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CONTRATOS DE PRODUCCION AGROPECUARIA; MOTOR PARA EL DESARROLLO DE PROVEEDORES Y LA AGROINDUSTRIA

CONTRACTS IN AGRICULTURE; DRIVER FOR THE DEVELOPMENT OF SUPPLIERS AND AGRO-INDUSTRIES

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Palabras clave: agroindustria, agricultura por contrato, rentabilidad, beneficios.

En general la cadena productiva de alimentos en los países en vías de desarrollo, tienen una gran participación de intermediarios antes de llegar al consumidor final, complicando y encareciendo los productos sin que el productor ni el consumidor reciban los beneficios que deberían. Los productores una buena retribución por su esfuerzo y los riesgos durante la producción, y los clientes el beneficio de alimentos de óptima calidad, a un precio razonable.

La importación de materias primas baratas y fuera de estándares desde Asia, está amenazando la supervivencia de los agricultores locales, con beneficio temporal de algunas agroindustrias. Pero en el ambiente globalizado actual, también las agroindustrias están viendo reducidos sus márgenes de utilidad por la introducción de productos finales importados a sus mercados locales.

EL MERCADO DE LAS HORTALIZAS

Los productos en fresco tienen grandes fluctuaciones de precios al momento de la cosecha, los cuales generalmente son regulados por la oferta y la demanda que a su vez se derivan de factores climáticos, biológicos y de los mercados destino.

Cuando los precios en fresco resultan atractivos, los productores no entregan el total de su contrato a la agroindustria, desmotivándola a continuar en esquemas de contrato y viceversa, cuando los precios son bajos la agroindustria especula con los precios contratados desalentando a los proveedores.

Cuando hay desconfianza entre las partes; la industria co-invierte poco o nada en la producción y, los productores no se aplican en asegurar mejores resultados en sus cultivos.

LA AGRICULTURA POR CONTRATO

Es una modalidad de compra venta en la cadena productiva en la que una parte requiere un producto en cantidades y características específicas conocidas, lo encarga a personas o empresas que puedan producirlo.

Ejemplos típicos de contratos y donde se ha desarrollado la experiencia de FIRA en la agricultura mexicana son los suscritos por: Los ingenios y los productores cañeros, Las empresas cigarreras y los productores de tabaco, Los molinos de granos y proveedores agrícolas (cebada, trigo y maíz) y Procesadoras de Hortalizas con horticultores (brócoli, zanahoria, ajo, lechuga y fresa).

Los contratos

- Predefinen precio de compra/venta
- Especifican volúmenes y calidad
- Política de pagos por pureza y madurez



- Programa técnico de actividades
- Asistencia técnica gratuita
- Aprovisionamiento de insumos específicos

Bases que dan solidez a la integración.-

- Colocación de acciones (valores bursátiles) cruzadas entre empresas de productores y la agroindustria.
- Los productores organizados ofrecen responsabilidad solidaria para el cumplimiento.
- La agroindustria, compradora final, funciona como parafinanciera.
- La agroindustria como apoyo corporativo para trámite de financiamientos, asistencia técnica, aporte de insumos, supervisa las siembras y cosechas y es proveedora de fletes.

Requerimientos mínimos:

“Ambos socios deben ser los mejores en la red alimentaria cercana”

Satisfacción básica de ambas partes que les permita una actividad rentable

Requerimientos mínimos para la industria:

- 1.- Precio base competitivo que asegure su rentabilidad internacional
- 2.- Calidad, volumen y oportunidad en las entregas del producto
- 3.- Productos obtenidos con BPA
- 4.- Productos diferenciados con Valor Agregado

Requerimientos mínimos para los productores:

- 1.- Precio base competitivo que asegure su rentabilidad
- 2.- Apoyos de la empresa en el financiamiento directo e indirecto.
- 3.- Apoyos de la empresa en programas de siembra y asistencia técnica.

“Socios que Agregan Valor en la Relación de Compra/Venta

PRECIO BAJO NO DEBE SER LA DIFERENCIACION

CONCLUSIONES

Los contratos equitativos generan beneficios mutuos en una relación sustentable como son:

- Bases sólidas para hacer inversiones y mejoras continuas en sus respectivos procesos hacia la competitividad
- Generan confianza en las instituciones para recibir financiamientos
- Reducción de sus costos operativos por compras y operaciones a escala
- Apropiación de tecnologías que consolidan su integración; la industria hacia la diversificación de derivados y mercados que le permitan demandar mas materia prima, y los productores hacia los rendimientos óptimos y con calidad.

Key words: agro-industry, contract farming, profitability, benefits.

SUMMARY

In the developing countries the goods in the food chain generally have a significant participation of intermediaries before they reach to final consumers complicating and raising the price of products without give any benefit that grower or the consumer would receive. The producers must receive a good retribution for their risks and effort during the farming process and the customers the benefits of best quality foods at a reasonable price.

Imports of cheap raw materials from Asia which, much of the times, are out of standards are hitting to local farmers benefiting temporarily to some agro-industries. But, in a globalized market, also the agro-industries are resenting reduction in their profits due to importation of processed foods into local markets.



VEGETABLES MARKET

Fresh vegetables and fruits have a big price fluctuations at the harvest moment which generally are regulated by offer/demand which in turn is derived from climate, biologic and final market factors. It occurs that when the prices of fresh products are attractive, growers do not deliver the total contracted with agro-industry discouraging it to continue in the contract scheme and vice verse, with low prices, the agro-industry speculate the contracted prices discouraging to suppliers.

It is symptomatic, under distrust environment between participants of a contract, the industry co-invest little if any economic resources with farmers and, the farmers put low attention to guarantee the best yields.

CONTRACT-FARMING

It is a modality of buying/selling in the productive chain in which a party requires a product, in a volume and with specific characteristics, entrust the task to an enterprise or person that is able to produce it.

Examples of typical contracts by which we, in FIRA, have developed experiences in Mexican agriculture are those subscribed by; sugarcane mills and cane growers, cigarettes processors and tobacco producers, grain mills and grain growers (say barley, wheat and corn), processors and freezers of vegetables and horticulturalist (chili, broccoli, cauliflower, carrots, lettuce, clover and strawberry).

The Contracts:

- Prefix the price of buying and selling
- Specify volume and quality of products
- Define criteria for payments considering purity and maturity
- Include Technical program for production
- Consider Technical Assistance for farmers
- Sometimes include supply of specific agricultural inputs

Basis that give strength to an association in a contract.-

- Crossing shares between agro-industry and growers' organizations
- Growers' Organization offer joint liability to the compliment of compromises
- When agro-industry partially lends the production costs
- When agro-industry offers corporative support for farmers to get: loans, technical assistance, discounts in buying inputs, supervise crops and harvest and other logistic services.

Minimum requirements to success

"Both partners must be the best in the food chain"

Basic satisfaction to both parties that permit them profits from the association

Minimum requirements for agro-industry:

- 1.- A competitive base price that secure its profitability in an international level
- 2.- Secured Quality, volume and opportunity in the produce received
- 3.- Produce obtained with Good Agriculture Practices
- 4.- Value added produce; cleansed, washed, sorted

Minimum requirements for farmers:

- 1.- A competitive base price that secure them profitability
- 2.- To receive support from the agro-industry to get direct or indirect loans for farming



3.- To receive support from agro-industry to establish and follow a crops program and technical assistance. Summarizing; "be partners that add value trough their association"

PRICES SHOULD NOT BE THE ONLY DIFERENCE, BUT INTEGRAL AND SUSTAINABLE BENEFITS

CONCLUSIONS

Fair Contracts generate mutual benefits in a sustainable relationship, such as:

- Solid basis that give confidence to the participants so, they can program medium and large term investments in order to improve their respective processes toward competitiveness.
- By reducing the market insecurity, this contract-association generates institutional confidence for get loans and other services.
- Reduced operative costs by buy wholesale.
- Development and appropriation of technologies that consolidate their integration; the agro-industry diversifying products and byproducts and markets so, demanding more raw materials to process and, the growers toward optimal yields with the best quality.



PHYTOPHTHORA BLIGHT (*Phytophthora capsici*) OF PEPPER IN ILLINOIS: OCCURRENCE AND MANAGEMENT

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ABSTRACT

Phytophthora blight, caused by *Phytophthora capsici*, is a serious threat to production of pepper in Illinois. To develop effective strategies for managing Phytophthora blight on peppers, an intensive research was conducted to investigate characteristics of *P. capsici* isolates, host range of the pathogen, resistance of pepper cultivars to *P. capsici*, chemical control of the disease, and survival of the pathogen in soil.

INTRODUCTION

Phytophthora blight of pepper, caused by the Oomycete *Phytophthora capsici* Leonian, is one of the most serious threats to production of pepper, cucurbits, and eggplant in Illinois and worldwide. Recently, the incidence of Phytophthora blight of pepper and cucurbits has dramatically increased in Illinois, causing yield losses of up to 100%. *Phytophthora capsici* infects more than 50 plant species in more than 15 families. Among the affected plants, peppers and cucurbits are the most susceptible hosts.

Phytophthora capsici survives as oospores in soil and as mycelium in plant residue. The pathogen can strike host plants at any stage of growth. It infects root, crown, stem, leaf, and fruit. Infection with *P. capsici* is favored by wet and warm (20-30°C) soil conditions. Once pepper plants are transplanted into a field, and the environmental conditions are favorable, oospores germinate and produce sporangia and zoospores (asexual spores). Zoospores, released in water, initiate primary infection. Following infection, a girdling lesion is formed at the base of the plant near the soil line. Sporangia are produced on the lesion surface and spread by splashing rain. Upon landing on a pepper plant, sporangia release zoospores, which initiate secondary infection. Production and spread of sporangia are repeated throughout the season. Plants eventually die and oospores formed within the lesions are released into the soil as the plant



decomposes. Oospores can survive in soil for several years. This research was conducted to develop effective strategies for managing *Phytophthora* blight of pepper and other vegetable crops.

MATERIALS AND METHODS

Isolate characteristics

Pathogen isolation. More than 100 isolates of *P. capsici*, collected from infected pepper and cucurbit plants during 2000-2004, were used in this study. *Phytophthora capsici* was isolated from infected plant tissues dipped in 70% ethanol for 3 min, rinsed in sterilized-distilled water (SDW), and plated on PARPH (Corn meal agar, 17 g; pimaricin 10 mg; ampicillin, 250 mg; rifampicin, 10 mg; PCNB, 100 mg; hymexazol, 50 mg; and distilled water, 1000 ml), a selective culture medium for *P. capsici*. Cultures were maintained on lima bean agar (LBA; Difco Lab., Detroit, MI; 23 g/L) slants at room temperature. The isolates were identified as *P. capsici* based on colony morphology and sporangial characteristics.

Colony characteristics. Fifty-seven single-zoospore isolates of *P. capsici* were used to determine colony characteristics. Plugs (7-mm-diameter) of mycelium in agar, from the edge of 4-day-old culture of *P. capsici*, were placed onto the center of Petri plates containing Difco potato dextrose agar (PDA), and the plates were incubated in darkness at 24°C. After 5 days, the plates were examined for colony texture and appearance. For temperature/growth responses, a mycelial disk (7-mm-diameter) was placed in the center of each LBA plate. Inoculated plates were incubated at temperatures of 10, 15, 20, 24, 30, 32, 35, 36, 37, and 38°C in a completely randomized design. Each isolate had three replicates. Colony diameter was measured after 3, 5, and 7 days of incubation and data were converted to radial growth in millimeters per day.

Mating type. All 57 isolates, used to study colony characteristics, were tested to determine their mating types by pairing with known A1 (ATCC-15427) or A2 (ATCC-15399) tester isolates of *P. capsici* that were obtained from the American Type Culture Collection (ATCC). Plugs of mycelium in agar (7-mm-diameter) from advancing margins of 4-day-old cultures were placed 2 cm apart on clarified V8-juice agar and incubated at 24°C in darkness for 3 weeks. The absence of oospores at the interface between colonies indicated the same mating type, whereas the presence of oospores indicated opposite mating type. The solo culture of each isolate was examined for oospore formation as a control. The positive control was a cross between two tester isolates of opposite mating types. For each isolate, 25 oospores were measured.

RAPD analysis. Twenty-four isolates of *P. capsici* were assessed for genetic differences by RAPD analysis. A total of 25 decanucleotide primers (Operon Tech., Alameda, CA) were screened using DNA extracted from 4 test isolates of *P. capsici* that represented different levels of pathogenicity. Seven of the primers (OPA-03, OPA-04, OPA-10, OPA-11, OPB-13, OPC-09, and OPD-04) were selected for this study based on the number of clear, reproducible bands amplified from the test isolates and the production of polymorphic bands that distinguished the test isolates. DNA amplification was performed in a thermal cycler (PTC-200, MJ Research Inc., Waltham, MA) with one cycle at 94°C for 5 min, 36°C for 2 min, and 70°C for 2 min, followed by 44 cycles at 94°C for 1 min, 36°C for 1 min, and 70°C for 2 min, and a final cycle at 70°C for 10 min. Each RAPD reaction was done in a total volume of 25 µl, containing 30 ng of genomic DNA, 1X PCR buffer, 120 µM of each dNTP, 0.4 µM of primer, and 2.5 units of Taq polymerase (KlenTaq, Ab Peptides Inc., St. Louis, MO). Amplified products were separated by electrophoresis in 2% agarose gels (Low EEO, Fisher Scientific, Fair Lawn, NJ) at a constant 70V in 1X TAE buffer for 4 h at room temperature. Fragments were visualized under UV light after staining with ethidium bromide and photographed.

Host range. Forty-five species of plants, including 36 species of crops grown in rotation sequences with peppers and cucurbits and nine species of weeds that commonly grow in pepper and cucurbit fields in Illinois, were screened for their susceptibility to *P. capsici*. Seeds of the plants were sown in 10-cm-



diameter plastic pots containing steamed soil mix (soil:sand:vermiculite; 1:1:1) and were grown in a greenhouse bench at 18-26°C. Four-wk-old seedlings were inoculated by adding the suspension of zoospores over the soil surface around the plant in each pot (5 ml/seedling/pot). Control seedling received 5 ml of SDW. The seedlings were placed on the greenhouse bench and watered twice daily. The experiment was performed using a randomized complete block design with four replications each with 10 plants. Beginning the second day after inoculation, seedlings were evaluated for development of lesions on stems, defoliation and damping-off symptoms, every day for three weeks.

Resistant cultivars. To identify resistant pepper cultivars to *P. capsici*, 68 cultivars/lines of bell pepper were tested. Seedlings were grown in 10-cm diameter pots containing a soil mix (soil:peat:perlite) in a greenhouse at 18-26°C. Eight-week-old seedlings were inoculated with *P. capsici* by adding 2 ml of zoospore suspension in sterile-distilled water (10^5 spores/ml) at the base of each seedling. Control seedlings were treated with only sterile-distilled water. Sixteen plants were included in each treatment. Beginning the 4th day after inoculation, seedlings were evaluated for development of Phytophthora lesions on the stems, defoliation, wilting, and death of the seedlings. The evaluation of disease development on the seedlings was continued until 24 days after inoculation, when no more new infection was observed.

Ten cultivars/lines, which showed resistant to *P. capsici* in the greenhouse trial, were tested in the field trials. California Wonder and Maxi Bell, susceptible bell pepper cultivars to *P. capsici*, were included in the field trial as control checks. The seedlings were grown in the greenhouse and eight-week-old seedlings were transplanted in a commercial field. The field was naturally infested with *P. capsici*. The experiment was performed in a completely randomized block design with four replications, each with 10 plants. The seedlings in each plot were planted in two staggered rows with plants spaced 30 cm apart within rows. The plots were spaced 96 cm apart. Disease incidence was determined as percent wilted and dead plants.

Red-light induced resistance. Seeds of bell pepper 'Hybrid SPP 6112' (Sakata Co., Morgan Hill, CA) were sown in 10-cm-diameter plastic pots containing steamed soil mix and were grown in a greenhouse under continuous red light irradiation (600-700 nm) from fluorescent tubes (FL20S-R-F, National Co., Japan). The fluorescent tubes provided red light with an intensity of $287 \mu\text{W}/\text{cm}^2$, which was a supplement to natural daylight. Control seedlings were kept under continuous white light (WL; FL20SS-D/18, Mitsubishi, Tokyo, Japan; 380-740 nm; $473 \mu\text{W}/\text{cm}^2$) or under natural daylight (NDL) in the same greenhouse. Three- or four-week-old seedlings were transferred from red light to NDL and were inoculated by adding the suspension of zoospores over the surface of the soil in each pot (5 ml/seedling/pot). Control seedlings, either grown in WL or NDL, were also inoculated using the same procedure. An additional set of control seedlings were inoculated with SDW only. Each pot contained one seedling and 14 pots were used for each treatment. Beginning the 4th day after inoculation, seedlings were evaluated for damping-off symptoms every day for 15 successive days. The seedlings were also evaluated on the 20th day after inoculation. Height, and fresh and dry weight of seedlings were also measured. Dry weight was determined after drying the seedlings at 70°C for 24 hrs.

Chemical control. Field trials were conducted in a *P. capsici*-infested commercial field to evaluate the effectiveness of selected fungicides for control of Phytophthora blight of bell pepper. Seedlings of bell pepper cultivar California Wonder were grown in a greenhouse. Eight-week-old seedlings were transplanted into raised beds with drip irrigation and black plastic mulch. The experiment was performed in a randomized complete block design with four replications. Each plot consisted of 10 seedlings spaced 30 cm within rows. Plots were spread 90 cm apart. Cyazofamid (Ranman 400SC) alone or tank mixed with dimethomorph (Acrobat 50WP), famoxadone + cymoxanil (Tanos 50WG), or metalaxyl (Ridomil Gold Copper 65WP) were spray-applied onto plants beginning one week after transplanting and continued (at 7-day intervals) for 6 weeks. Fungicides were applied with a backpack sprayer, using 470 L of water per hectare. Disease incidence was determined as percent wilted or dead plants on weekly intervals for 9 weeks, beginning one week after transplanting.



Enumeration of oospores in soil. A sucrose-centrifugation method was developed to extract oospores of *P. capsici* from soil. Oospores of *P. capsici* were produced *in vitro* by pairing opposite mating types in V8-CaCO₃ medium for 8 weeks. Five soil types were artificially infested with levels of 10², 10³, 10⁴, and 10⁵ oospores per 10 g of soil. Each 10 g of infested soil was suspended in 400 ml of water with two drops of Tween-20 and shaken vigorously for 10 min. The suspension was passed through 108, 68, and 38 µm sieves and the filtrate was collected. The debris on the sieves were washed using a sprinkler with gentle stream of water and the filtrate was collected. The collected filtrate (ca 2 L) was then passed through a 20-µm-mesh filter. The materials caught on the mesh were washed into two 50-ml centrifuge tubes and spun for 4 min (900 x g). The pellet was suspended in 30 ml of 1.6 M sucrose solution and centrifuged for 45 s (190 x g). The supernatant was passed through a 20-µm-mesh filter. This step was repeated five times. The materials caught on the mesh were collected and the number of oospores was determined using a counting chamber. The relationship between number of oospores recovered from soil and number of oospores incorporated into the soil was determined.

RESULTS AND DISCUSSION

Isolate characteristics

Colony characteristics. Isolates of *P. capsici* tested had four different growth patterns: cottony, petaloid, rosaceous, and stellate, with the occurrence of 5, 28, 14, and 53%, respectively. Isolates from the same field had similar growth patterns. All of the isolates grew at temperatures of 10, 15, 20, 24, 30, 32, 35, and 36°C, with the exception of four isolates, having cottony growth pattern, which did not grow at 36°C. Only 11 isolates grew at 38°C. Optimum temperature for growth among the isolates varied from 24 to 32°C.

Mating type. All 57 isolates of *P. capsici* tested were heterothallic. Thirty-one isolates were A1 mating type and 26 isolates were A2 mating type. Of seven fields from which more than one isolates were obtained, only A1, only A2, and both A1 and A2 mating types were found in 3, 2, and 2 fields, respectively. All of the oospores examined had amphigynous antheridia. The mean diameter of the oospores ranged from 22.1 to 38.4 µm. The mean oospore diameter in A1 mating type isolates (33.92 mm) was significantly ($P = 0.05$) greater than A2 mating type (25.55 mm).

RAPD analysis. Seven primers used in the RAPD analysis generated simple banding patterns that revealed DNA polymorphism among the isolates. A total of 65 polymorphic bands were scored in repeated amplifications from the 24 isolates of *P. capsici*. None of the primers distinguished all the isolates as different genotypes. Cluster analysis separated the isolates into six RAPD groups. RAPD groups corresponded to pathogenicity traits, not to location of origin. The genetic distance values ranged from 0.03 to 0.45.

Host range. Plants of 22 crop species (beet, cantaloupe, carrot, cucumber, eggplant, gourd, green bean, honeydew melon, lima bean, muskmelon, onion, pepper, spinach, radish, snow pea, squash, Swiss chard, tobacco, tomato, turnip, watermelon, zucchini) and two weed species (velvetleaf and nightshade) exhibited damping-off symptoms. All plants from Cucurbitaceae and Solanaceae, and most of the plants from Chenopodiaceae, families became infected and developed symptoms. Cucurbits and pepper were the most susceptible to *P. capsici*. No obvious changes in symptoms development was observed after 12 days post inoculation. *Phytophthora capsici* was reisolated from all of the symptomatic plants on PARP culture medium. Using the PCR method, *P. capsici* was detected in all symptomatic plants with exception of beet, snow pea, and Swiss chard. We were unable to detect *P. capsici* in these species by the PCR method for reasons unknown. None of the control plants developed disease symptoms and attempts to isolate *P. capsici* from their tissues were unsuccessful.

Plants of 14 crop species (Basil, broccoli, cabbage, cauliflower, celery, chive, corn, dill, kale, kohlrabi, mustard, parsley, soybean, and wheat) and seven weed species (cocklebur, crab grass, lamb's-quarters, pigweed, puncture vine, sandbur, and water hemp) did not develop any symptoms. Attempts to re-isolate



P. capsici from asymptomatic plant tissues of inoculated plants, or detect the pathogen by the PCR method, did not provide any indication of presence of *P. capsici* in these plants. Determining host range of *P. capsici* would help to establish effective cropping rotation sequences for managing Phytophthora blight of peppers.

Resistant cultivars. Brown lesions were observed on the crown and at the base of stems of inoculated seedlings 5 days after inoculation. Seven days after inoculation, most of the susceptible plants developed symptoms. Shedding leaves, wilting, and death of the seedlings followed by development of lesions on the crown and lower section of the stems. Twenty-four days after inoculation, almost all of the infected plants were dead. Four cultivars, Aristotle, Emerald Isle, Paladin, and Reinger, and six lines, Abbot-1, Abbot-2, Abbot-13, BHN-1P, BHN-2P, and Syngenta-7326 were resistant to *P. capsici*.

All four cultivars and six lines, resistant to *P. capsici* in the greenhouse trials, were also resistant to Phytophthora blight in the field. These cultivars and lines can be grown commercially, if the yield and quality are satisfactory. Paladin is now widely grown in Illinois.

In our greenhouse studies, we inoculated the seedlings by adding zoospore suspension onto the crown section of the seedlings. This procedure proved to be a reliable method for screening bell pepper cultivars and lines for resistance against *P. capsici* in the greenhouse.

Red-light induced resistance. Symptoms of Phytophthora infection began to appear in red-light treated pepper seedlings 12 days after zoospore inoculation and 36% of seedlings became infected and died. In contrast, symptoms on control seedlings (grown under WL or NDL) first appeared 5 days after inoculation and within 8 days of inoculation, 100% of the seedlings were infected, stem-girdled and died. In all of the red-light treatments, no more seedling damping-off occurred 15 days after inoculation of plants.

Chemical control. Phytophthora lesions were observed on crowns and at the base of stems of plants approximately 10 days after transplanting. Symptomatic plants gradually wilted and died. Twenty-four days after transplanting, the stand of asymptomatic plants in untreated control plots was significantly lower than those in fungicide treated plots. There was no significant difference in the stand of asymptomatic plants among the fungicide treated plots. Fifty-nine days after transplanting, the final stands of asymptomatic ranged from 70% in untreated control plots to 100% in the plots treated with Ranman plus Acrobat. The results showed that application of Ranman 400 SC alone or in combination with Acrobat 50 WP or Ridomil Gold Copper 65WP could protect bell pepper plants against *P. capsici* under moderate disease pressure.

Enumeration of oospores soil. The relationship between number of oospores recovered from soil and number of oospores incorporated into the soil was $Y = -1.311 + 1.472(X) - 0.0474 (X^2)$, with $R^2 = 95.6$, where $Y = \log_{10}$ of the number of oospores recovered from soil and $X = \log_{10}$ of number of oospores in soil. Percent of oospores germinated was less than 50. The method develop for determining inoculum density of *P. capsici* in soil would help to establish effective cropping rotation sequences for managing Phytophthora blight of peppers.

Disease management.

No single method is available to provide adequate control of Phytophthora blight. Various disease control practices can be integrated to manage Phytophthora blight, including: exclusion, cultural practices, and chemical control.

Exclusion. The most effective method of control for Phytophthora blight is to prevent *P. capsici* from moving into a non-infested field. *Phytophthora capsici* spreads by soil, water, and/or plant material. It is highly recommended to thoroughly clean all farm equipment that is used in an infested field before moving it to another field. Also, avoid using water sources (i.e. ponds or reservoirs) that receive run-off water from



an infested field. Water sources can be tested for the presence of the pathogen by baiting techniques.

Cultural practices. The following cultural practices can help to manage *Phytophthora* blight in commercial fields. Because *P. capsici* can survive in soil for several years, fields without a history of *Phytophthora* blight should be selected. Although no cropping rotation period has been established for effective management of *Phytophthora* blight of pepper, it is recommended to select only fields that have not had a history of cucurbits, eggplant, peppers, and/or tomatoes for at least 3 years. Fields should be selected that are well isolated from fields infested with *P. capsici*. High soil moisture favors the development of *Phytophthora* blight, thus well-drained fields should be selected and excessive irrigation should be avoided. Also avoid planting pepper in areas of the field that have poor drainage. Growing cover crops and/or mulching with plant materials including straw and rye vetch can also be used to manage the dispersal of the pathogen.

Chemical control. Fungicides may be used to reduce *Phytophthora* infection in pepper fields. Chemical control strategies should be integrated with cultural practices to manage *Phytophthora* blight. Chemical control measures commonly involve soil drenches early in the season, and foliar applications during the season. For the up-to-date recommendation on chemical use for control of *Phytophthora* blight of peppers, refer to the current edition of publication number C1373, "Midwest Vegetable Production Guide for Commercial Growers" (<http://www.entm.purdue.edu/entomology/ext/targets/ID/index.htm>). Two fungicides, dimethomorph (Acrobat 50 WP) and cyazofamid (Ranman 400SC), tank-mixed together, have been effective in reducing incidence of *Phytophthora* blight of bell pepper in Illinois. Also fungicide Tanos 50WG (famoxadone + cymoxanil), which is effective against *Phytophthora* blight of cucurbits, is being evaluated for its efficacy for control of *Phytophthora* blight of pepper and the results are promising.

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Figure 1. Blight of pepper, caused by *Phytophthora capsici*, in low area of the field.



Figure 2. Phytophthora blight in a bell pepper field, caused by *Phytophthora capsici*. Entire field is affected.



Figure 3. Root and crown rot of pepper, caused by *Phytophthora capsici*



Figure 4. Fruit infection of bell pepper, caused by *Phytophthora capsici*. (photo courtesy NCSU)

