fu**, a potato breeder from Inner Mongolia, and **Madam Sun Hui-sheng**, Deputy Director, Vegetable Research Institute, Shantung, are working in the Physiology, and Breeding and Genetics Departments.

Advanced Degrees

Luis Valencia received his Ph.D. degree in November from the University of Queensland, Brisbane, Australia, for his thesis on "Interactions Between the Potato Moth (*Phthorimaea operculella* (Zeller)) and its Main Host the Potato (*Solanum tuberosum* L.) in Laboratory and Field." His supervisor was Dr. Gordon Hopper in the Department of Entomology. Dr. Valencia has rejoined the Entomology Department at CIP and will soon leave for Colombia to initiate a program for integrated pest management studies on the potato.

Gloria Junchaya de Abad received her M.S. degree from the National Agrarian University (UNA), Lima, for her thesis entitled "*Phytophthora infestans* in the Central Zone of Peru: Pathogenic Variability, Resistance of Varieties, and Host Range." Her supervisors were Dr. Jan Henfling and CIP associate scientist, Dr. Enrique Fernández-Northcote of UNA.

Editor's Note

Please send all queries relating to articles published in the *CIP Circular* to: Head, Department of Training & Communications, International Potato Center, P.O. Box 5969, Lima, Peru.

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