Symposium 3 (S03): Potatoes–Healthy Food for Humanity: International Developments in Breeding, Production, Protection and Utilization

Monday · August 12

Location: Metro Toronto Convention Centre, Room 201CD

1100–1200
S03–O–1
TARGETED BREEDING FOR SUSTAINABLE PRODUCTION IN A GLOBAL POTATO IMPROVEMENT

Merideth Bonierbale*, J. Landeo, M. Ghislain

International Potato Centre, Apartado 1558, Lima 12, Peru

Developing countries incur inordinately high economic and environmental costs to combat world-important diseases of potato. CIP has consistently endeavored to develop and improve broadly based populations for tropical and subtropical highland and lowland agroecologies, with resistances to potato late blight and viruses as primary traits. Levels of quantitative resistance to late blight and PLRV, and frequencies of extreme resistance to PVY and PVX have been increased, and progress toward early bulking has been significant in breeding pools corresponding to our agroecological targets. Alliances and strategic testing procedures with national agricultural programs are increasingly important to orient the selection of varieties that meet staple and market needs and opportunities at the local level. Given the dynamic nature of late blight, the genetic advances accomplished to date, and the desire for new varieties with market traits, increased emphasis will be given to combining key resistances, evaluation for table and processing quality, and direct links with seed production systems in targeted countries to facilitate variety development. The application of classical and molecular genetic methods that link germplasm evaluation with crop improvement will be discussed.

1200–1220
S03–O–2
COMPARATIVE ANALYSIS OF NEW SOURCES OF LATE BLIGHT RESISTANCE USING PHENOTYPIC AND MOLECULAR GENETIC APPROACHES

Ednar Wulff*, Eliana Gonzales-Vigil, Jose Antonio Ortega, Susan Munive, Elisa Mihovilovich, Wilmer Perez, Merideth Bonierbale

International Potato Center, Apartado 1558, Lima 12, Peru

Late blight caused by *Phytophthora infestans* is one of the major constraints to the production of potato worldwide. As a key component of integrated disease management, durable genetic resistance would provide the most economical means to fight this disease, with a minimum of negative consequences to the environment. Varieties with qualitative (race specific) resistance based on major R-genes, and increasingly frequent applications of fungicides, have controlled late blight with moderate success until now. But these strategies are no longer effective due to recent migrations and new reproductive capacity of the pathogen, dynamic weather patterns, and other factors. In order to achieve broad spectrum and long lasting resistance to late blight, the International Potato Center (CIP) is seeking more durable resistance than that provided by R-genes. New resistance sources are available in wild Solanum germplasm, but both determining their durability in front of the variable pathogen and using them in breeding programs are complex. Fifty-one wild potato species were characterized for resistance to late blight in greenhouse and/or field experiments, and seven that showed quantitative resistance were further tested for the absence of R-genes in detached leaf assays using a complex and a simple isolate of the pathogen. Population samples of two promising species (*S. raphanipholium* and *S. megistracrolobum*) and a genetic mapping population derived from S. berthaultii have been characterized with defense gene markers and in QTL analysis, toward understanding the molecular genetic basis and environmental stability of quantitative resistance. Genes such as PAL, chalcone isomerase, cytochrome P-450, osmotin, etc. were found to be associated with quantitative resistance and/or quantitative trait loci (QTL). Comparative studies of new germplasm sources including molecular genetics will eventually assist in identifying complementary sources or components of resistance that can be combined in new varieties by marker-assisted selection and/or direct gene transfer.

1220–1240
S03–O–3
EVALUATION OF VARIETIES: GENOTYPES, ENVIRONMENTS AND GENOTYPE–ENVIRONMENT INTERACTIONS

George C.C. Tai*, T Richard Tarn

Potato Research Centre, Agriculture and Agri-Food Canada, P.O. Box 20280, Fredericton, New Brunswick, Canada, E3B 4Z7

One of the most popular models for variety performance evaluation is the Additive Main Effects and Multiplicative Interaction (AMMI) model. Let xi j be the observed data of a trait recorded for ith genotype tested in jth environment. xi j = (main effect of ith genotype)+(main effect of jth environment)+(sum of multiplicative terms consisting of genotypic and environment components) = u + (ui -u) + (u j -u) + gi ej. In many situations a series of physiological events, which lead to the final formation of a specific economic trait, can be scored during crop development. The relationship can be used to formulate a multiplicative model which assesses the relative importance of genotypes, environments and their interaction during the successive stages of growth on the performance of the economic trait. For example, the development of yield of potatoes follows the chronological sequence : X (number of stems) -> Y (number of tubers/stem) -> Z (weight/tuber). Yield (W) is the consequence of the sequence of development, i.e. W = XYZ. A multiplicative PATH model can be developed : xi j = (main effect of ith genotype) + (sum of multiplicative terms consisting of genotypic and environment components) = u + (ui -u) + g'i e'j .Data of marketable tuber yield and yield components were collected from a group of genotypes tested over a series of replicated trials conducted in New Brunswick in 1998 and 1999. Analyses were carried out based on the AMMI and PATH models. The estimates of main and multiplicative effects from both models are compared for the interpretation of differential responses of genotypes to the environments, and the interrelationship between the parameters in the two models are examined. Both models describe the differential responses of genotypes to the environmental effects on yield. The PATH model further reveals the patterns of plasticity of the genotype in responding to the environments during growth.

1340–1440
S03–P–4
CYTOGENETIC ANALYSIS OF SOMATIC HYBRIDS BETWEEN *SOLANUM BREVIDENS* AND *S. TUBEROSUM* ('SUPERIOR', 'DEJIMA' AND DIHAPLOID OF 'SUPERIOR') BY GISH

Yul-Kyun Ahn*[1], Bo-Sun Kim[2], Jae-Wook Bang[2], Hyo-Guen Park[3]

[1]Vegetable breeding division, National Horticulture Research Institute 540-41 Tapdong, Gwonseon-gu, Suwon 441-440, Republic of Korea; [2]Dept. of Biology, Chungnam National Univ., Daejeon, 305-764, Korea, Republic of Korea; [3]School of Plant Sciences, Seoul National Univ., Suwon 441-744, Korea

Cytogenetic analyses using Feulgen staining and GISH (gemonic in situ hybridization) were carried out in potato somatic hybrids between wild plant species *S. brevidens* and cultivars ('Superior', 'Dajima', Dihaploid of 'Superior'), the progenies from backcross between somatic hybrids and cultivars, and the progenies from BC2 between BC1 progenies and cultivars. Introduction of genes from wild species to somatic hybrids is also discussed. In conventional Feulgen staining, chromosome numbers in wild species (*S. brevidens*), cultivars of *S. tuberosum* ('Superior' and 'Dejima'), and dihaploid of 'Superior' line, were 2n=24, 48, 48, 24, respectively. Chromosomes of *S. brevidens* were maintained in somatic hybrids HBS5, HBHS6 and HBD24. While some chromosomes were missing in the progenies from BC1 and BC2. In GISH studies, it was confirmed that chromosomes of S. brevidens were maintained well in the somatic hybrids from wild species and cultivars. Chromosomal variations caused by crossing-over were also found in the plants from BC1 and BC2. GISH clearly identified all chromosomes of both parental genomes as well as recombinant chromosomes. The identification of the recombinant chromosomes provided evidence which chromosomes of the two species are homoeologous. Therefore, *S. brevidens* can be effectively transferred to the cultivated potato gene pool through backcrossing somatic hybrids with *S. tuberosum*.

1340–1440
S03–P–5
IDENTIFICATION OF A DIFFERENTIAL GENE EXPRESSION PATTERN RELATED TO RESISTANCE TO POTATO LATE BLIGHT

Patrice Audy*, Richard Tarn, Agnes Murphy

Potato Research Centre, Agriculture and Agri-Food Canada, 850 Lincoln Road,

P.O. Box 20280, Fredericton, New Brunswick, Canada, E3B 4Z7

Late blight pathogens, endemic and worldwide distributed, contribute significantly to reduce the yield and the quality of the potato crop yearly. Epidemiological studies have shown that polygenic (quantitative) resistance is more longstanding considering the genetic flexibility of the late blight isolates. Using primitive cultivated Andigena potatoes selected through many years of recurrent selection at the Potato Research Centre, subtractive libraries were prepared in which genes common to conditions of resistance (constitutive and induced) and susceptibility were mostly eliminated. The enriched gene fragments resulting from the subtractions were used to probe arrays constituted of a few thousands EST sequences from leaves of Andigena potatoes highly resistant to late blight. The blend of both technologies; the subtraction libraries with enriched genetic sequences and the microarray platform on Andigena ESTs, generated valuable information on genes associated with late blight resistance.

1340–1440

S03–P–6

POTATOES ON STAMPS. I. DOMESTICATION AND HISTORY

H. De Jong*, A. Murphy

Agriculture and Agri-Food Canada, Potato Research Centre, P.O. Box 20280, Fredericton, New Brunswick, Canada, E3B 4Z7

Postage stamps offer a unique window into the values of the societies from the countries and times where they have been issued. The potato (which is the world's fourth largest food crop) has been featured on the stamps of many countries. The crop was domesticated by the Indian civilizations on the altiplano of the Andes mountains in South America. It was subsequently introduced into Spain and then spread across Europe as well as along colonial trade routes around the rest of the world. These aspects and other events in its history are depicted on stamps.

1340–1440

S03–P–7

POTATOES ON STAMPS. II. CULTIVATION, UTILIZATION AND OBJECT OF ART

A. Murphy*, H. De Jong

Agriculture and Agri-Food Canada, Potato Research Centre, P.O. Box 20280, Fredericton, New Brunswick, Canada, E3B 4Z7

The potato is a very versatile crop of global importance. It is adapted to many different types of growing conditions and can be utilized in many different ways. Several countries have emphazied the importance of the potato in the rural economy and a healthy diet. In addition it has also attracted the attention of some of the world's greatest artists. These aspects are illustrated on stamps.

1340–1440

S03–P–8

CANDIDATE GENE ANALYSIS OF LOCI CONTROLLING NATURAL VARIATION FOR POTATO SKIN COLOR

Walter De Jong*, Nancy Eannetta, Darlene De Jong, Mary Bodis, Chun Suk Jung

Dept. of Plant Breeding, 309 Bradfield Hall, Cornell Univ., Ithaca, NY, USA, 14853

Three classical loci control most of the natural variation in potato tuber skin color. R is required for potato to produce red anthocyanin pigments while P is required to produce purple anthocyanins. I is required for the synthesis of anthocyanin pigments in tuber skin. van Eck et al. [Theor Appl Genet 1993 (86), 295-300; Heredity 1994 (73), 410-421] have previously localized R, P and I to chromosomes 2, 11 and 10, respectively. Many genes involved in anthocyanin biosynthesis have been cloned and characterized in Petunia. To determine if any known Petunia genes correspond to R, P or I we have now used an RFLP approach to genetically map homologs of Petunia genes in a tomato mapping population. The structural genes dihydroflavonol 4-reductase (DFR) and flavonoid 3', 5'-hydroxylase mapped to the same chromosomal regions as R and P, respectively, while a myb-like transcriptional regulator mapped to the same region as I. Sequencing portions of both alleles of DFR in a potato Rr heterozygote revealed a polymorphic BamHI restriction site. A simple PCR-based assay was developed to detect this polymorphism. In two diploid potato populations segregating for both R and I the BamHI-minus DFR allele was found to be present in all red-skinned clones and absent in many white-skinned progeny. More than 50 red-skinned and/or red-flowered potato varieties and breeding lines have also been evaluated and all were found to carry a BamHI-minus DFR allele. In contrast the BamHI site is present in all DFR alleles of many white skinned varieties. Collectively, the genetic data suggest that R encodes DFR; transformation experiments to functionally test this hypothesis are underway.

1340–1440

S03–P–9

BREEDING POTATOES FOR HORIZONTAL RESISTANCE TO THE COLORADO POTATO BEETLE

David Fisher*

Dept. of Life Sciences, Maharishi Univ. of Management, 1000 N 4th St., Fairfield, Iowa, USA, 52557

Horizontal resistance was assessed as a strategy to reduce potato defoliation by the Colorado potato beetle (CPB), starting with hybrids among Solanum tuberosum varieties adapted to Iowa and using a detached leaflet bioassay and field trials to evaluate feeding behavior. Beginning in 1998, resistance was increased annually over three years by intermating and selecting the most resistant 1-2% of each generation of 300-400 plants using the bioassay, which measured C (= mg leaf tissue consumed / neonate larva over 48 h). Feeding significantly decreased with each generation of intermating. When C was measured for the 1% most-resistant genotypes of all generations grown side by side in 2000, it ranged from 6.11 mg/larva in the parents to 2.31 for progeny of the F3 generation (a 62% drop in feeding activity) compared to 2.73 in ND2858-1, a resistant check. Field trials in Wisconsin also showed less defoliation in the F1 and F2 selected genotypes than in the parents, further suggesting that recurrent mass selection is effective. A foliar glycoalkaloid analysis revealed only relatively low levels of solanine and chaconine in the F3 selections: no leptines or leptinines were detected, so the phenotypic source of resistance is unknown. Because the parents were S. tuberosum varieties, in which vertical resistance to CPB is unknown, and because resistance to feeding from parents to F3 resistant plants was linear and gradual while ranging from initially very low to significantly higher in the third year, horizontal resistance is strongly implicated. The development of a significant degree of resistance after three rounds of breeding using relatively small breeding populations suggests that HR to CPB can be developed from varieties of Solanum tuberosum lacking initial high levels of resistance to this pest.

1340–1440

S03–P–10

ALTERING ETHYLENE RECEPTION IN POTATO RESULTS IN CHANGES TO GROWTH, DEVELOPMENT, DORMANCY, AND RESPONSE TO BIOTIC AND ABIOTIC STRESS

Margo Haines*[1], Patrick Shiel[2], Phillip Berger[2], John Fellman[1]

Dept. of Hort. & Landscape Arch., College of Agriculture & Home Econ., Washington State Univ., Pullman, WA, USA, 99164-6414

Sprouted potato tubers lose nutritional value, and their increased reducing sugar content renders them unsuitable for the french fry and chipping industries. Thus, tuber sprouting in storage is of major concern, and currently controlled by application of chemical sprout suppressants. Such suppressants are subject to widespread regulation by governmental agencies. Potato tuber dormancy is under study to reduce dependence on sprout suppressants and improve availability of raw product for the processing industry. Ethylene is a gaseous plant growth regulator implicated in all stages of plant development including seed dormancy and germination. To investigate the role of ethylene in potato (*Solanum tuberosum* L.) dormancy release, we transformed two potato cultivars, Russet Burbank and Gem Russet, with etr1, an ethylene receptor gene from Arabidopsis. Orientation of the transgene was either sense or antisense, and under control of either a constitutive 35S promoter, or a putatively tuber-specific, sucrose-inducible promoter. The resulting clones were genetically characterized to verify integration and expression of both the etr1 mRNA and protein (ETR1). Clones expressing the transgene in either orientation, and under control of either promoter, revealed developmental and morphological changes that were evident in both plant and tuber, apparent cultivar-specific altered responses to environmental stress and pathogen attack, and changes in phototropic responses. When stored at 20 °C , tubers of four transgenic Gem Russet clones showed a lengthening of dormancy up to 22 weeks, while dormancy in transgenic Russet Burbank tubers was unaffected. In selected clones grown in the presence of silverthiosulfate (STS), an ethylene action inhibitor, a restoration of normal plant morphology was observed.

These experiments demonstrate the pleiotropic effect of ethylene in potato and suggest that ethylene response varies with cultivar.

1340–1440

S03–P–11

CAROTENOID CONTENTS IN LEAVES AND TUBERS OF YELLOW-FLESHED DIPLOID POTATOES

Haynes, Kathleen,
W. Lu[1], K. Haynes*[1], E. Wiley[2], B. Clevidence[2]

[1]USDA/ARS, Vegetable Laboratory, Plant Sciences Institute, Beltsville, MD 20705, USA; [2]USDA/ARS, Phytonutrients Laboratory, Beltsville Human Nutrition Research Center, Beltsville, MD 20705, USA

Carotenoids may protect against a variety of chronic diseases, including cardiovascular disease, certain cancers, and macular eye degeneration. Enhancing carotenoid levels in more frequently consumed vegetables, such as potato, is one of the strategies to improve human health and quality of life. Large variations of potato tuber carotenoids exist in a diploid hybrid population of *Solanum phureja-S. stenotomum*, making this a valuable germplasm source for increasing carotenoid levels in tetraploid cultivars. This research was carried out to identify and quantify the carotenoids in leaves, investigate the diurnal changes of total and major leaf carotenoids, and determine if there is a relationship between leaf and tuber carotenoid contents in these diploid potatoes. Carotenoids were extracted with acetone. Chromatography was performed using the HP 1100 LC system with Chemstation software (Agilent Technologies) on a reverse phase C30 column (250 mm x 4.6 mm) from YMC at 20 °C with diode array detection at 450 nm. Both carotenes and xanthophylls were found in leaves, but only xanthophylls were detected in tubers. Total leaf carotenoid content was negatively associated with photon flux density (PFD) in high tuber carotenoid clones, whereas the change in total leaf carotenoid content can be described only by a quadratic equation in low tuber carotenoid clones. No correlations between the individual xanthophyll or total xanthophyll concentrations in leaves and tubers were found. The level of carotenoid in leaves is not a good indicator for tuber carotenoid content in these diploid yellow-fleshed potatoes.

1340–1440

S03–P–12

CLONAL SELECTION IN EARLY POTATO BREEDING PROGRAM AND DETERMINATION OF PLANT MATURITY BY USING A PLUG CULTURE SYSTEM

Kwan Soo Kim*[1], Hyun Mook Cho[1], Young Eun Park[1], Hak Tae Lim[2], Yoong Narm Song[2]

[1]National Alpine Agricultural Experiment Station, Pyeongchang, RDA 232-955, Korea; [2]Division of Applied Plant Sciences & Center for Korea Potato Genetic Resources, Kangwon National University, Chuncheon 200-701, Korea

The study was performed to investigate the effect of a plug culture method in the early stage of a potato breeding program. The 105, 200 and 288-cell plug trays were used for raising potato seedlings. The percentage of germination in plug trays ranged between 94% and 96%. Percent tuberization measured at 50 and 60, and 70 days after sowing was the greatest in 105-cell and 200-cell trays, respectively. However, tuberization was delayed the most in 288-cell trays. Thus, it is considered that 105-cell tray is the most effective for the selection of early maturing plants. Plant maturity was determined by the morphological characteristics at the seeding stage of stolons cultured in plug trays. Most of seedings with shorter stolons at seedling stage (1st generation) were the early-maturing, while most of seedlings with longer stolons were the late-maturing at the clonal stage (2nd generation). These results mean that the plant maturity in the early potato breeding program can be effectively grouped by observing the morphological characteristics of stolons after plug culture.

1340–1440

S03–P–13

RETROTRANSPOSON BASED MARKERS TO CHARACTERIZE SOMATIC HYBRIDS AND ASSESS VARIATION INDUCED BY PROTOPLAST FUSION OF MONOPLOID POTATO

G. Lightbourn*, R.E. Veilleux

Dept. of Horticulture, Virginia Polytechnic Institute and State Univ., Blacksburg, VA, USA, 24061

IRAP (Inter-Retrotransposon Amplified Polymorphism) is a PCR (polymerase chain reaction) based marker technique that uses the proximity of LTR (long terminal repeat) regions of adjacent retrotransposons to generate markers by use of outward facing primers (22-24 bp) that anneal to LTR target sequences. Active retrotransposons replicate via an mRNA intermediate that is reverse transcribed to cDNA and reinserted into the genome. The LTR regions tend to be highly conserved because they contain sequences essential for expression. New insertions lead to polymorphism in IRAP banding patterns. Our primers were designed to target the LTR of potato Tst1 retrotransposons to detect head-to-head and tail-to-tail orientations. The amplification product would then contain short stretches of retrotransposon LTR fragments and the intervening region between pairs of retrotransposons, resulting in fragment sizes ranging from approximately 200 to 3,530 bp. The potato populations under investigation consisted of regenerants following electrofusion of genetically distinct pairs of monoploids (2n=1x=12). Both somaclones from unfused parental protoplasts and somatic hybrids from actual fusions could be expected. The IRAP procedure led to amplification of 20 to 40 bands for each of four monoploids. Of these, 2 were unique and clearly distinguished the somatic hybrids from the somaclones among the regenerated plants. Variation among IRAP products between somaclones and the monoploid "parent" suggested that the Tst1 retrotransposon was active during the protoplast-to-plant process.

1340–1440

S03–P–14

STORAGE LIFE OF PRE-PEELED POTATOES AS AFFECTED BY STORAGE TEMPERATURE AND MODIFIED ATMOSPHERE PACKAGING

Jin-Cheol Jeong*, Sung-Yeul Kim, Chun-Soo Park, Myoung-Soon Yiem

Crop Res. Div., Nat'l Alpine Agri. Exp. Stn., RDA, Hoeng-Gae 3, Doam-Myun, Pyongchang-Gun, Kangwon, Korea, 232-955

Minimal processing for vegetables is becoming an important area of potential growth due to their fresh-like character and convenience. However, the prevention of browning of pre-peeled potatoes has been difficult to achieve because of the speed of the enzymatic oxidation of phenolic substrates. In this study, the effect of storage temperature (20 and 4 °C) and modified atmosphere packaging (0.03 mm thickness PE film, MAP) on the storage life and polyphenol oxidase activity of pre-peeled potatoes was evaluated for two cultivars during the storage. The effect of low temperature (4 °C) storage on the storage life of pre-peeled potatoes was significant for two cultivars. Potatoes maintained at 20 °C showed a rapid deterioration from 6 days after storage, so we couldn't continue the quality evaluation after that time. Storage life of pre-peeled potatoes showed the difference between cultivars. The color (Hunter's L value) of 'Atlantic' potatoes was maintained for a longer time, as compared with 'Superior' at both storage temperatures. A similar tendency was observed for the evaluation of texture. MAP by PE film was effective for the lengthening of storage life in pre-peeled potatoes. PPO activity of 'Atlantic' potatoes was lower than 'Superior'. Therefore, it was considered that the browning difference between two cultivars during the storage was due to the PPO activity difference. Low temperature and MAP were also effective in the inhibition of PPO activity.

1340–1440

S03–P–15

NO ABSTRACT AVAILABLE

1340–1440

S03–P–16

DEVELOPMENT OF USEFUL BREEDING RESOURCES IN SEVERAL WILD SPECIES OF POTATOES BASED ON THE ANALYSIS OF SPECIFIC GRAVITY AND REDUCING SUGAR CONTENT

Young Eun Park*[1], Hyun Mook Cho[1], Kwan Soo Kim[1], Hak Tae Lim[2]

[1]National Alpine Agricultural Experiment Station, Pyeongchang, RDA 232-955, Korea; [2]Division of Applied Plant Sciences & Center for Korea Potato Genetic Resources, Kangwon National Univ., Chuncheon 200-701, Korea

For the screening of breeding material to be used for potato chip processing, the specific gravity and reducing sugar contents of several relative-wild species of potatoes were evaluated. The mean tuber weight/plant of cv. Atlantic (4x cultivar) potato (*Solanum tuberosum* L.) was 447 g, and that of wild species was only

75.7 g, ranging widely from 28 g to 122.3 g. The highest specific gravity of 1.125 was found in *S. stenotomum* (stn), while *S. demissum* (dms) showed the lowest value in specific gravity. Most of clones with specific gravity higher than 1.080 belonged to *S. brachistorichum* (bst) and *S. chacoense* (chc). At harvest, the glucose contents of 9 wild species, *S. bulbocastanum* (blb), bst, chc, *S. cardiophyllum* (cph), *S. kurtzianum* (ktz), *S. phureja* (phu), S. sucrense (scr), *S. stoloniferum* (sto), *S. tuberosum* (tbr) and *S. infundibuliforme* (ifd) were lower than 0.25%, indicating that these species could be used as genetic resources for breeding processing potatoes. Another wild species, dms, *S. pinnatisectum* (pnt), *S. spegazzinii* (spg), stn and *S. vernei* (vrn), however, had high glucose contents of 0.29 to 0.60 in the range, unsuitable level for chip processing. After storage at 4 °C for 90 days, glucose contents in clones of bst, cph and phu species were very stable, so they were expected to be good genetic resources for breeding cold chipping potatoes. After reconditioning of cold-stored potatoes for 3 weeks at 20 °C, glucose contents in most of wild species decreased to the level of potatoes at harvest, but those of dms, pnt, spg, stn, and vrn species were still maintained at high level. Based on glucose contents, the highest positive correlation coefficients, $r = 0.866$, $r = 0.866$, and $r = 0.848$ were obtained between potatoes at harvest and after cold storage, between potatoes at harvest and after reconditioning, and between potatoes after cold storage and after reconditioning, respectively.

1340–1440

S03–P–17

EVALUATION ON SPECIFIC GRAVITY AND GLUCOSE CONTENT OF POTATO GERMPLASMS

Young-Eun Park*[1], Hyun-Mook Cho[1], Kwan-Soo Kim[1], Jung-Yoon Yi,[1] Hak-Tae Lim[2]

[1]National Alpine Agricultural Experiment Station, Pyeongchang, RDA 232-955, Korea; [2]Division of Applied Plant Sciences & Center for Korea Potato Genetic Resources, Kangwon National Univ., Chuncheon 200-701, Korea

Mean tuber specific gravity was highest in the Asia group of potato germplasms, at 1.075, and mean glucose content was lowest in the Oceania group of potato germplasms, at 0.21% compared with other potato groups. The variance analysis for specific gravity and glucose content showed significant difference between 'Genotype' and 'Year'. These results indicate that the specific gravity and glucose content were strongly influenced by the environmental factors during growing seasons. High significant correlation from the analysis for specific gravity and glucose content, was shown between year and year. These results indicate both characteristics are very useful as selection index for selection of clones with high specific gravity and low glucose content in the early breeding stage. Thirty two varieties with specific gravity greater than 1.080, 170 varieties with glucose content less than 0.25%, and 19 varieties with both high specific gravity and low glucose content were selected.

1340–1440

S03–P–18

ANTISENSE SUPPRESSION OF PHOSPHOLIPASE D AND ITS POTENTIAL FOR THE PREVENTION OF LOW TEMPERATURE SWEETENING IN POTATOES

R.G. Pinhero, K.C. Almquist, G. Paliyath, R.Y. Yada*

Functional Foods and Nutraceuticals Research Laboratory, Dept. of Food Science, Univ. of Guelph, Guelph, Ontario, Canada N1G 2W1

Potato chips and French fries are two of the most popular processed products. The crispness and ideal colour of these products are influenced by the relative concentration of starch and reducing sugars. Large quantities of reducing sugars such as glucose and fructose accumulate when tubers are stored below 10 °C, a phenomenon termed as low temperature sweetening (LTS). The occurrence of damage to the amyloplast membrane during chilling, has been proposed to be a major cause for the catabolism of starch into sugars. As phospholipase D (PLD) is the key enzyme that initiates membrane lipid catabolism, we are evaluating its potential role in LTS. The effects of antisense suppression of PLD in "Snowden" potatoes on several physiological and biochemical parameters are being investigated. An 870 bp coding region fragment of potato PLD cDNA was amplified using RT-PCR of potato leaf RNA and plant specific degenerate primers, designed according to the CODEHOP algorithm. A 2kb fragment of potato PLD cDNA was further amplified and isolated, and cloned into the T-DNA transfer vector pBIN-mgfp5-ER in the antisense orientation between a CamV 35 S promoter and NOS terminator. Potato was transformed by co-cultivating the leaf explants with Agrobacterium. Transgenic plants were selected by their resistance to kanamycin and propagated further. The transgenic plants were morphologically similar to the untransformed plants and showed lowered PLD activity in the leaves. As well, Western blots of leaf proteins using polyclonal antibodies raised against castor bean PLD, showed a 90kD band, the intensity of which was considerably lowered in the transgenic plants. The physiological characteristics of transgenic plants and tubers are being evaluated. Supported by the Ontario Ministry of Agriculture Food and Rural affairs and the Food Systems Biotechnology Centre, Univ. of Guelph.

1340–1440

S03–P–19

MOLECULAR MAPPING OF RESISTANCE TO LATE BLIGHT AND COLD SWEETENING IN DIPLOID POTATOES

M.C. Saha*[1], J.H. Lorenzen[2]

[1]Dept. of Plant Sciences, Loftsgard Hall, North Dakota State Univ., Fargo, ND 58105, USA; [2]Plant, Soil, and Entomological Science Dept., Univ. of Idaho, Moscow, ID 83844, USA

Late blight and cold sweetening are major constraints of the potato industry and substantially reduce profitability. Resistant varieties are one of the most effective ways to combat these problems. Marker-assisted breeding can be an effective tool in introgression of valuable traits. The current studies are aimed to identify molecular markers closely linked to resistance to late blight and cold sweetening. Wild diploid (*Solanum*) species are excellent sources of resistance to many pests and diseases. Clones of (*S. chacoense*) and (*S. microdontum*) were crossed with dihaploid (*S. tuberosum*) and resulting populations segregated for resistance to both late blight and cold sweetening. Backcross and intercross populations have been developed and analyzed for segregation. Detached leaf assays and inoculated field trials were conducted for the assessment of late blight resistance. Harvested tubers of each genotype were stored at 4 °C for 60 days and chip color was used as an indicator of cold-sweetening resistance. Molecular maps were developed for both parents in each population using a combination of AFLP and SSR markers. The initial F_1 populations had many markers that were polymorphic between the parents but monomorphic in the progenies, especially for (*S. microdontum*). Additionally, some markers were linked to the traits of interest but not associated with a linkage group. Backcross populations were then developed and used for mapping. We report the identification of markers linked to these two important traits, and their placement on chromosomal linkage groups in backcross populations.

1340–1440

S03–P–20

STUDY OF SOMACLONAL VARIATION IN POTATO

A. Shahpiri*[1], M. Omidi[2]

[1]Dept. of Biotecnology, College of Agriculture, Univ of Tehran, Karaj, Iran; [2]Dept. of Agronomy, College of Agriculture, Univ of Tehran, Karaj, Iran

Somaclonal variation was observed in calluses and regenerated clones induced in vitro from internodal and leaf explants of four varieties. In this study somaclonal variations were assessed by numerical chromosome variation. Chromosome variation is determined by chromosome counts in mitotic cells. Some cells of calluses and some of roots regenerated from calluses had modified ploidy levels.

1340–1440

S03–P–21

GENETIC AND ENVIRONMENTAL INTERACTIONS AFFECTING POTATO AFTER-COOKING DARKENING

Gefu Wang-Pruski*

Dept. of Plant and Animal Science, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada, B2N 5E3

Potato after-cooking darkening (ACD) is one of the most widespread, undesirable characteristics of cultivated potato. It occurs when potatoes are exposed to air after cooking including boiling, baking, frying or dehydration. ACD is caused by a non-enzymatic oxidation reaction. A bluish-gray compound ferridichlorogenic acid is responsible for the dark color formation. Currently ACD is partially prevented by adding sodium acid pyrophosphate during processing. Addition of the chemical adds significant cost to the processing. Despite of over 50 years investigation of the ACD phenomenon, and the breeding attempts to-

wards its elimination, there are no potato clones available to processors which do not darken to some extent and, at the same time, have agronomic and processing qualities requested. Genetic control governs the darkening, but the level of the darkening also depends on the plant growth environment and the length and conditions of storage. The author will present the latest research development on understanding the genetic and environmental control of ACD including the following: (i) inhibition of genes essential for chlorogenic acid biosynthesis in potato, and searching for genes responsible for ACD, (ii) discovering gene markers related to ACD using diploid populations and (iii) investigating the environmental factors contributing to ACD. While genes involved in the chlorogenic acid biosynthesis are cloned, we have identified 15 RAPD markers that are related to ACD. Investigation of the environmental effect in year 2000 and 2001 showed location had much more pronounced effect in Russet Burbank than Shepody, but location effect is not as strong as variety effect. Detailed results related to the above areas will be discussed. Acknowledgement is given to Dr. Yves Leclerc, and Dr. Dan Ronis, McCain Foods, Ltd, and to Dr. Henry De Jong, Agriculture and Agri-Food Canada, for their support and involvement of the research.

1340–1440

S03–P–22

TRANSFORMATION OF POTATO WITH CHILLING RESPONSIVE POTATO GENES

Hyesook Song*[1], Jaebok Park[1], Bu-Young Yi[1], Myong-Ok Byun[2]

[1]Dept of Evironmental Horticulture, Univ. of Seoul, Seoul 130-743, Korea; [2]National Institute of Agricultural Sciences, RDA, Suwon, Republic of Korea, 441-707

Several potato cDNA clones showed homology with Arabidopsis rd (responsive to dehyration) gene. After the full cDNA was sequenced and compared with Arabidopsis rd22, it was cloned into Ti-derived binary vector for agrobacteium mediatied transformation. Several Kanamycin resistant shoots were obtained and analyzed with PCR and showed positive transformation. Bioassay for tolerance to chilling and dehydration of the transformant were performed to investigate the structural gene and promoter of potato rd (responsive to dehydration) gene in several environments.

1340–1440

S03–P–23

EFFECT OF SUPPLEMENTAL LIGHTING, SUBSTRATE (POTTING MIX) VOLUME AND PLANT DENSITIES ON POTATO MINITUBER PRODUCTION DURING WINTER GREENHOUSE CULTURE IN QUEBEC

Jihad Abdulnour, Yves Desjardins, Guy Roy

Centre de recherche en horticulture, FSAA, Université Laval, Québec, Québec, Canada, G1K 7P4

An experiment was conducted to evaluate the effect of light, substrate volume and plant density on minituber yield of greenhouse-grown potato cv. FL-1207 during the winter season. Light was supplemented to provide either 150 or 300 mmol $m^{-2} \cdot s^{-1}$ at the plants level. Plants were grown on 5 or 10 cm deep potting mix (Promix BR) at two densities of 100 or 200 plants/m^2. There was no interaction between the light intensity, substrate volume or plant density. The high light intensity supplementation (300 mmol $m^{-2} \cdot s^{-1}$) increased minituber number and weight by 27 and 57%, respectively, over the 150 mmol $m^{-2} \cdot s^{-1}$ light supplementation. Similarly, the deeper substrate (10 cm) increased minituber number from 344 to 463/m^2, and doubled their yield from 1865 to 3739 g/m^2. The effect of plant density on minituber yield differed whether it was expressed per area (per m^2) or per plant. The highest plant density of 200 plants/m^2 increased minituber number from 367 to 440/m^2 but not their weight, thus decreasing their average biomass produced from 7.5 to 6.0 g. However the highest plant density reduced minituber number and weight per plant from 3.7 to 2.2 and 28 g to 14 g, respectively.

1340–1440

S03–P–24

FUNCTIONAL GENOMICS OF PROTEIN METABOLISM IN POTATO: PROTEASE CDNA CLONING AND EST-BASED GENE EXPRESSION ANALYSIS

Xiu-Qing Li*[1], Merideth W. Bonierbale[2], Birt Stevens[1], Muhammad Haroon[1]

Potato Research Centre, Agriculture and Agri-Food Canada, P.O. Box 20280, 850 Lincoln Road, Fredericton, New Brunswick, Canada, E3B 4Z7

Plant endogenous proteolytic enzymes and their inhibitors are important for the processing and degradation of the dietary proteins, the regulation of cellular protein catabolism, and the plant defense system during pathogen infection. To have a global view about the protease gene expression in the potato tubers, we used expressed sequenced tag (EST) approach to identify genes actively expressed during the tuber developing stage. A cDNA library was constructed using mRNA extracted from the main mass (storage parenchyma-perimedulla excluding the central pith) of immature tubers of a cultivated potato clone. Random cDNA phagemid clones were sequenced from the 5í-end. Sequences were compared with the most recent releases of GenBank using BLAST search. Out of the 900 high quality ESTs, seven ESTs were found having high homology with six different protease genes. Five of them were for the first time cloned from potato. The putative function and relative activity of these protease genes will be discussed in the presentation.

1340–1440

S03–P–25

THE EVOLUTION OF A POTATO PROGRAM TO BREED FOR FRENCH FRY VARIETIES

T.R. Tarn*, G.C.C. Tai, D. DeKoeyer

Agriculture and Agri-Food Canada, Potato Research Centre, P.O. Box 20280, Fredericton, NB, Canada, E3B 4Z7

Potential new french fry varieties must meet acceptable standards for a group of performance and quality traits. These traits include maturity, tuber shape and size, specific gravity, internal tuber defects, and fry colour and texture components. These have been among the criteria for selection and advancement in the Agriculture and Agri-Food Canada potato breeding program at Fredericton designed to produce superior french fry varieties. To align the program more closely with this objective, changes have been made in the use of parental clones, in crop management and in selection procedures over a 15 year period. The resulting changes in the frequency and level of expression of the key french fry traits were investigated using evaluation data from fourth field generation selections over this period. Multivariate statistical methods, including residual maximum likelihood (REML) and cluster analysis, were employed to evaluate the long-term progress of the breeding strategy and classify the advanced selections into clusters. The contribution of parent clones to the changing populations of selections was also analysed. The information obtained from these analyses will be used to further improve the efficiency of breeding french fry varieties.

1340–1440

S03–P–26

INDUCTION OF THERMOTOLERANCE IN POTATO MICROPLANTS BY SALICYLIC ACID DURING IN VITRO THERMOTHERAPY

Humberto Lopez-Delgado*, Oswaldo Rubio-Covarrubias, Mateo Cadena-Hinojosa

Programa de Papa Inifap, Metepec, Estado de Mexico, Mexico C.P. 52140, A.P. 10-1

Salicylates have different physiological roles in plants. Reports indicate that acetyl salicylic acid induces thermotolerance in potato microplants. The objective of this work was to induce thermotolerance, in order to increase the percentage of survival after in vitro thermotherapy for getting PVX free plants. Microplants (PVX (+)) of 30 genotypes were subcultured in MS medium including salicylic acid (SA) for thermotolerance induction as described before. Four weeks later the plants were subcultured in MS without SA and exposed to thermotherapy for 30 days at 42 grades centigrade. Controls were not incubated in SA. After thermotherapy, survival microplants of each genotype were recorded and subcultured to MS. Depending of the genotype, the percentage of survival of SA treated plants was significatively higher, 26.6 to 64.3%, whereas the control plants had 0 to 56%. The percentage of virus-free plants was also increased up to 100%.

1440–1500

S03–O–27

REDUCTION OF SPECIES IN THE WILD POTATO SOLANUM SECTION PETOTA SERIES LONGIPEDICELLATA: AFLP, RAPD AND CHLOROPLAST SSR DATA

David M. Spooner*[1], Ronald G. van den Berg[2], Glenn Bryan[3], Alfonso del Rio[4]

[1]Vegetable Crops Research Unit, USDA, Agricultural Research Service, Dept. of

Horticulture, Univ. of Wisconsin, 1575 Linden Drive, Madison, Wisconsin 53706-1590, USA; [2]Biosystematics Group, Dept. of Plant Sciences, Wageningen Univ., P.O. Box 8010, 6700 ED Wageningen, The Netherlands; [3]Crop Genetics Dept., Scottish Crop Research Institute, Invergowrie, Dundee, UK, DD2 5DA, UK; [4]Dept. of Horticulture, Univ. of Wisconsin, 1575 Linden Drive, Madison, Wisconsin 53706-1590, USA

Species boundaries were assessed with three molecular markers (AFLPs, RAPDs, chloroplast microsatellites, also known as chloroplast simple sequence repeats [cpSSRs]) for all six species of wild potatoes (*Solanum L*. section Petota Dumort.) assigned to ser. Longipedicellata: *S. fendleri*, *S. hjertingii*, *S. matehualae*, *S. papita*, *S. polytrichon*, and *S. stoloniferum*. These tetraploid (2n = 4x = 48) species grow in the southeastern United States (*S. fendleri*) and Mexico (all six species), and a recent morphological analysis supported only three species: 1) *S. polytrichon*, 2) *S. hjertingii* (including *S. matehualae*), and 3) *S. stoloniferum* (including *S. fendleri* and *S. papita*). We also analyzed putative outgroups (section Etuberosum, ser. Bulbocastana, Pinnatisecta, Polyadenia, Piurana) or close relatives or progenitors (ser. Acaulia, Demissa, and Tuberosa) in *Solanum* sect. Petota. Concordant with morphological data, AFLP and RAPD results support the synonymy of *S. hjertingii* and *S. matehualae*, and completely intermix *S. papita* and *S. fendleri*. However, accessions of *S. stoloniferum* have a tendency to cluster but with exceptions, and *S. polytrichon* is completely intermixed with *S. fendleri* and *S. papita*. The chloroplast DNA microsatellites fail to distinguish any of the species in ser. Longipedicellata, and in combined analyses with all three markers have little effect on results. Combined morphological and molecular data support only two species in ser. Longipedicellata: *S. hjertingii* and *S. stoloniferum*.

1500–1520

S03–O–28

VARIATION FOR ISOZYMES OF UGPASE IN 4X POTATOES AND ITS RELATIONSHIP TO COLD SWEETENING RESISTANCE IN 4X PROGENIES FROM BILATERAL POLYPLOIDIZATION

C.A. Thill*[1], J.R. Sowokinos[2], R.J. Hayes[1]

[1]Dept. of Horticultural Science, Univ. of Minnesota, 1970 Folwell Avenue, St. Paul, Minnesota, USA 55108; [2]USDA-ARS Potato Research Worksite, 311 5th Avenue NE, East Grand Forks, MN, USA 56721

Potato chip cultivars lacking light colored chips after processing have limited commercial potential. Currently, processing potatoes require storage at warmer temperatures (5.5 to 7 °C) to prevent 'cold-induced sweetening'; which can reduce product quality. Potatoes that are developed to resist sweetening when placed into cold storage (3 to 4 °C) offer greater production, storage, and marketing efficiency to producers. UGPase catalyzes the first-step committed to the sweetening pathway in potato tubers, which leads to reducing sugar formation. It is imperative that genes be identified that confer resistance to sweetening in the cold and that breeding methods be employed that identify genetic variation for chip color in early-generation populations of a potato-breeding program to promote rapid development of 4C chipping cultivars. Chromatography of potato extracts on DEAE-Sephacel yields two distinct peaks of UGPase activity, designated A-I and A-II. Fifty-four genetically diverse potato clones were examined for the presence of A-I and/or A-II fraction of UGPase isozymes in relation to their ability to accumulate sugar in cold storage. Clones having A-I experience a rapid rate of sweetening in cold storage, while those having A-II had a degree of cold tolerance. The A-II polypeptides were found to have unique catalytic properties. Therefore, tetraploid progeny from unilateral polyploidization (2x-4x, 4x-2x) and from 4x-4x crosses were examined for chip color in relation to segregation of isozyme patterns of UGPase. Populations developed by sexual polyploidization had superior means and larger variances resulted in significantly more acceptable chipping progeny: 2x-4x (3 mo: percent acceptable-15.4%; 6 mo: 21.0%), 4x-2x (3 mo: 10.7%; 6 mo: 11.8%) compared to 4x-4x (3 mo: 0.4%; 6 mo: 0.6%). Superior performance is likely due to the introgression of cold chipping alleles from species and potentially the superior transmission of cold chipping through 2n gametes.

1520–1540

S03–O–29

REDUCTION OF TOTAL STEROIDAL GLYCOALKALOIDS IN POTATO TUBERS USING ANTISENSE CONSTRUCTS OF A GENE ENCODING A SOLANIDINE GLUCOSYL TRANSFERASE.

K.F. McCue*[1], D.L. Corsini[2], L.V.T. Shepherd[3], C.P. Moehs[4], P. Joyce[5], H. Davies[3], and W.R. Belknap[1]

[1]Agricultural Research Service, 800 Buchanan Street, Albany, CA 94710 USA; [2]Small Grains & Potato Germplasm Research Unit, 1691 S 2700 W, P.O. Box 307, Aberdeen, ID 83210 USA; [3]Scottish Crop Research Institute, Invergowrie, Dundee, DD2 5DA UK; [4]Dept. of Biochemistry, Univ. of Nevada, Reno, NV 89557 USA; [5]5 Small Potatoes, Inc., 1202 Ann Street, Madison, WI 53713 USA

Accumulation of steroidal glycoalkaloid (SGA) toxicants in potatoes affects food quality and food safety. High levels of SGAs hampers breeding efforts to develop new varieties of potatoes with improved agronomic and post harvest properties. To speed breeding efforts for reducing SGAs in breeding lines and to correct otherwise flawed selections we have taking a molecular genetic approach to reduce SGAs. A cDNA encoding a solanidine glucosyltransferase (SGT) was isolated and used to construct antisense transgenes transcribed either from the CaMV35S or a tuber-specific granule bound starch synthase (GBSS) promoter. Transgenic lines of potato expressing these transgenes exhibit phenotypes with significantly lower total steroidal glycoalkaloids. Field trials over several years in Idaho and Wisconsin have resulted in reproducible and statistically significant reductions in tuber alkaloid levels of up to 40% of total SGAs. Reduction in glycoalkaloids is accompanied by expression of the SGT antisense RNA transcripts and a reduction in SGT protein levels. Analysis of transgenic Desire potatoes expressing the GBSS-SGT antisense transgene revealed essentially complete down-regulation of solanine biosynthesis in several transgenic lines. Chaconine biosynthesis in these lines was not significantly affected. Additional transgenes with SGT and other SGA related sequences are currently being evaluated.

1540–1600

S03–O–30

ASCORBIC ACID CONTENT AND STABILITY IN NORTH AMERICAN POTATO GERMPLASM

Stephen L. Love*[1], Thomas Salaiz[1], Bahman Shafii[1], William J. Price[2], Alvin R. Mosley[3], Robert E. Thornton

[1]Univ. of Idaho, College of Agriculture and Life Sciences, Moscow, ID 83844, USA; [2]Oregon State Univ., Dept. of Crop and Soil Sciences, Corvallis, OR 97331, USA; [3]Washington State Univ., Dept. of Horticulture and Landscape Architecture, Pullman, WA 99164,USA

Ascorbic acid (vitamin C) is important in the human diet as an essential vitamin and antioxidant. Potatoes are a major source of ascorbic acid and the development of cultivars with higher concentrations will result in an increase in consumption of this important nutrient. This study is the initial step in breeding for higher levels of ascorbic acid. Germplasm from twelve North American potato breeding programs was evaluated for ascorbic acid concentration and stability of expression across environments. Seventy-five clones were grown at locations in Idaho, Oregon, and Washington in 1999 and 2000. Using ANOVA, significant (P <0.05) clone and clone x environment interaction effects were observed. Clones ranged from a high of 29.8 mg per 100 g FW (ND4027-4) to a low of 11.5 mg per 100 g (A8792-11). The clone x environment interaction was explored using AMMI analysis of a subset of 10 commercially available cultivars and standard clones. There were large differences in stability of clones across environments. Ranger Russet had the second highest ascorbic acid concentration among all clones at 29.4 mg per 100 g, but was highly unstable across environments. Chipeta, Yukon Gold, and A85331-16 had both high levels of ascorbic acid and were stable across environments. These clones have the appropriate combination of traits to serve as good potential parents in breeding for increased levels of ascorbic acid in potatoes.

1600–1620

S03–O–31

POTATO BREEDING AT THE CROSS ROADS—OPTIONS TO CONSIDER

R.H. Coffin*[1], J. Coffin[2], R. Singh[3], X. Nie[3], R.Y. Yada[4]

Cavendish Farms, PO Box 3500, Summerside, PEI C1N 5J5; [2]Long Lane Farm, RR#6 Kensington, PEI, C0B 1MO; [3]AAFC, PO Box 20280, Fredericton, N.B., E3B 4Z7; [4]Food Science Dept., Univ. of Guelph, N1G 2W1

Traditional potato breeding programs have selected seedlings with yield potential to assure profitable yields to growers and acceptability for table markets and processing quality for chips and French fries. Potatoes are prone to colonization by a wide array of insects, nematodes, bacteria, fungi and viruses. A challenge exists for traditional breeders to release new varieties with a balance of

quality attributes combined with disease resistance. The widespread use of pesticides as well as the development of transgenic potatoes have been controversial issues. Genetically transformed varieties with several traits i.e. resistance to Colorado Potato Beetle (CPB) and Potato Virus Y (PVY) in the Shepody variety and CPB, PVY or Potato Leaf Roll Virus (PLRV) in the Russet Burbank variety have been used commercially. A 5 year viral testing study of the above varieties, confirmed the PVY resistance was stable under field conditions in both varieties and the PLRV resistance in R B was partial. While the commercialization of these genetically transformed clones was accepted by some producers as a technique for disease and insect control, the movement away from these varieties has left a serious void in virus control measures. Numerous researchers continue to investigate the possibility of altering inherent metabolic pathways, in existing varieties, using genetic engineering techniques to introduce desirable processing traits from other genotypes or Solanum species i.e. resistance to cold temperature sweetening. The issue of developing new potato germplasm, which is acceptable to regulatory personnel and the public, while being commercially viable will be discussed.

1620–1640
S03–O–31–A
TO BE ANNOUNCED

1640–1700
S03–O–31–B
TO BE ANNOUNCED

Tuesday · August 13

1100–1200
S03–O–32

MOLECULAR BIOLOGY OF THE INTERACTIONS BETWEEN POTATO AND ITS MAJOR PATHOGENS

Paul R.J. Birch*, Vivian Blok, Ian K. Toth

Scottish Crop Research Institute, Invergowrie, Dundee, Invergowrie, Dundee, Scotland, DD2 5DA UK

Little is known about biochemical or signalling pathways in potato that are involved in resistance to pathogens, whether mediated by resistance genes or as a component of 'field' or 'durable' resistance. No published information compares resistance in leaf tissue with that in root. Knowledge from such comparisons could be crucial in developing broad-range plant disease resistance strategies. Our labs at SCRI have focused on the discovery of plant genes that are up-regulated during resistant and susceptible interactions between potato and foliar pathogens (*P. infestans* and *E. carotovora*) and potato and root pathogens (potato cyst nematodes). These pathogens are amongst the most economically devastating for potato. We are using several approaches to isolate differentially expressed plant genes. Subtracted libraries have been made from potato tissue infected with all of these pathogens at different time points during compatible and incompatible interactions. SCRI is thus in a unique position, through co-ordinated on-going studies of the expression and function of genes discovered in these projects, to meet the following objectives: to identify common and distinct pathogen response pathways in root and leaf tissues, to compare resistance mechanisms in different pathosystems, to identify key general rapidly activated pathogen response promoters, and to characterise the function of genes activated in resistance responses in potato. We are also keen to answer key questions about the pathogens themselves: what genes are required for successful infection? What are avirulence genes? What are the molecular bases of host-specificity in these pathogens? To tackle these questions we have adopted genomics approaches. In the case of P. infestans, a framework of integrated genetic, physical and transcriptional maps is being constructed to facilitate rapid discovery of genes involved in the interaction with the host plant. In the case of E. carotovora, and the closely related *E. chrysanthemi*, I will report on the current status of full genome sequencing projects for these organisms, and the development of post-genomics resources for transcriptional and proteomic profiling and a transposon mutation grid to rapidly isolate mutants in any given gene.

1200–1220
S03–O–33

CHARACTERISTICS OF RESISTANCE TO COLUMBIA ROOT-KNOT NEMATODE INTROGRESSED FROM SEVERAL MEXICAN AND NORTH AMERICAN WILD POTATO SPECIES

Charles R. Brown*[1], Hassan Mojtahedi[2], G.S. Santo[2]

[1]USDA/ARS, 24106 N. Bunn Rd., Prosser, WA, 99350; [2]WSU-IAREC, 24106 N. Bunn Rd., Prosser, WA, 99350

Columbia root-knot nematode is a serious pest of potato in the Pacific Northwest and in the Netherlands. At present, control is achieved by chemical fumigation, a costly practice. Resistance has been found in several wild species endemic to Mexico and the United States. This type of resistance is expressed as lower root infestation rates and a barrier to the successful establishment of a feeding site, giant cell, and reproduction. In resistant roots, the juveniles remain in a vermiform stage. It appears that localized cell death accompanies the resistance reaction, suggesting the functioning of an R-gene. The inheritance and chromosomal location was identified for two sources of resistance, *Solanum bulbocastanum*, a diploid, and *S. hougasii*, a hexaploid, as the upper arm of chromosome 11, suggesting synteny and possible presence of the primitive B genome, previously hypothesized for *S. bulbocastanum*, in the two species. Recent surveys have confirmed that two out of twelve plant introduction accessions of *S. fendleri* tested were 100% resistant to race 1 of Columbia root-knot nematode. Resistance derived from *Solanum bulbocastanum* was introduced into cultivated potato by protoplast fusion, and a traditional backcrossing program has produced advanced breeding clones with root-knot resistance, good horticultural type, acceptable fry color and long tuber shape.

1220–1240
S03–O–34

DEVELOPMENT OF MOLECULAR MARKERS LINKED TO THE VERTICILLIUM WILT RESISTANCE GENE HOMOLOGUE IN POTATO (*SOLANUM TUBEROSUM* L.)

Ivan Simko*[1], Stefano Costanzo[2], Kathleen G. Haynes[1], Barbara J. Christ[2], Richard W. Jones[1]

[1]USDA-ARS, Vegetable Laboratory, 10300 Baltimore Avenue, Beltsville, MD 20705, USA; [2]Department of Plant Pathology, Penn State University, University Park, PA, USA, 16802

Verticillium wilt is a vascular disease caused by the soil-borne fungi *Verticillium dahliae* and *Verticillium albo-atrum*. Most of the commercial potato cultivars grown in the USA are susceptible to *Verticillium*, resulting in significant crop losses. Development of new cultivars with resistance gene(s) against the pathogen can be assisted with molecular marker technology that allows identification and tracking of resistance genes. In tomato, resistance to race 1 of *Verticillium dahliae* is conferred by two closely linked genes (Ve1, Ve2) that were mapped to linkage group IX. We have developed primers for PCR reaction that amplifies the leucine-rich repeat (LRR) domain from tomato Ve1 gene. The primer set was applied on selected resistant and susceptible potato genotypes. The Ve1 gene homologue has been detected in resistant cultivar Reddale when using genomic DNA as a template. Deduced amino acid sequence of the homologue shows high similarity to Ve1 (93%) and Ve2 (91%) tomato resistance genes. The Ve1 potato homologue appears to be a functional gene based on sequence analysis of the genomic clone and presence in a potato cDNA library. Sequence comparison revealed differences between the homologous fragment from resistant and susceptible potato genotypes. PCR derived markers were developed based on detected differences and used for screening a collection of potato genotypes.

1340–1440
S03–P–35

MODELING LEADING EDGE OF POTATO LATE BLIGHT FIELD INFECTION

Kathleen M. Baker*[1], William W. Kirk[2], Jeffrey M. Stein[2], Jeffrey A. Andresen[1]

[1]Dept. of Geography, Michigan State Univ., East Lansing, MI, USA; [2]Dept. of Plant Pathology, Michigan State Univ., East Lansing, MI, USA

Because potato late blight (*Phytophthora infestans*) spreads rapidly, limited options are available to growers once the crop canopy has become in-

fected. Analysis of spatial and temporal dynamics of late blight has not focussed specifically on improving post-infection recommendations. To better inform management decisions, this paper identifies desiccation zone parameters by exploring spatial consistency of localized late blight infection spread in experimental plots both between replicates and between years. The analysis focuses on both the outer extent of spread, the farthest lesion from inoculation, and the leading edge of the field lesion, where late blight infection is continuous. Percent foliar infection was monitored from the time plots were inoculated until complete defoliation of the canopy, in 1997-99 and 2001. From the time lesions could be visually detected in the plot, until they reached the outer edges of the plot, assessments were daily. Assessments then followed a 3-5 day schedule until complete defoliation. A model, defined by using half of the research plot quadrants (randomly selected with inoculation point as their corner point), was created to estimate the distance of farthest single lesion from the inoculation point. Assessment of accuracy incorporates the other quadrants. Physical-based logical rules are derived from foliar infection, weather, and canopy characteristics to further predict to create a usable spatial model of potato late blight spread through time. Results indicate that field desiccation zones should include all plants within 20 m of visible infection.

1340–1440

S03–P–36

ANALYSIS OF 300KB OF GENOMIC SEQUENCE ASSOCIATED WITH LATE BLIGHT RESISTANCE OF POTATO

James M. Bradeen*, S. Kristine Naess, Junqi Song, Susan M. Wielgus, Geraldine T. Haberlach

1630 Linden Drive, Dept. of Plant Pathology, Univ. of Wisconsin, Madison, WI, USA, 53706

As part of our efforts to map-based clone late blight resistance genes from the wild potato species *Solanum bulbocastanum*, we have generated approximately 300kb of genomic sequence in collaboration with The Institute for Genomic Research (TIGR). We have completed detailed sequence analyses, including microsyntenic comparison of *S. bulbocastanum* and *Arabidopsis*, comparison of approximately 31 kb of sequence information originating from each of two distinct *S. bulbocastanum* homologs, and gene prediction analyses. The late blight resistant phenotype maps genetically to approximately 55 kb within the sequenced 300 kb genomic region. At least five gene-like areas within the 55 kb resistance region show high (~90%) sequence similarity to resistance-like areas of the tomato genome. These resistance gene candidates have apparent nucleotide binding capabilities and a characteristic leucine rich repeat (LRR) region. Gene isolation and transformation analyses will be discussed. This project is funded in part by NSF Plant Genome Project #DBI-9975866.

1340–1440

S03–P–37

EFFICACY OF PYRAMIDING TWO TOXINS (*LEPTINE GLYCOALKALOIDS*, *BACILLUS THURINGIENSIS*) TO DELAY RESISTANCE IN COLORADO POTATO BEETLE, *LEPTINOTARSA DECEMLINEATA* SAY (COLEOPTERA: CHRYSOMELIDAE)

Susannah G. Cooper*[1], David Douches[1], Edward Grafius[2]

[1]Michigan State Univ., Dept. of Crop and Soil Sciences, A499B Plant and Soil Sciences Bldg, East Lansing, MI 48824; [2]Michigan State Univ., Dept. of Entomology, 243 Natural I Science Bldg, East Lansing, MI

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), is the most destructive insect pest of potato, *Solanum tuberosum* (L.) in eastern North America. The insect has readily adapted to every insecticide it has encountered. Host plant resistance offers an additional control tactic in an overall integrated pest management strategy, to decrease reliance on insecticides alone. Combining multiple host plant resistance factors into a single cultivar has been suggested as a means to extend the effective life of each individual resistance factor. The objective of this study was to evaluate if the pyramiding of host plant resistance factors provides a better, more durable control. Three different potato lines with natural (leptine glycoalkaloids), engineered (*Bacillus thuringiensis*-cry3A), and combined host plant resistance factors were evaluated in a no choice detached leaf bioassay. The assays were performed separately on three Colorado potato beetle populations (susceptible, insecticide resistant, and Bt resistant beetles) at each of the four larval instar stages. Ten larvae of same population and initial instar were placed on the foliar tissue for four days; the defoliation of the leaflet and the final instar, weight and mortality of the larvae were recorded. In a no choice situation, the combined host plant resistant (Bt and leptine) line was a more effective control method to deter feeding in Colorado potato beetle larvae.

1340–1440

S03–P–38

FIELD EVALUATION OF FOLIAR RESISTANCE TO *PHYTOPHTHORA INFESTANS* IN POTATO

David Douches*[1], Kim Felcher[1], Joseph Coombs[1], Willie Kirk[2]

[1]Dept. of Crop and Soil Sciences, Michigan State Univ., East Lansing, MI 48824; [2]Dept. of Plant Pathology, Michigan State Univ., East Lansing, MI 48824

Late blight disease of potato, caused by *Phytophthora infestans*, is the most important disease worldwide. Foliar resistance is an important component in managing late blight in the field. The objective of our research was to identify germplasm that can be used in breeding cultivars with foliar resistance to *P. infestans*. From 1997 to 2001, replicated experiments were conducted at the Muck Soils Research Farm in Bath, MI. Approximately 50 days after planting an isolate mixture of the US8 genotype of *P. infestans* was applied through the sprinkler irrigation system to inoculate the foliage. Percent infection of late blight on the folaige and stems were visually estimated on 2-4 day intervals until 100% infection was recorded in susceptible lines. Relative area under the disease progress curve was calculated for each line. Over the 5-year period more than 500 lines were tested. The majority of the cultivated germplasm tested was classified as susceptible to *P. infestans*. This category includes the current cultivars grown in the U.S. The most resistant lines were A90586-11, AWN86514-2, B0718-3, Jacqueline Lee (MSG274-3), J138K6A22, NY121, R8, R9 and Tollocan. Some selections from crosses with B0718-3, Jacqueline Lee and Tollocan were resistant suggesting that the resistance is transmissible. These resistance sources provide the opportunity to breed late blight resistant cultivars from a diverse pool of cultivated germplasm.

1340–1440

S03–P–39

BALANCE OF PESTS AND NATURAL ENEMIES IN POTATO PLANTATIONS IN NILE DELTA, EGYPT

Abdel Khalek M. Hussein*, M.S. El Naggar

Plant Protection Research Institute, Nadi el Saied Str., Dokki, Cairo, Egypt

A total of 573 individuals of soil fauna were obtained by appling 75 pit-fall traps (Southwood 1978), in potato field in Menoufiya, Nile Delta, for 15 weeks .The obtained fauna (30 species and /or higher taxa) were devided into the 3 main categories: insects, natural enemies (predators) and detritivores. Absolute Importance Value (AIV), according to Ghrabbour and Shakir, 1997, was calculated for each species and for the whole category of functional group. Results showed that the biodiversity of insects was 40% higher than of the natural enemies, which only recorded 30%. The main insects were: *Pentodon bispinosus* (Scarabidae: Coleoptera), *Lepidoptera* larvae, *Tropinota squalida* (Scarapidae: Coleoptera), *Pieris rapa* (Pieridae: Lepidoptera) and Aphi sp. (Aphididae : Homoptera) with AIV of 4.36, 4.33, 4.32, 3.92 and 3.53 units respectively. The insects of lowest AIV were Phitonomus sp.(Curculionidae:Coleoptera), Lepidoptera adults, and fomicid ants (Hyminoptera) with 1.85, 2.48 and 2.83 units respectively. The main natural enemies for these insects were: spiders (Araenidae), Philanthus sp.(Sphecidae: Hyminoptera), Syrphus corolla (Syrphidae: Diptera), Carabidae (Coleoptera), and larvae of Chrysoperla carnea (Chrysopidae: Neuroptera) with AIV 5.62, 4.81, 4.50, 4.30 and 3.29 units respectively. The whole AIV for the natural enemies (Predators) recorded 32.64 units, slightly lower than that of insects, which recorded 37.46 units, resulting in a C/H ratio as 1 : 1.15. The highest population density (29.8 individuals / trap) was recorded after 6 weeks of cultivation, with a C/H ratio 1 : 1.27. The latter occurred during the vegetation growth period and before tuber formation, therefore, it was concluded that there was no need for pestcides.

1340–1440

S03–P–40

POTATO VARIETY TOLERANCE TO FLUMIOXAZIN AND SULFENTRAZONE IN THE PACIFIC NORTHWEST

Pamela J.S. Hutchinson*[1], Rick A. Boydston[2], Brent R. Beutler[1], Dennis J. Tonks[3]

[1]Aberdeen Research and Extension Center, Univ. of Idaho, Aberdeen, ID 83210; [2]USDA-ARS, Irrigated Agriculture Research and Extension Center, Prosser, WA 99350; [3]Washington State Univ., Davenport, WA 99122

Weed-free field studies were conducted in 2000 and 2001 to evaluate potato variety tolerance to two new mode-of-action, preemergence herbicides: flumioxazin and sulfentrazone. Russet Burbank, Russet Ranger, Russet Norkotah, and Shepody were tested for tolerance both years at Aberdeen, ID, and in 2001 at Paterson, WA. Alturas and Bannock Russet were included at Aberdeen in 2002. Sulfentrazone was applied at 1X or 2X the proposed rates in 2000 and 2001. Flumioxazin was applied at 1X or 2X the proposed rates in 2001. Untreated checks were included for comparison. In 2000, the 1X sulfentrazone rate resulted in significantly greater Russet Burbank and Shepody injury, and the 2X rate resulted in significantly greater Russet Burbank, Shepody, and Ranger Russet injury compared to the untreated controls. All herbicide treatments resulted in significantly greater height reduction of Russet Burbank and Russet Norkotah compared to their respective untreated controls. In 2001, at Aberdeen, there was no variety by herbicide treatment interaction for visual injury. Averaged over varieties, herbicide treatment was significantly different. Flumioxazin 1X and 2X resulted in 7and 12% visual injury, and sulfentrazone 1X and 2X resulted in 14 and 17% visual injury, respectively. There was a significant variety by herbicide treatment interaction for height reduction. Russet Burbank and Bannock Russet were most affected by the 2X rates of either herbicide. In 2001, the 1X flumioxazin rate caused only slight visual injury to all four varieties at Paterson. The 2X flumioxazin rate was not included. The 2X sulfentrazone rate resulted in >10% injury of Russet Burbank, Ranger Russet, and Shepody. Regardless of year or location, initial visual injury and plant height reduction did not translate to significant tuber yield loss, and there was no significant variety by herbicide treatment interaction for tuber yields.

1340–1440

S03–P–41

VARIABILITY FOR DISEASE RESISTANCE IN POPULATIONS OF POTATO HAPLOIDS

Shelley H. Jansky*[1], Douglas I. Rouse[2]

[1]Dept. of Biology, UW-Stevens Point, Stevens Point, WI, 54481; [2]Dept. of Plant Pathology, UW-Madison, Madison, WI, 53706

Genetic variability hidden in tetraploid potato (*Solanum tuberosum*) clones may be revealed in populations of haploid plants (2n=2x=24). Because haploids are parthenogenetically derived, a population of haploids from a tetraploid clone represents a pool of gametes. These plants may express traits that were not exhibited by their tetraploid parents, providing a valuable source of genetic variation for potato breeders. This study was carried out to determine whether haploid clones could be identified with higher levels of disease resistance than their tetraploid parents. Populations of haploid clones derived from the cultivars Atlantic, Chippewa, and Merrimack were evaluated for disease resistance at the Hancock (Wisconsin) Agricultural Experiment Station in 2001. They were grown in a field containing high levels of the soil-borne pathogens that cause potato early dying disease (*Verticillium dahliae*) and common scab (*Streptomyces scabies*). During the summer, plants were scored for vine vigor, vine maturity, and symptoms of potato early dying disease. At harvest, tubers were scored for incidence of scab lesions. Significant differences among families were detected for all traits. Atlantic and Chippewa haploids were more vigorous, later to mature, and exhibited a lower incidence of disease than Merrimack haploids. Levels of symptom expression in some haploid clones were significantly lower than those of their cultivar parents. Haploids are commonly used to access the germplasm of wild diploid *Solanum* species. Therefore, disease resistant haploid clones would be valuable for use in breeding programs that utilize wild species germplasm. They may provide resistance genes that complement those introduced by the species.

1340–1440

S03–P–42

RESISTANCE TO PLRV AND PVY IN PROGENY OF *S. TUBEROSUM* FUSIONS

Jerad Liedberg*[1], James Lorenzen[2]

[1]Dept. of Plant Sciences, North Dakota State Univ., Fargo, ND 58105; [2]Plant, Soil, and Entomological Science Dept., Univ. of Idaho, Moscow, ID 83844

Aphid-vectored diseases such as potato Y virus (PVY) and potato leafroll virus (PLRV) are significant problems for potato production. New sources of resistance are needed to develop virus-resistant culivars. Several potato clones were developed through somatic fusion of Solanum tuberosum, a wild potato species known to have resistance to PVY and PLRV. We screened several third-backcross populations from these clones to investigate the usefulness of this breeding material with regard to virus resistance. A field experiment that relied upon natural vector populations was more successful than a controlled cage experiment utilizing viruliferous aphids. However, in years with low aphid flights, controlled artificial experiments would be more useful. The double antibody sandwich (DAS) ELISA protocol was used to detect PVY and PLRV in sap from late season plants and from daughter plants after breaking dormancy. Incidence of positive plants was much higher in daughter plants. One of the putative resistant parents and its progeny populations were susceptible in year 1, so these populations were dropped and new populations from resistant parents were selected. More detailed results and conclusions from this two-year study will be presented.

1340–1440

S03–P–43

FORECASTING POTATO LATE BLIGHT UNDER SEMIARID SPRINKLER-IRRIGATED CONDITIONS

J.S. Miller*[1], T.D. Miller[2], N.L. Olsen[1], B. Miller[1], P. Nolte[3], D.A. Johnson

[1]Univ. of Idaho, Dept. of Plant, Soil, and Entomological Sciences, Aberdeen, ID 83320; [2]Miller Research, Inc., 1175 E 800 N, Rupert, ID 83350; [3]Washington State Univ., Dept. of Plant Pathology, Pullman, WA 99164

Late blight forecasting models have the potential to reduce the number of fungicide sprays when weather conditions are unfavorable for pathogen infection or development. Weather conditions are often unfavorable for late blight in the semiarid potato production area of southern Idaho. The purpose of this study was to evaluate the efficacy of various late blight forecasting models in southern Idaho from 1998 to 2001. Each year at least eight weather stations were placed in commercial potato fields throughout southern Idaho after plant emergence. Weather data were downloaded twice weekly and forecasts were calculated from the data. Late blight was reported in late July of 1998 and was widespread in central and eastern Idaho. Blitecast and the Ullrich-Schrödter negative prognosis model did not consistently predict the initial occurrence of late blight. However, a modification of the Wallin portion of Blitecast that uses periods of leaf wetness instead of 90% relative humidity resulted in a more predictive forecast. In 1999, late blight was reported in 11 fields in eastern Idaho in mid-August, but none of the models accurately predicted late blight by that time. Late blight was not reported in 2000 but models still predicted the occurrence of disease. Three fields were identified with late blight in 2001 at the end of August. The leaf wetness modification of the Wallin model provided a four week warning. However, none of the other models predicted disease that year. In all seasons, starting the forecast day-step at 3:00 pm in place of midnight or 12:00 pm resulted in the fewest disruptions of favorable periods. Weather conditions in an irrigated potato canopy appear to trigger model alarms despite differences in macro-scale weather conditions from year to year. The poor performance of Blitecast and the Ullrich-Schrödter negative prognosis model indicate these forecasts cannot be reliably used in Idaho growing conditions.

1340–1440

S03–P–44

EVALUATING THE FACTORS THAT INFLUENCE THE SPREAD OF NET NECROSIS (PLRV INDUCED) WITHIN FIELDS AND WITHIN TUBERS OF RUSSET BURBANK IN PEI

Stephen Moorehad*[1], Yves LeClerc[2]

[1]McCain Foods (Canada), PO Box 100, Borden-Carleton, PE, C0B 1X0; [2]McCain Foods (Canada), 107 Main St, Florenceville, NB, E7L 1B2

Net Necrosis (NN) is a disease symptom expressed in potatoes that have been infected with the Potato Leafroll Virus (PLRV). 15 Russet Burbank fields were intensively monitored across PEI and benchmark data was established in each, to determine the key factors that influence the spread of NN. A statistical analysis was conducted using the Pearson Correlation Coefficient method. There was a relatively close correlation between the spread of PLRV and net necrosis present in the tubers (0.79). The production factor with the highest correlation with both NN and PLRV spread was petiole nitrate levels at 80-99 days after planting, the correlation value was 0.66. Although this information does not prove that a plant with a higher petiole nitrate level has an increased susceptibility to PLRV infection, it does indicate a significant trend and association between the two variables. Past studies indicate that NN symptoms in Russet Burbank pota-

toes are caused by the current season infection of healthy potato vines with PLRV from aphid transmission (Gilbert, A. 1928). Conflicting results from researchers stimulated us to investigate this phenomena in PEI field conditions. 10 previously infected PLRV plants were identified in 15 commercial fields. Tubers from each plant were harvested and graded for NN. NN was found in 7 out of 15 fields at various degrees of severity. It was concluded that NN symptoms can be induced in plants with previous PLRV infection. An experiment was set up to determine if net necrosis symptoms spread during storage and how rapid and severe this spreading occurs. For this experiment, 320 feet of potato row was harvested from each of the 15 fields. Samples from each field were split into 3 sub-samples for Nov., Jan. and Mar. evaluation dates. On an average of 15 fields, the percentage of NN was 2.22% in Nov., 9.48% in Jan. and 9.75% in Mar. NN did increase during storage from Nov. until Jan., but did not increase from Jan.until Mar.

1340–1440

S03–P–45

SCREENING BEAN CULTIVARS AS AN OPTION FOR NEMATODE MANAGEMENT IN POTATO FIELDS

Sundararaj Palanisamy*, Saad L. Hafez

29603 U of I Lane, Parma, Parma, Idaho, USA, 83660

Two experiments were conducted under green house conditions to screen the tolerance level of 30 cultivars of bean against the Columbia root-knot nematode (*Meloidogyne chitwoodi*) and Northern root-knot nematode (*Meloidogyne hapla*) for consideration as a rotational crop in the potato cropping system. Experimental design was a complete randomized block design with 30 cultivars of seven replications each. Single seed of each cultivar was planted in a cone filled with 150 cc of sterilized soil and one week after, inoculated with 3000 J2 of either *M. chitwoodi* or *M. hapla* obtained from culture maintained on tomato plants. Seven weeks after planting, plants were uprooted and nematodes populations in the root, dry weight of root and nematodes per g dry weight were recorded. In two cultivars 'Apore' and 'Carioca' *M. chitwoodi* was not detected in the root. Lowest level of total *M. hapla* population and per g of root was observed in the cultivar Kodiak.

1340–1440

S03–P–46

THIDIAZURON, A CYTOKININ, ENHANCES FUNGICIDAL ACTIVITY AGAINST EARLY BLIGHT IN POTATO

Alexander D. Pavlista*

Univ. of Nebraska, Panhandle Research & Extension Ctr., 4502 Avenue I, Scottsbluff, Nebraska, USA, 69361

Early blight is an important disease of potato and is associated with plant senescence. Thidiazuron (TDZ), a plant growth regulator, exhibits cytokinin-like activity including anti-senescence. Would TDZ added to common protectant fungicides delay the onset and progress of early blight? Chlorothalonil zinc (CHZ) at 1.23 kg/ha and mancozeb (MNZ) at 1.68 kg/ha, both with and without TDZ at 0.56 kg/ha, and TDZ alone were applied to potato cv. Atlantic four times at 6-day intervals when physiological days passed 400. Plots were evaluated every two to three days after treatment by percentage of plot exhibiting foliar necrosis. Disease progress curves for each treatment and the untreated check were compared to evaluate the time for plots to reach 25, 50 and 75% necrosis. In 2000, MNZ and CHZ resulted in 7 and 8-day delays in necrosis compared to checks; the addition of TDZ resulted in an 11-day delay. In 2001, MNZ and CHZ resulted in 4 and 8-day delays; adding TDZ, the delays in disease development were increased to 10 and 12 days, respectively. TDZ alone delayed early blight by 3 days and, when added to the fungicides, gave an additional 3-6 days protection against early blight. TDZ prolonged plant tolerance to the spread of early blight suggesting that maintaining healthy plants and delaying aging lessens susceptibility.

1340–1440

S03–P–47

POTATO VERTICILLIUM WILT AS CAUSED BY FOUR VERTICILLIUM SPECIES

H.W. (Bud) Platt*

Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, 440 Univ. Avenue, Charlottetown, PEI, Canada, C1A 4N6

In most cases, verticillium wilt of potatoes is caused by *Verticillium albo-atrum* or *V. dahliae*, but *V. tricorpus* has also been shown to be involved with this disease. Furthermore, a putative species (*Verticillium albo-atrum/2*), with morphological characteristics similar to *V. albo-atrum*, has been isolated from plants with verticillium wilt symptoms. The relative roles that these pathogens play in regards to disease occurrence and impact are not well known which affects disease management effectiveness. Healthy seed tubers of a number of potato cultivars grown commercially in North America were planted in a randomized block design in field studies. After plant emergence and just prior to the establishment of the final 'hill', inoculum suspensions of these pathogens were applied to the root zones of the plants. This timing coincided with a common disease initiation period that occurs in the field when roots are injured during cultivation operations and are more susceptible to attack by soil-borne pathogens. For the remainder of the growing season, plant disease occurrence and severity were monitored weekly. The greatest amount of plant wilt and premature senescence was caused by *Verticillium albo-atrum*. Similarly, plants inoculated with *V. dahliae* had more disease that those inoculated with *V. tricorpus*. However, in most cases, the putative species, *V. albo-atrum/2*, caused disease responses that were more similar to those found with *V. tricorpus*. Further studies are underway to determine the potential interactions that these soil-borne pathogens have and the role of these interactions in the occurrence and severity of *verticillium* wilt.

1340–1440

S03–P–48

INFLUENCE OF SOIL MOISTURE THRESHOLDS ON SEVERITY OF COMMON SCAB OF POTATO (*STREPTOMYCES SCABIES*)

Elise Poole*[1], D.S. Douches[2], R. Hammerschmidt[1], W.W. Kirk[1]

[1]Dept. of Plant Pathology, Michigan State Univ., East Lansing, MI 48824; [2]Dept. of Crop and Soil Science, Michigan State Univ., East Lansing, MI 48824

Potato scab, caused by *Streptomyces scabies*, is the most economically important disease caused by *Streptomyces* and is the fourth most problematical disease of potatoes. Potato tubers are most susceptible to infection by this bacterial pathogen during the early stages of tuber development. *S. scabies* invades directly through tuber stomata and immature lenticels. Tubers with well-developed skin are no longer susceptible to infection. The most important management strategies in controlling potato scab are the use of highly resistant cultivars in addition to maintaining adequate soil moisture. Irrigation applied early in the growing season has been shown to reduce common scab on susceptible cultivars. Irrigation may inhibit invasion by the pathogen by altering the environment of the soil and the tuber surface. The objective of this study is to investigate the interaction between cultivar resistance and soil moisture on scab incidence and severity of tubers. Greenhouse experiments using soil boxes filled with sand and compartmentalized into individual sections will be used to evaluate the effects of four moisture regimes and three varieties differing in susceptibility. Tubers will be sampled after maturation and assessed for incidence and severity of common scab. Soil populations of *S. scabies* will be determined during each experiment to evaluate the minimal inoculum requirements for potato scab infection by quantitative PCR.

1340–1440

S03–P–49

PURPLE TOP: A SERIOUS THREAT ON THE POTATO PRODUCTION IN MEXICO

Antonio Rivera-Peña*[1], Mateo Cadena-Hinojosa[2], Humberto Almeyda-León[3]

[1]Campo Experimental Valle de Toluca, CIRCE-INIFAP, Conjunto SEDAGRO s/n, Metepec, Edo. de México, C.P. 52140, Mexico; [2]Campo Experimental Valle de México, CIRCE-INIFAP, Texcoco, Edo. de México; [3]Campo Experimental, General Terán, CIRNE-INIFAP, Facultad de Ciencias Biológicas, UANL, San Nicolás de los Garza, N.L.

Potato in Mexico is cultivated in temperate and sub-tropical zones and it faces numerous diseases which limits its production. Purple top (PT) of potato is a disease caused by a Phytoplasm. Similar diseases are also present in other crops, such as aster yellow, stolbur, etc. and are associated with the disease in several hundred plant species. PT has during the last ten years become a serious threat to the potato production in Mexico. Reports indicate that in some areas up to 60% of tubers are damaged in the field. PT was reported in the sixties but through the times it has increased its severity and is present in most potato areas. Studies have been made to identify the strains and apparently at least two are

present in Mexico. Breeding potatoes against diseases is an strategy of control, under these circumstances a project started up in 2001. The main objectives are to develop technologies to control the disease. Backcrossing and Recurrent Selection methodologies for developing genotypes with genes for resistance and/or tolerance in our populations of the genebank are being used for screening and searching. Description of the disease and technical approaches are discussed.

1340–1440

S03–P–50

SOIL APPLICATION OF LIME DECREASES FOLIAR AND TUBER LATE BLIGHT INFECTION IN POTATOES GROWN IN TOLUCA, MEXICO.

Oswaldo Rubio-Covarrubias*, Humberto Lopez-Delgado, Mateo Cadena-Hinojosa

Programa De Papa. INIFAP, Conjunto Sedagro S/N, Metepec, Edo. De Mexico, C.P. 52140, MEXICO

Two field experiments were carried out in the Toluca Valley, Mexico, in 1997 and 1999. The objective was to asses the influence of soil amendments of lime (0, 200, 400, 600 kg/ha) on foliar and tuber late blight infection in potato, Alpha variety. Our results indicate that 200-400 kg lime/ha applied on the row, close to the seed, decreased Late Blight foliar infection in both experiments for the two years. Lime application also decreased tuber infection of Late Blight in one of the two years. In the 1999 experiment, lime and dolomite were compared, and dolomite demonstrated greater effectiveness in decreasing late blight foliar infection. Soil pH in the Toluca Valley is acid, and we suspect that lime amendments increased soil pH and also supplied calcium which is a key nutrient used directly or as a signal in defense mechanisms of the plant against invasion of pathogens.

1340–1440

S03–P–51

TOLERANCE OF EIGHT POTATO VARIETIES TO *S-METOLACHLOR*, PENDIMETHALIN AND RIMSULFURON

Thomas A. Salaiz*[1], Stephen L. Love[1], Pamela J.S. Hutchinson[1], Asunta Thompson[2]

[1]Univ. of Idaho, Aberdeen R&E Center, PO Box 870, Aberdeen, ID 83210 USA; [2]Plant Sciences Dept., Loftsgard Hall, North Dakota State Univ., Fargo, ND 58105-5051 USA

Potato varieties can vary in susceptibility to herbicides. A two year study was conducted to evaluate herbicidal phytotoxicity on eight potato clones including Alturas, A84118-3, Bannock Russet, Frontier Russet, Gem Russet, IdaRose, Russet Burbank and Umatilla Russet. All clones were treated with pre- or postemergence applications of 1X and 2X labeled rates of s-metolachlor, pendimethalin and rimsulfuron. Plant height at time of postemergence applications was 10.2–17.8 cm. Plant injury and chlorosis were evaluated twice during the season. After harvest total and US No. 1 yield as well as specific gravity were evaluated. Preemergence applications of s-metolachlor and pendimethalin caused foliar injury symptoms. These symptoms varied by clone resulting in a statistically significant herbicide treatment by clone interaction. No foliar injury symptoms were observed for either rimsulfuron pre-emergence treatments. Postemergence applications of all three herbicides caused foliar injury symptoms that varied by clone resulting in statistically significant herbicide treatment by clone interactions. No herbicide treatment by clone interactions were observed for either total yield or US No. 1 yield for any of the herbicides. Specific gravity was unaffected by any of the herbicide treatments. Total yield for the 2X postemergence s-metolachlor treatment was lower than the untreated control. US No. 1 yield was not affected by s-metolachlor applications. Preemergence treatments of pendimethalin resulted in higher total and US No. 1 yield than the untreated control. The postemergence pendimethalin treatments resulted in lower total and US. No. 1 yield than the untreated control. Total and US. No. 1 yield were unaffected by any of the rimsulfuron treatments.

1340–1440

S03–P–52

A 12-YEAR REVIEW ON ELISA MONITORING OF MAJOR POTATO VIRUSES IN DORMANT SEED-TUBERS IN BRAZIL

José Alberto Caram de Souza-Dias*, Juarez Antonio Betti

Instituto Agronômico de Campinas, Centro de Fitossanidade–Virologia, Cx. Postal 28, Campinas, São Paulo, Brazil, 13020-902

The potato industry in Brazil produces 2,000,000 ton/yr on 170.000 ha in 3 main seasons. Local seed-potato production (230,000 ton/yr) is partially dependent on imported seed (6-8,000 ton/yr). The principle challenge of local seed multiplication is the rapid virus accumulation in seed lots through each generation, whether disease free seed stocks are imported or started from tissue culture locally. Pressure of aphids (many species) and viruses (mainly PVY and PLRV) are high throughout the year. The value of disease free seed for seed production (US$ 1/kg) leads seed producers to voluntarily seek Agronomic Institute of Campinas (IAC) ELISA services before deciding the use of their production: seed or consumption (>75%). This service started in 1989 with kits of polyclonal IgG and conjugates being purchased from major international suppliers or locally from EMBRAPA-CNPH, Brasilia-DF. Nearly 70,000 tests/yr have been performed for PLRV and PVY with fewer tests for PVX, PVS and PVA. Records shows PVY (races O and N) surpass historical PLRV incidence since the mid 1990's. PVX and PVA have been absent. PVS was present in over 80% of a last year imported 'Atlantic' seed lot; thus, tubers produced were used exclusively for processing. Over the past 12 years, the lab has been receiving increasing numbers of samples. Besides developing the capability for tuber-eye testing the lab has developed alternative low cost devices for quick and accurate sap extraction and microplate washings systems. These methods have been adopted by other potato virology labs in Brazil and might be useful as alternative low cost ELISA methods for other developing countries.

1340–1440

S03–P–53

THE EFFICACY OF FULFILL (PYMETROZINE) IN CONTROLLING *MYZUS PERSICAE* (SULZER) ON SHEPODY AND RUSSET BURBANK POTATOES IN PRINCE EDWARD ISLAND

S.E. Stewart*[1], R. Coffin[2]

[1]Biology Dept., Univ. of Prince Edward Island, 550 Univ. Avenue, Charlottetown, PEI, Canada, C1A 4P3; [2]Cavendish Farms, PO Box 3500, Summerside PEI, Canada, C1N 5J5

The development of target specific pesticides is imperative for the successful implementation of Integrated Pest Management (IPM). Fulfill (pymetrozine) is a highly selective aphicide which has minimal effects on beneficial organisms. This new aphicide inhibits the capacity of aphids to feed, which ultimately leads to their starvation. Fulfill is currently not registered in Canada. Field and laboratory experiments were carried out to determine the efficacy of Fulfill in controlling *Myzus persicae* (green peach aphids) under Prince Edward Island (PEI) conditions. Green peach aphids reared in the lab were placed in vented aphid bags and attached to potato leaves in the field. Fulfill's efficacy in the field was compared to that of the contact aphicides Monitor® and Pirimor®. Fulfill's effect on the feeding behaviour of aphids was also examined and recorded on video. Laboratory experiments consistently yielded 100% mortality in *Myzus persicae* exposed to Fulfill via feeding on potato leaves sprayed in the field at 2.75 ounces per acre. Monitor® and Pirimor® showed excellent control of *Myzus persicae* in the field. Fulfill exhibited erratic control of *Myzus persicae* under field conditions. Field conditions which may limit Fulfill's efficacy will be explored, as well as the possible effect of aphid bags in Fulfill's efficacy in this experiment. Within the first hour of exposure to Fulfill via feeding, aphids consistently exhibited signs of irritation which included twitching and tremors. Aphids ceased feeding immediately after their first exposure to Fulfill and observations did not reveal the resumption of feeding in most cases. This new aphicide shows promise in becoming an effective tool for Integrated Pest Management within the PEI potato industry.

1340–1440

S03–P–54

SELECTION OF ANTAGONIST MICROORGANISMS AGAINST *HELMINTHOSPORIUM SOLANI*, THE CAUSAL AGENT OF POTATO SILVER SCURF

Mélanie Michaud, Carole Martinez, Richard R. Bélanger, Russell J. Tweddell*

Horticultural Research Center, Pavillon de l'Envirotron, Université Laval, Québec, Québec, Canada, G1K 7P4

Silver scurf, caused by the fungus *Helminthosporium solani*, is an important disease affecting potato tubers worldwide. Control of the disease has been hampered by the development of *H. solani* strains resistant to thiabendazole, the only fungicide used in post-harvest treatment. As a result, alternative control strate-

gies are needed. In this study, 100 selected soils from the province of Québec were tested for their effect on silver scurf development on potato tubers. The results showed that 10 soils were able to decrease silver scurf development on tubers incubated at either 10 °C, 15 °C or 24 °C. Many microorganisms were isolated from these soils and tested for their ability to reduce H. solani development using a whole tuber assay. Several of them, including *Arcanobacterium haemolyticum, Arthrobacter oxydans, Aquaspirillum autotrophicum, Bacillus mycoides, Kocuria rosea, Alcaligenes piechaudii, Streptomyces griseus* and a fungus of the class Zygomycetes, displayed an ability to reduce the development of silver scurf on potato tubers at either 10 °C, 15 °C or 24 °C. These findings can find useful applications towards a biocontrol program of potato silver scurf as post-harvest or seed tuber treatment.

1340–1440

S03–P–55

TRANSMISSION AND CHARACTERIZATION OF PHYTOPLASMA DISEASES ASSOCIATED WITH CULTIVARS IN ALBERTA

A.-H. Khadhair*[1], P. Duplessis-McAllister[2], K. Ampong-Nyarko[2], P. Bains[2]

[1]Alberta Research Council, Bag 4000, Vegreville, AB T9C 1T4, Canada; [2]Alberta Agriculture, CDC North, Edmonton, AB T5B 4K3, Canada

A population study was conducted on leafhopper insects associated with the transmission of phytoplsma diseases. The survey was conducted on a total of 10 potato fields throughout Alberta, focusing on the Edmonton area and the Brooks/Taber area. Our initial data indicates a variation in leafhopper population directly proportional to environmental conditions and plant development. A total of 63 potato plants, representing 10 different cultivars, and showing typical phytoplasma symptoms, were collected after full germination during rouging practices. A representative sample of each cultivar was tested using molecular assays to detect and identify the infecting phytoplasma. In 82% of the samples tested, potato witches'-broom (PWB) and purple top (PT) phytoplasmas were positively identified by specific DNA testing. These two phytoplasmas were identified by DNA amplification with one universal primer pair (P1/P6) and two specific primer pairs (R16F1/R1 and 1A/1B). Based on RFLP analyses, PWB and PT phytoplasmas were found to belong to the clover proliferation and aster yellows phytoplasma groups, respectively. These two groups are commonly found associated with various field, vegetables and special crops in Alberta, Canada. Initial study on tuber transmission of phytoplasma indicated association of PWB phytoplasma in infected potato plants after germination of tubers collected from infected potato plants. Studying the impact of phytoplasma infection on quality aspects of processed potato products is underway.

1340–1440

S03–P–56

POTENTIAL FOR USE OF THE MYZUS PERSICAE DENSO VIRUS (MPDNV) FOR BIOLOGICAL CONTROL OF APHID-TRANSMITTED PLANT VIRUSES

P.E. Thomas[1], K.S. Pike[1], G.L. Reed[2]

[1]USDA-Prosser, IAREC, 24106 N Bunn Road, Prosser WA 99350; [2]Hermiston Agricultural Research and Extension Center, Hermiston OR 97838

The green peach aphid (*Myzus persicae*) (Sulzer) transmits about one in three of all plant viruses. A new denso virus of *M. persicae*, MpDNV, has characteristics that adapt it for use in biological control of the aphid. This virus is very stable and remains viable for years in dried aphids. It is transmitted to offspring in both oviparous and viviparous modes. Aphids may be infected by spraying virus suspensions on plants that harbor aphids and by feeding aphids on virus suspensions through membranes. The virus is transmitted very rapidly from aphid-to-aphid on plants. Incidence of infection approaches 100% within 16 days after single infected aphids are introduced into a virus-free colonies. Transmission on plants includes both through the plant and surface modes. A common isolate of the aphid virus reduces fecundity of aphid colonies by about 75%. Methods for isolation of more virulent isolates have been developed. Efficacy of potato leafroll virus (PLRV) transmission is reduced by infection. The periodic and precipitous population declines (crashes) that characterize the ecology of *M. persicae* have been associated with build-up in incidence of infection by the aphid virus. Populations crash as infection incidence approaches 100%, and few of the residual aphids following a crash are infected. Few apterous aphids that survive winter on plants are infected.

1340–1440

S03–P–57

INFLUENCE OF TIME OF INFECTION WITH POTATO LEAFROLL VIRUS ON YIELD AND NET NECROSIS DEVELOPMENT IN RUSSET BURBANK POTATO

P.E. Thomas

USDA-Prosser, IAREC, 24106 N Bunn Road, Prosser, WA 99350, Prosser, Washington, USA, 99350

Time of infection with potato leafroll virus (PLRV) markedly affects tuber yield, foliage growth, foliage symptoms at harvest, and the expression of net necrosis in Russet Burbank potatoes. Early season infection reduces tuber yield up to 83%. This reduction in yield diminishes with time until there is little or no yield loss when infection occurs late in the season. The initial symptoms involve vascular necrosis, are severe, and are similar whenever infection occurs throughout the season. Although infected plants remain severely stunted, symptom severity on new growth diminishes with time after infection until symptoms on plants infected early in the season come to resemble those of chronic (seed perpetuated) PLRV infection. Tuber symptoms reflect those of the foliage. Early infections produce mild net necrosis symptoms at low incidence. Later infections that occur when tubers are bulking rapidly produce severe net necrosis symptoms at high incidence. Net necrosis caused by late season infection increases dramatically during storage. The storage loss can be avoided by processing late-season infected fields immediately after harvest before net necrosis develops. Because foliage symptoms are largely restricted to tissues that are not yet mature at the time of infection, fields with late season infection may be more difficult to recognize than those with early infection.

1340–1440

S03–P–58

EVALUATION OF SYSTEMIC ACQUIRED RESISTANCE IN POTATO

Roy Navarre*, Chuck Brown, Peter Thomas

USDA-ARS, 24106 N. Bunn Rd, Prosser, WA, USA, 99350

Systemic acquired resistance (SAR) is a natural plant defense mechanism shown to be effective against a broad range of pathogens and has been best characterized in tobacco and Arabidopsis. As a step towards evaluating the potential to use SAR for disease control in potato, the effectiveness of different inducers of SAR, including salicylic acid, BTH and harpin was examined. The timing and magnitude of defense gene activation in response to these compounds was monitored in roots, stems and leaves. The ability of SAR inducers to give resistance against various potato pathogens was evaluated and correlated with the efficacy of defense gene induction.

1340–1440

S03–P–59

FIRST REPORT OF SIGNS OF RESISTANCE TO DIMETHOMORPH FOR PHYTOPHTHORA INFESTANS IN KOREA

Y.I. Hahm*, J.T. Kim, K.Y. Ryu, J.S. Kim, M. Kwon

Lab of Plant Protection, Dev. of Potato Research, NAAES, RDA, Pyongchang, Kangwon, Rep. of Korea, 232-950

A country wide survey was conducted from 1998-2001 in which isolates (453) were collected from 69 potato fields. Metalaxyl sensitivity, tested by chemically amended agar, showed that the frequency of highly susceptible isolates dramatically increased from 0% in 1998 to 83.9% in 2001. The frequency of the resistance at 50% effective concentration was fairly consistent, at 12.1% in 2000 and 12.9% in 2001. These resistant isolates were confined to Kimchon, as well as the Daekwallyong area, one of the largest potato production regions in Korea. Dimethomorph sensitivity was tested in 134 isolates. There were no resistant isolates until 1999, but the frequency of lower resistant isolates at 50% effective concentration increased from 5.0% in 2000 to 10.5% in 2001. These resistant isolates were confined to the alpine regions, in the northwestern part of South Korea, the main seed production area. Therefore, this is the first evidence for possible resistance of *P. infestans* to Dimethomorph.

1340–1440

S03–P–60

TOMATO SPOTTED WILT VIRUS IN CLONAL SEED OF POTATO

Jerad Liedberg*[1], Jim Lorenzen[2]

NDSU Plant Science, Loftsgaard Hall #166, Fargo, ND 58105; [2]Plant, Soil, and Entomological Science Dept., Univ. of Idaho, Moscow, ID 83844

Tomato Spotted Wilt Virus (TSWV), which has many hosts including potato, is an important disease worldwide in horticultural and field crops. Because of its extremely wide geographical distribution and abundance of hosts and vectors (thrips), TSWV has the potential to cause problems for producers and breeders of horticultural crops. There is little awareness of this problem for potatoes in the U.S.A. because it has not been an economically important disease in potato. After TSWV hampered progeny evaluation for resistance to other viruses (PVY, PLRV) at North Dakota State Univ., an investigative study was done to verify putative TSWV survival in clonal seed of potato. Many potato researchers assume that TSWV does not survive in clonal seed but is self-eliminating. However, experiments performed on a few individuals indicated that TSWV could indeed survive in clonal seed and develop in the next clonal generation. Leaf and tuber symptoms were documented and were very similar to TSWV symptoms in potato described in Australia. This information could be very important in a potato-breeding program that could unintentionally propagate this virus in clonal seed. More detailed results and conclusions about TSWV in potato from this investigative study will be presented.

1440–1500
S03–O–61
USEFUL LESSONS LEARNED FROM SOMATIC HYBRIDS

John P. Helgeson*, Geraldine T. Haberlach

USDA/ARS, Dept. of Plant Pathology, Univ. of Wisconsin, Madison, WI 53706, USA

Some 20 years ago we set out to make genes from wild, 1 EBN diploid *Solanum* species more available to plant breeders. These species often contain potentially useful disease resistance genes but often are extremely difficult to cross with either tetraploid or diploid potatoes. To circumvent this barrier we have used somatic hybrids–plants formed from fusion of leaf protoplasts of a wild species and a tetraploid or diploid potato. In general, as long as both the wild species and the potato parent were fertile, the somatic hybrids could be crossed to potato cultivars. Somatic hybrids of potato with *Solanum bulbcastanum, S. brevidens, S. polyadenium, S. etuberosum* and *S. commersonii* have been obtained. All could be crossed to cultivars. Depending upon the hybrid, new resistances to PLRV, PVY, Early Blight, Late Blight, Soft Rot, Verticillium wilt, and Bacterial Wilt have been found in these materials. In each case tested, the resistance of the wild species was captured in the hybrid and passed on to progeny of crosses with susceptible potatoes. Molecular analyses of introgression have been carried out. Current efforts are focused on cloning a late blight resistance gene from *S. bulbocastanum*. The deployment of these materials could result in significantly lower levels of pesticide use in potatoes.

1500–1520
S03–O–62
POPULATION SUBSTRUCTURING OF *PHYTOPHTHORA INFESTANS* ON AMERICAN POTATO CLONES IN THE TOLUCA VALLEY, MEXICO

Héctor Lozoya-Saldaña*[1], Niklaus Grünwald[2], Edith Garay-Serrano[3], Anne Sturbaum-Abud[4], Charles R. Brown[2]

[1]Departamento de Fitotecnia, Universidad Autonoma Chapingo, Chapingo México, 56230; [2]USDA/ARS, 24106 N Bunn Rd., Prosser, WA 99350, USA.; [3]PICTIPAPA, Apartado Postal 3-12, Metepec 3, México 52176.; [4]CEEM/PICTIPAPA, Apartado Postal 3-12, Metepec 3, México, México 52176

A recent study highlighted the degree of genetic variability typical for a sexually reproducing population of the late blight pathogen, *Phytophthora infestans*, in the Toluca Valley, México (Grünwald et al., 2001). This study lends support to the idea that the Valley is an ideal location for testing potato clones for genetic resistance to the pathogen. In recent years thousands of clones from different American breeding programs have been exposed to natural infection in Toluca in the absence of fungicides. More than 100 *P. infestans* isolates from resistant American potato clones were obtained between 1998 and 2000. Each isolate was obtained from a single discrete lesion. The number of samples varied depending on the incidence of the disease on one to five plants planted per clone. Mating types were identified by pairing each isolate with known A1 and A2 testers on Rye-A agar. The allozyme genotypes for peptidase (Pep) and glucose-6-phosphate isomerase (Gpi) were determined by cellulose acetate membrane electrophoresis. The A1 mating type was predominant on a 75% (3 : 1) with respect to A2, and homothallic cultures were identified in about 20% of the populations (A1, A2). The 100/100 Pep genotype predominated with just two isolates being of the 96/100 genotype. For Gpi, six genotypes were identified, the most frequent one being 122/122, followed by 86/122. The predominant multilocus genotypes were "A1, 100/100, 122/122" (mating type, Pep, Gpi), especially on the potato clones AWN86514-2 and A90586-11. However, no new P. infestans genotypes were isolated from the American clones in Toluca, nor did the level of resistance show signs of diminishing.

1520–1540
S03–O–63
MULTIPLE RESISTANCE TO DISEASES IN AN ELITE POPULATION OF LONG-DAY ADAPTED ANDIGENA POTATOES

T.R. Tarn*[1], A.M. Murphy[1], K.G. Proudfoot[2], D.H. Wilson[1], V.J. Burns[1]

[1]Potato Research Centre, Agriculture and Agric-Food Canada, P.O. Box 20280, Fredericton, NB E3B 4Z7, Canada; [2]P.O. Box 84, Goulds, NF A1S 1G3, Newfoundland

Primitive Andean cultivated potatoes of *Solanum tuberosum* group Andigena contain genes for resistance to many diseases including resistance to common scab (*Streptomyces scabies*), resistance to foliar infection by late blight (*Phytophthora infestans*), extreme resistance to PVY and resistance to wart (*Synchytrium endobioticum*). In the base population 49% of the clones were resistant to only one of these diseases. No clones were resistant to all four. A recurrent mass selection program was carried out in a long-day adapted Andigena population to produce clones with combined resistance to the four diseases for use as breeding parents. In cycle four selection for resistance to PVX was added. At the end of six selection cycles elite clones were recovered combining resistance to all five diseases. Changes in resistance frequencies through the selection cycles are described. Disease resistance and agronomic characteristics of these elite clones are reported and their value as parental breeding clones is discussed.

1540–1600
S03–O–64
EVIDENCE OF SYNERGY BETWEEN PHYTOPHTHORA INFESTANS AND P. ERYTHROSEPTICA IN POTATO TUBERS

R.D. Peters*[1], H.W. (Bud) Platt[1], A.V. Sturz[2], I.K. Macdonald[1], G. MacKenzie[1], K.A. MacIsaac

[1]Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, 440 Univ. Ave., Charlottetown, PE, Canada C1A 4N6; [2]PEI Dept. of Agriculture and Forestry, Plant Health Research & Diagnostics, P.O. Box 1600, Charlottetown, PE, Canada C1A 7N3

In Prince Edward Island, Canada, Phytophthora infestans, causal agent of late blight, and P. erythroseptica, causal agent of pink rot, have increased in importance as agents of post-harvest disease in potatoes over the past decade. In addition, both pathogens are commonly found co-infecting diseased tubers in potato storages. To further examine the relationship between these pathogens, experiments were conducted to assess disease incidence and severity on potato tubers (cvs. Norland, Shepody, and Yukon Gold) and greenhouse-grown plants (cv. Green Mountain) inoculated with spore suspensions of *P. infestans* and *P. erythroseptica*, either singly or in combination. Co-inoculation of P. erythroseptica with P. infestans resulted in significantly ($P < 0.05$) greater necrosis than inoculation with either pathogen singly, particularly in the tubers of the cultivar Norland. The incidence of tuber late blight was similar, whether inoculum of *P. infestans* was applied singly or in combination with *P. erythroseptica*. However, the incidence of pink rot in tubers was significantly ($P < 0.05$) increased in certain cultivars (particularly 'Norland') when tubers were co-inoculated with both pathogens. Our studies show that co-inoculation of *P. infestans* and *P. erythroseptica* causes a synergistic increase in tuber rot of potatoes, thereby exacerbating storage losses. We posit that the increase in severity of late blight caused by the spread of aggressive genotypes of *P. infestans* in the 1990s, contributed to the reemergence of pink rot as a major potato disease in Canada and the United States.

1600–1620
S03–O–65
THE USE OF RADIANT HEAT TO REDUCE INOCULUM LEVELS OF SILVER SCURF (*HELMINTHOSPORIUM SOLANI*) ON POTATO TUBERS (*SOLANUM TUBEROSUM*) BEFORE STORAGE.

T.P.C. Johnson*, C.F.H. Bishop, B.W. Grout, A. Perera

The Univ. of Essex, Dept. of Science & Technology, Writtle College, Lordship Road, Writtle, Essex, UK, CM1 3RR

Silver scurf (*Helminthosporium solani*) is a skin blemish disease of potato tubers affecting visual quality, water retention and processing of tubers leading to downgrading or rejection of consignments intended for quality markets. Losses to silver scurf have steadily increased over the last twenty years, yet to maintain the tuber quality required by processors, potatoes are stored at high relative humidity (RH) and at temperatures near optimum for pathogen growth. Both temperature and RH are the two most important epidemiological factors that influence silver scurf inoculum production in potato stores. For the past two decades control has come from the broad-spectrum, postharvest fungicide thiabendazole (TBZ); silver scurf resistance to TBZ is now well documented. Good store hygiene practices and continued use of TBZ will reduce disease incidence but new methods of control are required. Heat treatments are used successfully to control fungal pathogens on a number of horticultural crops and radiant heat is under investigation as a method to reduce silver scurf on potatoes. This work demonstrates that exposure to radiant heat, raising temperatures at the tuber surface and on in vitro silver scurf cultures to 50 to 60 °C has a destructive effect on the biology of the fungus, halting its growth. The effect of varying heat load has been investigated. The use of radiant heat emitted from efficient halogen bulbs, combined with a heat resistant roller table has the potential to provide a fast, clean and consumer-desirable method of controlling skin blemish diseases of potatoes.

1620–1640
S03–O–65–A
TO BE ANNOUNCED

1640–1700
S03–O–65–B
TO BE ANNOUNCED

Thursday August 15

1100–1200
S03–O–66
PRECISION MANAGEMENT OF NITROGEN AND WATER IN POTATO PRODUCTION THROUGH MONITORING AND MODELLING

Anton Haverkort*

Plant Research International, Wageningen Univ. and Research , PO Box 16, 6700 AA, Wageningen, The Netherlands

Potato production and yields in temperate climates have stabilized but the quality demands for the processing industry still increase. Beside variety, the quality is mainly influenced by the availability and timing of nitrogen and water. The efficient use of resources and reduced emission of nutrients to the environment are requirements demanded by the general public, thereby increasing demands for precision management of nitrogen and water. Such management makes use of state of the art crop-environment interactions expressed in a crop growth simulation model, real time validated with sensing techniques of the crop (nitrogen) and soil (water). Experimental data gathered in a crop growth model LINTUL-Potato have shown how much nitrogen a potato crop needs to contain at a certain time to achieve a desired yield level. A proper nitrogen decision support system contains three elements: a) how much nitrogen in total is required inside the crop to achieve the desired yield level; b) how much should be applied early and late in the season; and c) what is the appropriate application time slot. To establish the crop nitrogen content a sap kit, chlorophyll content (SPAD) and reflection at various wavelengths (Cropspan) are used. The crop growth model LINTUL-Potato calculates yields based on the temperature dependent length of the growing season, the amount of solar radiation (potential yield) and on the moisture availability (achievable yield). Timing and amount of irrigation follow from the depletion rate, which depends on the proportion of the ground covered by green foliage, and on the evapotranspiration rate of green foliage. LINTUL-Potato calculates such proportions and rates using meteorlogical data. Monitoring soil moisture may be done with , e.g., gopher, gypsum blocs or tensiometers and monitoring of soil cover by green foliage with a grid or, again, through crop reflection characteristics.

1200–1220
S03–O–67
USE OF A NONIONIC SURFACTANT TO IMPROVE NITROGEN USE EFFICIENCY OF POTATO

K.A. Kelling*, P.E. Speth, F.J. Arriaga, B. Lowery

Dept. of Soil Science, Univ. of Wisconsin-Madison, 1525 Observatory Drive, Madison, WI 53706-1299, USA

Overhead sprinkler irrigation of potatoes grown on sandy soils have sometimes resulted in nonuniform wetting of potato hills and the creation of dry zones near the shoulders of the hills. This field study was initiated to evaluate if the use of a nonionic surfactant, applied to the hill at planting, could improve nitrogen use efficiency of Russet Burbank potato. The experimental design for these two experiments was split plot, in randomized complete blocks with four replications, where surfactant (+ or–at 9.1 L/ha) was the main plot and N rate (0, 134, 202, or 269 kg N/ha) or time of N application (split two, three, or four times at 202 kg N/ha) were the splits. In addition to measuring tuber yield and grade, crop N status was monitored by petiole nitrate-N levels several times during the season as was tuber N uptake and soil water N concentrations below the root zone. Preliminary results showed a tendency for a significant interaction between surfactant use and N rate with optimum N rate about 60 kg/ha lower where the surfactant was used. Yields were similar at the respective optimum N rates (52.6 Mg/ha). Although tuber N concentrations were similar at the optimum N rates, N use efficiency as measured by apparent recovery was higher for the surfactant plots due to the lower amount of N needed to achieve a given yield. These preliminary data are encouraging in that some improvements in N use efficiency may be realized by use of a surfactant to keep a greater proportion of the hill moist and contributing to N uptake.

1220–1240
S03–O–68
EARLY AND LATE HARVEST POTATO CULTIVAR RESPONSE TO DRIP IRRIGATION

Eric P. Eldredge, Clinton C. Shock*, Lamont D. Saunders

Malheur Experiment Station, Oregon State Univ., 595 Onion Ave., Ontario, OR, USA, 97914

Potato (*Solanum tuberosum*) is grown using sprinkler and furrow irrigation for processing into frozen French fries in Idaho, Oregon, and Washington, USA. Water quality and water availability may lead some growers to consider adopting drip irrigation for potato production. 'Russet Burbank', 'Shepody', and 'Ranger Russet' are cultivars commonly contracted by processing companies, while promising new cultivars from the Tri-State Cultivar Development Program such as 'Umatilla Russet', 'Wallowa Russet', or the clone 'AO92023-3' may be more productive or better adapted to drip irrigation. In southeastern Oregon and southwestern Idaho, potato growers' contracts provide incentives for early delivery of potatoes suitable for processing. The objective of these trials was to compare the yield, grade, and processing quality of potato cultivars at early and normal harvest dates, grown using drip irrigation. Potato trials were grown in silt loam in 1999, 2000, and 2001. Soil water potential was maintained by high frequency, automated drip irrigation. Irrigation timings were based on a soil water potential of -30 kPa. Water was supplied by one drip tape per two-row bed, with injection of a dilute solution of calcium nitrate in each irrigation. The early harvest trial was harvested approximately 85 days after emergence and the late harvest trial was harvested approximately 120 days after emergence. Less water and N were used with drip irrigation than is typically used growing potatoes in this region. 'Russet Burbank' grown under drip irrigation had relatively low marketable yields in 2000 and 2001 and a high percentage of US Number two tubers. New cultivars had higher early yield of large US Number one tubers.

1340–1440

S03–P–69

INTERGENERATIONAL EFFECTS ON SEED POTATO PHYSIOLOGICAL AGING

P.H. Brown*, B. Beattie, R. Laurence

School of Agricultural Science, Univ. of Tasmania, GPO Box 252-54, Hobart, Tasmania, Australia, 7001

Seed tuber physiological age is an important determinant of potato crop establishment and early performance. The effects of crop management practices and growing climate of the previous generation(s) of seed potatoes on physiological aging have been acknowledged but have received little research attention. Growing environment and industry structure in Tasmania, Australia, dictates that seed potato crops are produced under a wide range of field conditions and crop management practices. For example, soil types range from sandy to heavy clay, mean maximum temperatures vary by over 5 degrees between different production locations, and crops may be killed off prior to lifting or left to senesce naturally. The rate of physiological ageing of seed potatoes produced under these conditions varies significantly when cold stored for similar durations, suggesting that conditions during the production of the seed tubers have a major impact on physiological seed quality. Field performance and sprouting index (sprout weight and number produced from tubers held at 20 °C in moist sand for 30 days) measurements have been made to investigate intergenerational effects on seed tuber physiological condition in Russet Burbank. Differences in sprout weight of up to 400% have been recorded in Russet Burbank tubers from crops produced in different locations, harvested one week after foliage senescence and stored for 6 months at 4 °C. Multiple sprouting occurs at the completion of dormancy in seed tubers from crops allowed to senesce naturally, while a short apical dominant phase exists in tubers from crops which have been killed off early through dessicant spray or mechanical haulm removal. Soil water status and temperature during tuber development also influence sprouting pattern and vigour. Further studies detailing physiological changes under different production conditions will be presented.

1340–1440

S03–P–70

IN VITRO TUBERIZATION OF POTATO IN RESPONSE TO ABA, LIGHT AND AGAR

M.A Bustamante*, J. Pérez

Universidad Autónoma Agraria, Antonio Narro, Buenavista, Saltillo, Coahuila, México, 25315

Microtubers of potato produced under in vitro conditions, can be used to facilitate the storage and interchange of new or important cultivars, as well as to produce minitubers in greenhouses during a normal seed production program. The in vitro tuberization of potato has been accomplished by several researchers, but the optimal conditions to obtain the best response in terms of number and quality of the microtubers remains to be determined. This work reports the effect of ABA, light and agar on formation of microtubers in the "Alpha" variety. Nodal segments of in vitro grown plantlets were established (20 nodes/"gerber" flask) on MS medium (30 mL) containing 30 g/L sucrose and 8g/L Agar, and incubated with a temperature of 25/18 °C (day/night) and a photoperiod of 16 hours, for 30 days. After this period, we added to each flask 5 mL of MS liquid medium containing 90 g/L sucrose with 0, 0.1, 0.2, 0.4, or 0.8 mg/L ABA, incubating the plantlets under a temperature of 19 °C, and a photoperiod of 8 hours, for 45 days. There were 10 flasks (replicates) per treatment. After this time, 5 flasks from each treatment were subjected to dark conditions and the other 5 flasks continued under the same 8 hour photoperiod for 30 more days. In another similar experiment, the nodal segments were established at the beginning on MS liquid medium (without Agar), using filter paper bridges. The results showed that the best microtuber formation occurred on a medium containing Agar and 0.2 mg/L ABA, and under a continuous 8 hour photoperiod, where we obtained 20 microtubers per flask and these were 4 mm in diameter and weighed 62 mg after the total incubation period of 105 days.

1340–1440

S03–P–71

EFFECT OF SOIL SALINITY AND *FUSARIUM SAMBUCINUM* INFECTION ON DEVELOPMENT OF POTATOES CV. ATLANTIC

Samantha Dzengeleski*, Andrea B. da Rocha, William W. Kirk, Ray Hammerschmidt

Michigan State Univ., Dept. of Plant Pathology, 62 Plant Biology Building, East Lansing, Michigan, 48824-1312 USA

In the United States today, potatoes are being grown in many different areas, including soils with high levels of salinity. As a consequence, higher soil salinity causes stress to the plant, which is evident by biochemical and physiological changes, such as internal tuber browning. In some instances further stress may be induced by infection with a pathogen, which could result in more complex symptoms. Irrigation of the field can aggravate the effect of soil salinity and provide an environment beneficial for infection by certain pathogens such as *Fusarium sambucinum*. Internal tuber browning is a symptom that has been observed frequently in potatoes from fields with high soil salinity content and potentially infested with *F. sambucinum.* However, no information is available regarding the interaction between soil salinity and *F. sambucinum* infection. In this study we examined the effects of varying levels of soil salinity, with and without infection of *F. sambucinum*, on potato plant development. We intended to recreate the environmental conditions responsible for tuber browning. An outdoor experiment was carried out in the field in East Lansing, MI/USA. Potatoes cv. Atlantic were planted in pots (15 gal. capacity) on June 28, 2001; half were inoculated with *F. sambucinum* prior to planting. The first salt treatment (sea water level, 75%, 50%, and 25% of sea water level) was applied to the pots seventy-six days after planting, and four additional treatments were applied, each about 7 days apart. Results indicate that high salinity and *F. sambucinum* infection caused tuber browning and an increase in proline content in the leaves. Chlorogenic acid and polyphenoloxidase content were greater in tubers infected with *F. sambucinum*. All treatments resulted in a reduction in tuber weight, and the production of many smaller tubers.

1340–1440

S03–P–72

PERFORMANCE OF RUSSET BURBANK USING GREEN- AND NON-SPROUTED SEED UNDER FALL AND SPRING TILLAGE

S.Y.C. Essah*, W.C. Honeycutt

USDA-ARS, New England Plant, Soil, and Water Lab, Orono, ME, USA, 4469

Management practices that drain soil moisture early in the spring and/or promote early plant emergence may enable potatoes to reach harvest maturity earlier and possibly increase marketable yields and tuber quality. Field studies were conducted at the USDA-ARS Presque Isle Experimental Site to evaluate performance of Russet Burbank planted in fall raised beds, fall formed ridges, and spring chisel plowed soil, using green-sprouted and non-sprouted seed. Shoots from green-sprouted seed emerged faster in all tillage systems. The effect of seed sprouting on growth and yield depended on the tillage system used. Leaf area index (LAI) was higher in green-sprouted treatments than in non-sprouted treatments until 12-13 weeks after planting (WAP). Thereafter LAI declined rapidly in green-sprouted treatments grown in ridge (RDS) and chisel plowed soil (CHS), compared to plants grown from non-sprouted seed in similar tillage systems (RDN and CHN, respectively). LAI declined more rapidly in plants from non-sprouted seed grown in raised bed (RBN) than green-sprouted seed grown in raised bed (RBS). RBS attained the highest LAI at 12 WAP. The highest total dry matter (DM) accumulation was observed in CHS in 2000 and in RBS in 2001, and these were due to higher DM accumulation in the tubers. The differences in DM accumulation between years was related to differences in soil moisture content during tuber bulking. Fresh tuber yield in raised bed was higher when planted with green-sprouted seed than non-sprouted seed. Differences in ridge and chisel plow tuber fresh weights were observed from 90 days after planting,and were higher in non-sprouted seed than green-sprouted seed. RBS produced more tubers with greater than 2 inch diameter, 3 inch length, and 10 oz weight when compared to all other treatments during 2000. In 2001, RBS produced more tubers with greater than 2 inch diameter and 10 oz weight than raised bed non-sprouted seed, but non-sprouted seed in ridge and chisel plow produced more than the green-sprouted treatments. Less sunburn was observed using green-sprouted seed in raised bed during 2000 and 2001. Maximun total and marketable yields were obtained in 2000 with green-sprouted seed planted in raised bed.

1340–1440

S03–P–73

SAND-HYDROPONIC SYSTEM TO PRODUCE NUCLEAR STOCKS OF POTATO SEED

Newton do Prado Granja*, Nilson Borlina Maia, Odair Alves Bovi, Hilario da

Silva Miranda Filho

Instituto Agronomico de Campinas–Centro de Horticultura, Av. Jorge Tibirica, 1149, Jardim Oliveiras, Campinas, Sao Paulo, Brazil, 13043-390

Brazil imports most of the Foundation potato seed from abroad. In order to reduce costs and to decrease the phytosanitary risks involved, a sand-hydroponic system was set up and tested to produce locally high quality potato seeds. The system had a total area of 200 m^2, protected by anti-aphid screen and entrance hall. The planting area was composed by 14 boxes made of brick at ground level, with 12 m^2 area each. The planting boxes (0.2 m deep) were filled with coarse sand (2-5 mm). The irrigation system had a reservoir at a higher level than the planting boxes and another reservoir (with a pump) at a lower level than the planting boxes. Irrigation and drainage were gravity driven and the nutrient solution was pumped back from the lower to the higher-level reservoir. The irrigation frequency varied from each 4th day in the summer to each 15th day in the winter, and could be controlled separately for each planting box. In vitro plantlets of Atlantic (6 cm tall) were transplanted to the planting boxes and protected from direct sunlight with a 50%-shade screen, during 2-3 days. Planting density was 200 plants/m^2, which proved to be excessive. Tuber yields were 2.5, 3.2 and 3.5 kg/m^2 at 70, 77 and 84 days after planting, respectively. Tuber numbers varied from 343 to 381 per m2. Tuber sizes were classified (weight basis) according to Brazilian standards in 5 classes: (40-50 mm in diameter) 10%; (30-40 mm) 52%; (23-30 mm) 20%; (15-23 mm) 15% and (10-15 mm) 3%, in the 84 days after planting harvest. The tuber yield and quality obtained with this system was excellent, when considering the local conditions (22º 42' S, 47º 38' W, 650 meters above sea level) without environment control.

1340–1440

S03–P–74

VITAMIN DS (SMALL S) IMPROVE CALCIUM UPTAKE IN MICROPROPAGATED POTATO PLANTLETS.

A. Habib*, D.J. Donnelly

Plant Science Dept., McGill Univ., 21,111 Lakeshore Road, Ste Anne de Bellevue, Quebec, Canada, H9X 3V9

The Vitamin D group, including D2 (ergocalciferol), D3 (cholecalciferol) and their active metabolites, has been detected in several plant species; mostly within the family *Solanaceae*. Vitamin Ds improve calcium (Ca^{2+}) uptake in animals and stimulate the calcium-binding protein calmodulin in both animals and plants. Quantification of Ca^{2+} uptake resultant from exposure to Vitamin Ds is lacking in plants. The effect of Vitamins D2 and D3 on $^{45}Ca^{2+}$ uptake was compared in micropropagated potato (*Solanum tuberosum* L. 'Russet Burbank') plantlets evaluated ex vitro in solutions containing different concentrations of Ca (5 or 15 mM). Vitamin Ds stimulated $^{45}Ca^{2+}$ uptake compared with the controls, and D3 was more effective than D2, over exposure intervals of 6 to 24 hours. It is clear from this study that Vitamin Ds significantly improve calcium uptake in potato plantlets and that D3 is more efficient in this respect than D2.

1340–1440

S03–P–75

EFFECT OF PACLOBUTRAZOL TREATMENTS ON GROWTH AND TUBER YIELDS IN GREENHOUSE-GROWN SHEPODY SEED POTATOES

B.R. Hughes*, C.N.F. Keith

Univ. of Guelph, NLARS, Box 6007, New Liskeard, Ontario, Canada, P0J 1P0

Applications of 100 to 4000 mg·L^{-1} paclobutrazol significantly reduced plant height for the duration of the crop. However, yields were significantly reduced and more aerial tubers formed on the plants sprayed with paclobutrazol. Minitubers from the crop sprayed with 500 to 4000 mg·L^{-1} paclobutrazol were planted in the field in 2000 and observed for carryover effects. There were no visual differences in vegetative growth, but the higher concentration treatments significantly reduced tuber yields. In 2001, paclobutrazol was applied at 0.01 and 0.10 mg·L^{-1} in single foliar applications 16, 23, 30 and 37 days after planting, and in dual applications at days 16 and 30, and days 23 and 37. The rate of 0.01 mg·L^{-1} had no significant effects on stem or internode length, or minituber yields regardless of when or how often it was applied. Single applications of 0.10 mg·L^{-1} paclobutrazol at either day 16 or day 37 also did not affect yield or stem length. All other applications of 0.10 mg·L^{-1} significantly reduced the stem and internode lengths, with the greatest effects seen in the dual treatments. The single application at day 23 and both dual applications significantly reduced the weight of minitubers produced. The only paclobutrazol treatment which reduced stem length without significantly reducing yields was the application of 0.10 mg·L^{-1} 30 days after planting. Aerial tuber formation was not increased by the application of either 0.01 or 0.10 mg·L^{-1} paclobutrazol.

1340–1440

S03–P–76

EVALUATION OF NITROGEN BEST MANAGEMENT PRACTICES FOR POTATO PRODUCTION IN NORTHEAST FLORIDA

Chad M. Hutchinson*[1], Rao Mylavarapu[2]

[1]Hastings REC, Univ. ofFlorida/IFAS, Hastings, FL 32145-0728 USA; [2]Soil and Water Science Dept., Univ. of Florida/IFAS, Gainesville, FL 32611 USA

Best Management Practices (BMPs) have been developed by state agencies for potato production in the tri-county agricultural area near Hastings, Florida to reduce nitrate non-point source pollution in the St. Johns River watershed. A project was developed to determine whether legumes planted as a summer cover crop and/or fall cash crop could supply nitrogen to a spring potato crop reducing the need for inorganic nitrogen fertilizer. The experiment was designed as a split plot, complete block with four replications. All crops were irrigated with subsurface seepage irrigation. Summer cover crop main plot treatments were sorghum-sudan grass (*Sorghum vulgare* x *Sorghum vulgare* var. sudanese, var. SX17) and cowpea (*Vigna unguiculata*, var. Iron Clay). Fall split plot treatments were green beans (*Phaseolus vulgarus*, var. Stallion) and fallow. Potatoes (*Solanum tuberosum*, var. Atlantic) were planted in a split plot on 28 February 2001 and fertilized at five nitrogen rates (0, 112, 168, 224, 280 kg/ha). Soil, water, and plant tissue samples were taken over the potato season and analyzed for nitrogen. Potatoes were harvested and graded into five size classes on 1 June, 2001. Total potato yield for the sorghum and cowpea cover crop plots were not significantly different at 31.8 and 31.4 MT/ha, respectively. Total potato yield for the green bean and fallow fall treatments were not significantly different at 31.8 and 29.6 MT/ha, respectively. Tuber yields in the fall cover crop–nitrogen rate interaction alludes to the potential of the system. Potato plants in the green bean-0 kg N/ha treatment produced 10 MT/ha more tubers than the fallow–0 kg N/ha treatment. This was the first year of a three-year study and a transitional period between a traditional and alternative system. However, results suggest that legumes planted in sequence with potatoes may help growers successfully implement new BMPs.

1340–1440

S03–P–77

CONSUMPTION QUALITY OF POTATO TUBERS IN FIELD CULTIVATION WITH AGROTEXTILE COVERS APPLIED

Romualda Jablonska-Ceglarek*, Wanda Wadas

Univ. of Podlasie, Dept. of Vegetable Crops, 14 B. Prusa St., Siedlce, Woj. Mazowkickie, Poland, 08-110

Agrotextile covers were applied in early crop potato cultivation to change the conditions of initial plant growth and development, and increase the yield accumulation. This covering can accelerate plant vegetation and influence quality of potato tubers. The effect of cultivation methods on consumption quality of immature tubers of very early potato cultivars was investigated. The experiment was carried out in the middle-east part of Poland on brown soil. Three methods of potato cultivation were applied–no covering; agrotextile Pegas Agro 17 from planting to full emergence; agrotextile Pegas Agro 17 from planting to a 15 cm plant height. The presprouted potato seeds were planted in the 2nd or 3rd ten days of April and harvested within 60 and 75 days from planting, respectively. Dry matter, starch, protein and vitamin C content in potato tubers were measured. Potato tubers harvested within 60 days from planting contained, on average, 15.5% of dry matter, 7.2% of starch, 1.4% of protein and 12.0 mg% of vitamin C, compared to those harvested within 75 days from planting whose contents totalled 18.2%, 8.3%, 1.5% and 14.1% mg, respectively. The physiological age of the tubers did not have any effect on the protein and vitamin C content for either harvest date. The forwarding of plants' vegetation by agrotextile covering resulted in a slight increase of the dry matter and starch content in potato tubers, when compared with cultivation with no covering. The length of time of plant covering (from planting to full emergence or from planting to the plants' height of 15 cm) did not have any effect on the dry matter and starch content in potato tubers. The dry matter, starch, protein and vitamin C content in tubers is more dependant on the genetic factors of the cultivar than on the method of potato cultivation.

1340–1440
S03–P–78
EFFECT OF SUPPLEMENTAL CALCIUM FIELD FERTILIZATION ON THE INCIDENCE OF POTATO TUBER BRUISING

Bjorn H. Karlsson, Jiwan P. Palta*, Senay Ozgen

1575 Linden Dr. Dept. Hort., Univ. of Wisconsin-Madison, Rm 431, Plant Science Bldg, Madison, WI, USA, 53706

Our previous field experiments suggested that supplemental calcium applications can reduce tuber bruising and internal defects following mechanical harvest. However, systematic study on the impact of supplemental calcium on bruising or associated traits has not been documented. For three seasons, 1999-2001, five commercially relevant cultivars (Russet Burbank, Atlantic, Snowden, Superior and Dark Red Norland), were supplied in the field with 168 kg·ha^{-1} supplemental calcium in a complete randomized design (three split applications) while control plots were given none. All plots received equal nitrogen. After harvest, tuber medullary tissue was sampled and analyzed for calcium concentration by atomic absorption analysis. Tuber calcium levels increased dramatically following supplemental calcium application. Calcium concentration increased up to 30% as compared to control. Improvement in tuber quality was equally dramatic. In the 2000 season, for example, treatment of Russet Burbank with combined calcium nitrate, calcium chloride and urea reduced bruising by 25% as compared to control. In 1999, the same calcium treatment reduced the incidence of bruise for Atlantic by 50%. In both seasons, most cultivars demonstrated a reduction in bruise with calcium treatments, as well as, dramatic but consistent differences in bruising among cultivars for a given treatment. For example, Atlantic was the most prone and Red Norland the least prone to bruising and these cultivar differences appear to be related to specific gravity. Specific gravity, tested in the 2001 season, was slightly reduced for all cultivars following supplemental calcium applications suggesting calcium to modulate tuber solids. The calcium link to bruise mitigation by regulating bruising associated traits are explored in an effort to elucidate its potential to reduce expensive defects significantly affecting the potato industry.

1340–1440
S03–P–79
INTERACTION OF CROP PROTECTANTS ON OPTIMUM POTATO NITROGEN MANAGEMENT

K.A. Kelling*[1], P.E. Speth[1], W.R. Stevenson[2], R.V. James[2]

[1]Dept. of Soil Science, Univ. of Wisconsin-Madison, 1525 Observatory Drive, Madison, WI 53706-1299, USA; [2]Dept. of Plant Pathology, Univ. of Wisconsin-Madison, 1630 Linden Drive, Madison, WI 53706, USA

The availability and use of new crop protectants, including azoxystrobin (Quadris) in combination with fumigation, have resulted in the extension of the Central Wisconsin effective growing season by 2 to 4 weeks. This study was initiated to evaluate the influence of including these crop protection practices on the optimum nitrogen rate and time of application for Russet Burbank potato. Established as two split-split plot experiments, in randomized complete blocks, fumigation (+ or –) with metam sodium was the main plot and fungicide treatment [Bravo (chlorothalonil) alone or Bravo alternated with Quadris for the first six sprays] was the first split and N rate (179, 224, 269, or 313 kg /N ha) or N timing (N split into two, three, or four applications at 179 or 269 kg N/ha) as the final split. Not fumigating severely repressed crop responses to both fungicide treatment and N rate. On average, the use of Bravo/Quadris with fumigation resulted in a 5.6 Mg/ha yield gain; however, where fumigation was not applied, the Bravo alone and Bravo/Quadris treatments yielded equally and about 14 Mg/ha lower. Optimum N rate was about 80 kg/ha lower where fumigation was not used, but there was no apparent interaction with fungicide treatment. Although fumigation, fungicide treatment and time of N application each influenced tuber yield, and to some degree quality, no interactions between these factors were statistically significant. As has been observed previously at this site, in generally non-leaching years, a yield advantage (about 2.2 Mg/ha) was seen when supplemental N applications were split between emergence and mid-tuberization, with no later applications.

1340–1440
S03–P–80
ALTERING POTATO PRODUCTION SYSTEM IN OMAN BY MODIFYING THE PLANTING STRATEGY AND SEED SUPPLY MECHANISMS

I.A. Khan*, M.L. Deadman, H.S. Al-Nabhani, K.A. Al-Habsi

Dept. of Crop Sciences, College of Agriculture, Sultan Qaboos Univ., Muscat, Sultanate of Oman

Oman has a limited growing season between September and April. The potato is grown from imported seed, which arrives early November. Planting a crop during November leaves very little possibility of growing a second crop. We have investigated planting time before and after November. At that time, the seed is barely three months old. We have shown emergence of such seed is unpredictable and erratic. Two sets of experiments were performed using seed potatoes of varied physiological age and origin. The first experiment included seed of 20 varieties from a local harvest and stored at 4 °C and 10 °C. The seeds were taken out of cold storage on 20-8-1999 and planted on two dates, i.e. September 6 and September 27. There were non-significant differences between the two planting dates but significant differences between varieties with respect to their emergence. The data showed that 9 out of 20 varieties reached 80% emergence within 3 weeks after planting, 7 varieties were above 60% and the remaining four were at 50% or higher level of emergence within three weeks of planting. These emergence rates were in clear contrast to the emergence data for the same varieties when grown from imported seed. The reason for the differerence is probably a reflection of physiological age. The second experiment used imported seed of 8 varieties with three planting dates, namely 15-11-1999, 30-11-1999, and 15-12-1999. The analysis of variances revealed the expected significant differences among three planting dates for imported seed of 8 varieties. When analyzed as individual dates, there were non-significant differences among varieties at D1 and significant differences at subsequent planting dates. Early planting of imported seed, while showing a low rate of emergence also gave a reduced number of branches per plant. There was a significant relationship between emergence and number of branches with yield. Potato varieties were also screened for planting at different times over 4 consecutive years for 11 planting dates. Our data suggest shifting potato planting from November to the first half of December without any loss of yield. That will allow 3 months before potato crop to raise an early vegetable crop, or early potato crop. These findings have a broad application for the Gulf region.

1340–1440
S03–P–81
NO ABSTRACT AVAILABLE

1340–1440
S03–P–82
AGRONOMY OF SEED TUBER PRODUCTION FOR AN INDIGENOUS POTATO VARIETY PARS-70 BRED IN PAKISTAN

I.A. Khan*[1, 2], M.M. Khan[2], I. Ahmad[2]

Dept. of Crop Sciences, Sultan Qaboos Univ., P.O. Box 34, Muscat, Sultanate of Oman, PC-123; Dept. of Horticulture, Univ. of Agriculture, Faisalabad, Pakistan

Potato is an important cash crop in Pakistan. Grown as a vegetable, it contributes more than 28% of all vegetables produced here. Three crops of potato can be grown within a year due to climatic diversity available in the country. Nearly all of the current production is based on imported seed of exotic varieties with partial seed multiplications under local conditions. An indigenous variety PARS-70 has been approved and released for cultivation in Pakistan. An agronomic package was needed for seed multiplication of PARS-70. Experiments were carried out to evaluate the effect of seed weight, spacing, and depth of sowing. Data were collected on germination, growth and yield characters as well as on the tuber characters. The conventionally produced seed was compared with the seed derived from microtubers. The yields were significantly different at different planting spaces. The interactions between the three major factors were not significant except for seed size X spacing. The total number of tubers and number of small tubers were highest at the shallow sowing, and decreased with increased sowing depth. There was non significant correlation of plant height with yield and a highly significant correlation was observed between the number of tubers and yield. The conventional seed produced more vigorous plants than the plants derived from tissue culture origin, but the differences between two categories of seed were not significant. The performance of tissue culture derived seed for growth characters improved after every cycle of multiplication. The yield performance of two sources of seed was similar during the three years of investigation. The conventional seed multiplication was always carried out during autumn when the incidence of virus vectors was very low. As a result, the conventional seed has remained virus free and vigorous. PARS-70, being best in long-term storage, is well suited for design of an indigenous seed multiplication mechanism.

1340–1440

S03–P–83

PRODUCTION OF POTATOES USING PLASTICULTURE TECHNOLOGY

William James Lamont Jr.*, Michael D. Orzolek, Bruce Dye

Dept. of Horticulture, 206 Tyson Building, The Pennsylvania State Univ., Univ. Park, Pennsylvania, United States, 16802

Potatoes were planted both in high tunnels and in the field using plasticulture technology. In the high tunnels, four varieties of potatoes Dark Red Norland, Red Pearl, Eva and Michigan Purple were grown on small, raised beds with drip irrigation. In the field three varieties of potatoes, Kueka Gold, Eva and Dark Red Norland were planted using a waterwheel planter on raised beds covered with three colors of plastic mulch -red, silver, black or no mulch. Prior to making the beds and applying the plastic mulch and drip irrigation tape, in both the high tunnels and field sites, fertilizer was broadcast based on soil test recommendations. Spacing between the mulched beds in the high tunnels was 1.1 m while in the field it was 1.8 m. Drip irrigation was used with all treatments. Typar, a floating row cover material, was applied to the potatoes in both the high tunnel and field plantings. Standard pest management practices were utilized throughout the growing season. Although there was a clearly observable increase in growth of the potato plants there was no significant effect of row cover on yield of either of the varieties in both field and high tunnels. All mulches significantly increased yields compared to bare ground.

1340–1440

S03–P–84

NITROGEN AND SPACING AS FACTORS IN PRODUCTION OF ADVANCED POTATO LINES (TABLE-STOCK AND CHIP-PROCESSING) FROM MSU

Chris Long*, Sieg S. Snapp, D.S. Douches, R.W. Chase

Dept. Crop and Soil Science, Michigan State Univ., A412 Plant Soil Science Bldg, East Lansing, MI, USA, 48824

A profile of plant response to nitrogen (N) management and spacing is crucial information for rapid assessment and uptake of new varieties by industry. The objectives of this study are to investigate the response of promising new lines to plant population density (narrow and wide within-row spacing, from 0.2 to 0.35 m) and fertilizer levels from 200 to 400 kg N/ha. Response of four new lines from the Michigan State Univ. potato-breeding program was compared to the chip-processing standard Snowden. The lines were: MSA091-1 a 10 °C storage chipper with resistance to scab (*Streptomyces scabies* Thaxter), MSG227-2 a cold storage (7 °C) chipper with scab resistance, MSE192-8Rus a Russet table-stock line with excellent internal quality, and MSG274-3 a European type table-stock line resistant to the US 8 genotype of *Phytophthora infestans*. A randomized complete block design field trial was conducted at the Montcalm Research Farm in Central Michigan on a Alfic Fragiorthod loamy sand soil. Stand establishment, early vigor and canopy cover were evaluated, along with pre-season profile inorganic soil N and seasonal petiole nitrate-N. At harvest, yield and tuber quality were assessed, including: bruise potential, internal quality, gravity, processing ability, store ability and after-cooking darkening levels. At the wide spacing and 200 kg N/ha level, US #1 yield levels were: Snowden 36 tons/ha, MSA091-1 30 tons/ha, MSE192-8Rus 20 tons/ha, MSG227-2 39 tons/ha and MSG274-3 22 tons/ha. An addition of 100 kg N/ha increased yield in all varieties between 10 and 20%. Compared to wide spacing, narrow spacing consistently increased yields of all lines by approximately 25%. At narrow spacing there was almost no response to additional N. It appeared that table-stock lines were inefficient users of N compared to chip-processing lines, as petiole N status reflected higher N fertilizer levels without a concurrent increase in yield.

1340–1440

S03–P–85

THE ROLE OF ETHYLENE IN WOUND-INDUCED SUBERIZATION OF POTATO TUBER (*SOLANUM TUBEROSUM* L.).

Edward C. Lulai*, Jeffrey C. Suttle

USDA-ARS, Northern Crop Science Laboratory, P.O. Box 5677, Fargo, North Dakota, USA, 58105-5677

Wound-induced suberization is a vital process required to control potato tuber dessication, development of defects, and to block infection of harvest damaged tubers and tubers cut for seed. The hormone ethylene has been shown to be involved in various kinds of plant stress, but its regulatory role in wound-induced suberization has not been determined. The role of ethylene in wound-induced suberization of potato tuber was examined over a 9 d wound-healing period using a variety of ethylene biosynthesis and action inhibitors. Ethylene evolution was stimulated by wounding and reached a maximum 48-72 h after tuber wounding, and then gradually declined. Although the non-competitive ethylene antagonist silver-thiosulfate blocked suberization, it also caused tissue necrosis. The competitive inhibitor 2,5-norbornadiene had no effect on suberin accumulation. Similarly, the antagonist 1-Methylcyclopropene had no apparent affect on wound-induced suberin accumulation. Exogenous ethylene, applied either before or after wounding, had no effect on suberization. Treatment with the ethylene biosynthesis inhibitor, AVG, blocked wound-induced ethylene production, but did not affect wound-induced suberization. Collectively, these results indicate that although increased ethylene evolution is part of the tuber wound response, it is not required for wound-induced suberization.

1340–1440

S03–P–86

THE EFFECT OF COMMERCIAL BRASSINOSTEROID ON GROWTH AND STEROIDAL GLYCOALKALOID CONTENT OF CULTIVATED POTATO (*SOLANUM TUBEROSUM*) AND S. CHACOENSE GROWN IN VITRO

A. Raymond Miller*[1], J.C. Jang[2], N. Jean Flickinger[1]

[1]Horticulture & Crop Science/OARDC, 1680 Madison Ave., Wooster, OH 44691; [2]Horticulture & Crop Science/OSU, 2021 Coffey Rd, Columbus, OH 43210

Leaves of potato (*Solanum tuberosum*; tub) contain the steroidal glycoalkaloids (SGAs) solanine and chaconine, whereas leaves of certain accessions of wild S. chacoense (chc) contain solanine, chaconine, leptinines and leptines. Leptines are the primary source of natural resistance in chc to herbivory by larvae and adult Colorado potato beetles (*Leptinotarsa decemlineata* Say). The aglycons of solanine, chaconine, leptinines and leptines are solanidine (SD), leptinidine (LD) and acetylleptinidine (ALD), respectively. On a dry weight basis, leaves of field- and greenhouse-grown plants contain relatively higher (four to ten times) levels of the SGAs (measured as SD, LD and ALD) than leaves of plants grown in vitro on MS medium lacking hormones. In addition, leaves from field-grown chc plants contain more ALD than SD, while leaves from in vitro-grown plants contain more SD than ALD. Previous experiments have shown that a variety of plant growth regulators have small but significant effects on the SGA quantity and/or ratio of in vitro-grown tub or chc. In new experiments intended to understand the regulation of SGA levels in tub and chc, plantlets were grown in vitro for 28 days on MS medium containing dilutions (0 to 10,000x) of a commercial brassinosteroid (BR) preparation (Tianfengsu; Jiangmen Pesticide Factory, P.R. China). Highest BR levels (1x, 10x dilutions) significantly inhibited growth of tub and chc plantlets compared to controls lacking BR. Lower BR levels (100x to 10,000x dilutions) had no significant effect on plantlet growth. Analysis of plantlets showed that BR (10x, 100x dilutions) significantly affected SGA levels and those results will be presented.

1340–1440

S03–P–87

INFLUENCE OF STORAGE CONDITIONS ON 'RANGER RUSSET' TUBER QUALITY

Nora Olsen*[1], Gale Kleinkopf[2], Lynn Woodell[2]

[1]Univ. of Idaho, Twin Falls R&E Center, Twin Falls, ID 83303-1827; [2]Univ. of Idaho, Kimberly R&E Center, Kimberly, ID, 83341-5076

The potato cultivar 'Ranger Russet' has many desirable production and processing attributes. Unfortunately, the management practices required for optimum long-term storability for this cultivar have not yet been established. Processing quality concerns, such as french fry color variation, mottling and darkening, occur after extended time in storage. The standard storage treatment was to cure tubers at 12.8 °C for 2 weeks and decrease by 0.3 °C/day to 8.9 °C. Curing at 15.6 °C compared to 12.8 °C did not significantly affect glucose concentration, fry color, and the incidence or severity of mottling. Restricting airflow by 50% increased glucose concentration and produced a darker fry color after 9 months in storage. Restricting airflow did not impact the incidence or severity of mottling. A second application of chloropropham after 4 months in storage in-

creased glucose content transiently, the level was reduced by the next month, and fry color was not affected. A cool temperature treatment of 3.3 °C for 6 days after harvest had the greatest and quickest impact on glucose levels, fry color and mottling. The incidence of mottling in this treatment was 100% after 1 month in storage compared to 42% with no cold exposure. The severity of mottling was greatest early in the storage season with the 3.3 °C exposure and highest by 9 months in storage with either a 7.2 °C holding temperature or 3.3 °C exposure. Tubers stored at 7.2 °C either directly after curing or transferred to 7.2 °C after 3 months in storage at warmer temperatures had higher glucose concentrations, darker fry color, and greater severity and incidence of mottling. The incidence of mottling was 100% in all treatments by 7 months in storage. Tubers could not be reconditioned after 8 months in storage at 7.2 °C. Any exposure to 7.2 °C or lower negatively impacted the processing quality of the potatoes.

1340–1440

S03–P–88

CALLUS INDUCTION AND PLANT REGENERATION IN VITRO IN POTATO

Mansoor Omidi*, Azar Shahpiri

Dept of Agronomy, College of Agriculture, Univ. of Tehran, Karaj, Tehran, Iran

This study was conducted to determine effects of variety, explant, light, D (1,2, and 3 mg/L) and kinetine (0, 0.1, and 0.01 mg/L) for Callus induction and regeneration in potato. In six varieties of potato (Agria, Diamant, Kasmos, Santeh, Concord and Ajax) leaves and internodes were dissected and planted in petri dishes using a solid MS medium. The dishes were incubated in darkness and light (16 h light and 8 h darkness) at 25 °C. The induced calli were sub-cultured on the same medium after one month. In this study, the following variables were analyzed: number of responding explants; growth rate of calli; and size of calli. The analysis of variance indicated a significant effect of variety, explant, light, D and kinetine 2,4. Leaf explant induced callus only in darkness but stem induced callus in darkness and light, and most of these were embryogenic.

1340–1440

S03–P–89

TOTAL SOLUBLE PROTEINS VARY BETWEEN CULTIVARS IN FRESH AND STORED TUBERS

E. Ortiz-Medina*, D.J. Donnelly

Plant Science Dept., McGill Univ., 21,111 Lakeshore Road, Ste Anne de Bellevue, Quebec, Canada, H9X 3V9

Total soluble protein (TSP) concentration was determined for 8 (1999) and 20 (2000) cultivars in both fresh and stored (6 months) potato tubers (Solanum tuberosum). TSP concentration was quantified separately in three tissue layers (periderm, cortex and pith) using the Bradford method. In most cultivars, the TSP concentration on a dry weight (DW) basis was greater in the periderm compared with the cortex and pith. The TSP concentration ranged from 45 to 92, 29 to 67 and 34 to 76 mg TSP/g DW in the periderm, cortex and pith, respectively. After 6 months of tuber storage the TSP concentration decreased (mean of 26%) in seven cultivars, increased (mean of 23%) in four cultivars and was unchanged in 9 cultivars. To evaluate the utility of microtubers as a model for studying protein in potato tubers, a subset of 8 cultivars was used to compare the concentration and distribution of TSP between in vitro-and field-grown tubers. The TSP concentrations tend to be greater in microtubers than in field-grown tubers; possibly a function of the readily available nitrogen in tissue culture media. This study showed that among the 20 cultivars tested there were large differences in the nutritional quality of both fresh and stored tubers.

1340–1440

S03–P–90

ROOT ZONE CALCIUM CAN DRAMATICALLY INFLUENCE POTATO TUBER INITIATION AND TUBER SIZE

Senay Özgen*[1], Matthew D. Kleinhenz[2], Jiwan P. Palta[1]

[1]Univ. of Wisconsin-Madison, Dept. of Horticulture, 1575 Linden Drive, Madison,WI 53706; [2]The Ohio State Univ., Dept. of Horticulture and Crop Science, Wooster, OH 44691-4096

Calcium has been known to be important in the maintenance of cell membrane functions. Free Ca has been found to function as a secondary messenger thus regulating growth and development of plants. Using an artificially inert media and continuous flow of solution we investigated the influence of free soil Ca on tuber initiation and size in potatoes. Plants were supplied with a balanced (Hoagland) nutrient solution with known Ca levels (0.2, 1, 5, 25, 125 ppm). We found that as root zone Ca decreased there was a dramatic increase in the number of tubers while simultaneously a drastic decrease in tuber size. In order to determine the relevance of these findings under field conditions we repeated these studies using 20 liter pots filled with field sandy loam soil. For this purpose, plantlets of cultivar Russet Burbank raised in tissue culture were used. All treatments received the same total amount of nitrogen. Calcium was applied in four split applications (equivalent to 42 kg/ha at each application). A randomized complete block design with 8 replicates per treatment was employed. Tubers were harvested and evaluated four months after planting. Tuber number was decreased from 24 to 15 per plant by application of Ca. However, mean tuber weight was significantly increased by Ca treatment. There was no significant difference on total yield among all the treatments. As expected Ca content of the tuber was also dramatically increased by supplemental Ca application. These results provide evidence that root zone Ca can dramatically alter tuber initiation and tuber size.

1340–1440

S03–P–91

DEVELOPING PRECISION AGRICULTURE METHODOLOGIES FOR CHIP-PROCESSING POTATO CULTIVATION IN MICHIGAN

Edgar Po*, Sieglinde Snapp

Dept. Crop Soil Science, 171D Plant Science Bldg., Michigan State Univ., East Lansing, MI, USA, 48824

A number of methodologies have been developed to monitor crop stress level and correlate this with yield, including precipitation and potential evapotranspiration (PET). There are a host of other factors aside from moisture that determine the yielding capacity of crops. Most of these methodologies are designed to predict agricultural production levels in regions composed of huge acreages of land, and serve as an advisory for the next cropping seasons. Hence, any interventions usually do not occur during the growing season but on subsequent cropping seasons. With the advent of precision agriculture and the availability of sophisticated monitoring equipment, it is possible to develop a methodology to monitor yield indicators to aid crop management decision regime in real time and on a regular basis within one growing season. Quantifying the relative contributions to the final yield of each of the different combinations of management practices across space and time can help toward this objective. Soil bio-physical and chemical characteristics and quality parameters are hypothesized to be critical predictive factors for degraded field sites. Soil organic matter provides one proxy for soil quality status, along with water infiltration rates, bulk density, soil aggregate stability and nutrient availability. This presentation will examine the existing literature and on-farm monitoring results pertaining to precision agriculture methodology measurements with applications to chip-processing potato. Methodologies can then be refined for potato growing conditions in the State of Michigan.

1440–1500

S03–O–92

SOIL AMENDMENT EFFECTS ON ORGANIC POTATO YIELD AND QUALITY

M.D. Kleinhenz*[1], J. Cardina[2]

Dept. of Horticulture and Crop Science, The Ohio State Univ., Ohio Agricultural Research and Development Center, 1680 Madison Avenue, Wooster, Ohio, U.S.A. 44691-4096; [2]Dept. of Plant Pathology, The Ohio State Univ., Ohio Agricultural Research and Development Center, 1680 Madison Avenue, Wooster, Ohio, U.S.A. 44691-4096

We report here on the first in a series of studies designed to aid in the development of integrated nutrient and weed management strategies for organic vegetable systems. Using potato (*Solanum tuberosum* L.) as a model system, we are examining whether genetic variation in crop nutrient efficiency (uptake, utilization) and canopy size, structure, and rate of formation can be used to help overcome nutrient and weed management challenges in organic systems. Data regarding the frequency of nutrient deficiencies and excessive weed growth in organic systems, light and soil nutrient effects on crop and weed growth, and genetic variation in crop nutrient efficiency and canopy variables suggest that variety selection and soil amendment have key, interactive roles in organic systems. In 2000 and 2001, 89-112 m^2 plots of three red-

skinned potato varieties reported to differ in maturity and mature canopy size were established in early June (following a legume grown the previous year) and arranged in a RCB design with four replications at the OARDC in Wooster, OH. Land and methods used met local organic certification requirements. Composted dairy manure was applied and incorporated into half of the plots three weeks before planting, delivering approximately 62 kg N/ha. Rows were machine cultivated three times before canopy closure. Vines were killed by mowing sixty days after planting and tubers were harvested and graded for size and external quality. In 2001, nine plants per plot were removed at vegetative maturity to assess treatment effects on leaf area and shoot, root, and tuber mass. On average, compost amendment increased the yield of U.S. #1 and B-size tubers 14% and 12%, respectively, but did not impact plant growth variables. Year- and variety-compost interactions were not significant.

1500–1520
S03–O–93
DIURNAL CYCLES OF STOLON AND TUBER EXPANSION DURING POTATO TUBERISATION

P.H. Brown*, S. Yang

School of Agricultural Science, Univ. of Tasmania, GPO Box 252-54, Hobart, Tasmania, Australia, 7001

Nutrient film technique (NFT) hydroponic systems for potato minituber production represent one of the major new technological advances in seed potato production. Tuber yields per plant in NFT systems can be considerably higher than for conventional pot or field grown plants. In addition to manipulation of the environmental parameters such as daylength and temperature, it is possible to manage nutrient solution composition and pH to modify the tuberisation response in hydroponically grown plants. This ability to manipulate tuberisation, combined with the ease of access to tubers, stolons and roots, makes the NFT system ideal for investigation of tuberisation at the whole plant level. An investigation of stolon and tuber growth rates using a series of webcams (video imaging systems capable of capturing high resolution images at preset times) revealed characteristic diurnal patterns of growth under different tuberisation inductive and non-inductive conditions. Expansion of tubers and elongation of stolons tended to occur in the late afternoon and night period under inductive treatments. Shoot and stolon water potential display similar diurnal patterns of change, and stolon/tuber growth rate appears to be linked to shoot water potential. Further studies examining diurnal changes in rates of accumulation and mobilisation of leaf starch, changes in stolon osmotic and turgor potential and soluble carbon distribution in stolons will be presented.

1520–1540
S03–O–94
INTERACTION OF TEMPERATURE AND YIELD COMPONENTS OF EXOTIC POTATO VARIETIES SCREENED IN OMAN

I.A. Khan*, M.L. Deadman, H.S. Al-Nabhani, K.A. Al-Habsi

Dept. of Crop Sciences, College of Agriculture, Sultan Qaboos Univ., Muscat, Sultanate of Oman

Potato is a relatively new crop in the Arabian Gulf region where Oman is located. Potato crop in this region faces unique exposure to temperature variations and related heat stress. We have been screening a range of potato varieties (5-26) for local adaptation by planting over a scatter of several planting dates (3-11) between September and December months during years 1997-2001. There were significant differences among the varieties and planting dates as well as a significant interaction between two factors. The temperature plays a critical role in determining the varietal response to local conditions. The temperature relations were determined by a regression analysis of pooled data. As expected, the yield was always found to be a positive function of number of tubers and weight of tuber per hill. The number of tuber and size varied with varieties. The number of tubers was strongly correlated with minimum temperature (R^2 0.51) and the weight of tuber strongly correlated with maximum temperature (R^2 0.68). Conversely, the correlations were not significant between minimum temperature and weight of tuber and maximum temperature and number of tubers. The interaction of varieties to the prevailing temperatures and day/night fluctuations provided us indices to select varieties for local adaptations. Several such selections have been identified during the course these studies; these could prove valuable in broadening the cultivar base for potato production in Oman.

1540–1600
S03–O–95
TUBER SIZE CONTROL IN SHEPODY AND RUSSET BURBANK POTATOES VIA MODIFICATION OF SEED TUBER STORAGE CONDITIONS

Kris Pruski*[1], Robert Prange[2], Babara Daniels-Lake[2], Sam Asiedu[1], Jerzy Nowak[3]

[1]Dept. of Plant and Animal Science Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3; [2]Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, Nova Scotia, Canada, B4N 1J5; [3]Dept. of Horticulture, Virginia Polytechnic Institute and State Univ., Blacksburg, VA 24061, USA

Seed potato growers want to produce a high yield of small tubers, whereas production for French fry processing aims for fewer large, uniform potato tubers. The number of tubers produced in each hill depends upon the number of stems each mother tuber produces and the number of stolons on each stem, whereas tuber size is inversely proportional to tuber number. Among the most popular processing cultivars, 'Russet Burbank' tends to produce a large number of tubers per plant, frequently too small for processing, while 'Shepody' produces a small number of large-sized tubers, giving a poor yield of seed tubers. Our long-term objective was to develop potato management systems to control tuber size, to either 1) produce a high number of small tubers for seed; or 2) produce large, uniform tubers for processing. These two production outcomes were successfully attained by the addition of ethylene (4 FL L-1 applied continuously, beginning in either November or February) and/or 1-methylcyclopropene (EthylBloc™, MCP; applied as a gas for 48 hrs only–early December) to the seed storage atmosphere and by variation in planting density in the field. In growth room and field experiments, apical dominance was reduced in ethylene-treated tubers, increasing number and length of stems and stolons in both cultivars, compared with untreated controls. For example, in 'Russet Burbank' approx. 4 stems with 9.3 stolons averaging 5 cm in length were observed in ethylene treatments (1.3 stems with 3.6 stolons averaged in 3.3 cm each in controls). In field trials, number of stems and yield of uniform tubers was also higher in ethylene-treated tubers compared control. The MCP treatment reduced number and length of stolons in 'Shepody' but not in 'Russet Burbank', compared with untreated control. These results, plus effects of planting density on yield and tuber size distribution will be discussed further.

1600–1620
S03–O–96
EFFECTS OF LOCATION AND YEAR OF PRODUCTION ON HYBRID TRUE POTATO SEED QUALITY AND PERFORMANCE

Mahesh D. Upadhya*, Rolando Cabello, Rosario Falcon, Enrique Chujoy

International Potato Center (CIP), Av. La Molina, La Molina, Lima, Peru

Hybrid True Potato Seed (TPS) technology has gained commercial acceptability for potato production in a number of countries. Also both governmental, non-governmental and private agencies have started producing and selling hybrid TPS varieties. However, there is paucity of experimental data on the effects of location and year of hybrid TPS production on the TPS quality parameters and field performance. Therefore, at CIP, studies were conducted with a view to providing information on these aspects. Hybrid TPS of eight varieties produced at two of CIP's experimental locations in the last three years were used for these studies. Data were taken on the average seed weight, seedling vigor and field performance of seedling transplants. Significant differences among varieties, locations and years of production were found. Results will be discussed to provide useful information on these aspects of hybrid TPS technology for the agencies involved in hybrid TPS production.

1620–1640
S03–O–96–A
TO BE ANNOUNCED

1640–1700
S03–O–96–B
TO BE ANNOUNCED

Friday August 16

0800–0900
S03–P–97
RESPONSE OF POTATO CULTIVARS (*SOLANUM TUBEROSUM* L.) TO NITROGEN FERTILIZATION

Milan Poljak*, Mirjana Æustiæ, Tomislav Æosiæ, Martina Ljubièiæ

Univ. of Zagreb, Faculty of Agriculture, Dept. of Plant Nutrition, Zagreb, Croatia

Nitrogen fertilization is often required for maximum potato (*Solanum tuberosum* L.) production. Nitrogen, along with potassium, is well known for its influence on potato tuber yield and quality. The goal of this study was to evaluate the responses of potato cultivars to different nitrogen rates in three different agroecological areas of Croatia, where potatoes are grown for consumer consumption and for the processing industry. Two-factor experiments with five nitrogen doses (0, 100, 150, 200 and 250 kg N/ha) combined with three potato cultivars (cv. Victoria, cv. Red star and cv. Remarka) were conducted in three replications during 2000 and 2001 at three locations (Brinje, Slovinska Kovaèica and Belica). No significant differences in potato tuber yields were recorded between cultivars at the Brinje location. In contrast, the highest tuber yield of the Victoria cultivar was produced both at Belica and at Kovaèica locations (47.2 and 38.3 t/ha, resp.). The order of productivity for the potato cultivars in all three locations was: Victoria>Remarka>Red star. Nitrogen fertilization influenced an increase of the potato tuber yield compared to 0 kg N/ha, with the exception of the Belica location. The cultivar x fertilization interaction had no statistically significant effect on the yield, yield quality or yield components. Participation of large tubers (>55 mm), dry matter content, starch content and specific gravity varied depending on the cultivar. The order of tuber specific gravity for the potato cultivars in all three locations was: Red star>Victoria>Remarka. Nitrogen fertilization had a significant influence on the increase of the tuber specific gravity and starch percent only at the Brinje location, whereas a diminishing trend was recorded at the other two locations.

0800–0900
S03–P–98
THE EFFECTS OF INTRA-ROW SPACING AND N FERTILIZER ON THE YIELD OF TWO FOREIGN POTATO CULTIVARS IN IRAN

A. Rahemi*[1], A. Hasanpour[2], B. Mansoori[2], A. Zakerin[2], Sadat Taghavi[1]

Deputy of Horticulture, Ministry of Agriculture, Tehran, Iran; [2]Fars Agriculture Research Center, Zarghan, Iran

We compared the yield of a new potato cultivar named “Marfona” with a relatively old variety named “Diamant”. The “Marfona” variety was introduced from the Netherlands and we had little information about its adaptability and cultural practices. Intra-row and N fertilizer are considered as major factors affecting potato yield. These factors were studied in two successive years, 1996-1997, in Shiraz, a potato-growing district in southwest Iran. If the “Marfona” showed adaptability to the climate and has a good yield, we will extend it to other places and replace it with “Diamant”. The experiment was conducted as split-split plot design. Two potato cultivars were as the main plot, and intra-row as sub-plot and N fertilizer as sub-sub plot. The separately recorded data were germination date, percentage of germination, length of stems, number of stems per hill, and time of flowering for each cultivar. At the end of the growing season, yield was recorded and statistical analysis was performed for each year and for two successive years separately. Results indicate that effect of potato cultivars is significant in combined analysis at $P < 0.01$. The cultivar “Marfona” showed 28.71% increase in yield over Diamant. Combined analysis at $P < 0.01$ indicated intra-row affected yield. Twenty centimeter spacing resulted in 23.31% increases in yields over thirty centimeter spacing. Additionally, N fertilizer affected yield. Combined analysis, at $P < 0.05$, indicated more N fertilizer, 225 kg/ha, resulted in 7.5% higher yield over the lower amount, 175 kg/ha. Combined analysis indicated the positive effect of the year at $P < 0.01$ and year*cultivar*N fertilizer at $P < 0.05$ on the yield. However, other interactions were not found to affect the yields significantly. Another goal was to correct the cultural practices of the farmers. Therefore our 5-person team conducted the research and the results were extended in the area by the local offices.

0800–0900
S03–P–99
EVALUATION OF VARIOUS CHEMICALS ON DORMANCY BREAKING AND SUBSEQUENT EFFECTS ON GROWTH AND YIELD IN POTATO MICROTUBERS UNDER GREENHOUSE CONDITIONS

Fazal Rehman*[1], Seung-Koo Lee[2], Joung Hyouk[3]

[1]Dept. of Agriculture, Northeren Areas Gilgit, Pakistan; [2]Dept. of Horticulture, College of Agriculture and Life Science, Seoul National Univ. South Korea; [3]Director Plant Biodiversity Project, Korea Research Institute of Bioscience and Biotechnology, Taejon South Korea

A series of experiments were carried out to evaluate the effect of various chemicals on dormancy breaking, subsequent effects on plant vigor and tuber yield of potato microtubers under greenhouse conditions. The chemicals were tested on microtubers of three potato cultivars (Atlantic, Desiree, and Diamont) having different dormancy breaking characters. The microtubers treated with GA3 took 19 days for 50% of tubers to sprout for cultivar Desiree, while for cultivars Atlantic and Diamont the tubers treated with GA3 and rindite took a period of 31 and 21 days, respectively. The tubers treated with thio-urea showed the highest decay ratio as compared with other treatments. The GA3 treated tubers produced very thin and elongated sprouts, while vigorous and flattened sprouts were produced in the case of tubers treated with CS2 and thio-urea. The tubers treated with GA3 gained the highest emergence gain for all the cultivars under investigation as compared with other treatments. For cultivar Diamont the tubers treated with thio-urea gained the highest plant height followed by rindite treatment. Significant differences were observed among the cultivars and treatments for various yield characters. The tubers treated with thio-urea yielded the highest number of tubers/pot for all the cultivars.

0800–0900
S03–P–100
CHANGES IN CELL WALL PECTIN ASSOCIATED WITH PERIDERM MATURATION IN POTATO TUBER

Robert P. Sabba*[1], Edward C. Lulai[1], Thomas P. Freeman[2]

[1]USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58105; [2]North Dakota State Univ., Northern Crop Science Laboratory, Fargo, ND 58105

Potato (*Solanum tuberosum* L.) periderm maturation is an important physiological process that reduces tuber susceptibility to skinning injury. Skinning of potato tubers results in millions of dollars of losses to producers in the United States every year. Maturation of tuber periderm is often incomplete at harvest and renders the tuber susceptible to skinning injury. A skinned tuber is vulnerable to dehydration and infection during storage until it develops a wound periderm to replace the damaged native periderm. Both native and wound periderms consist of three different cell types: phellem, phellogen, and phelloderm. The phellem and phelloderm are derived from the merstematic phellogen layer. We have recently determined that changes in the architecture of the phellogen cell walls upon periderm maturation are directly associated with development of resistance to skinning injury. The radial walls of phellogen cells are thin and labile to fracture in immature periderm, but thicken and become resistant to fracture upon maturation of the periderm. Our research indicates that an increase in un-esterified pectins in phellogen cell walls accompanies maturation of the native periderm. Immunolocalization of both methyl-esterified and un-esterified pectin in native and wound periderm will be discussed. These results are important in identifying the biochemical processes responsible for periderm maturation and resistance to tuber skinning.

0800–0900
S03–P–101
ROLE OF ETHYLENE IN NAPHTHALENE-MEDIATED SPROUT GROWTH INHIBITION

Jeffrey C. Suttle*

USDA-ARS, Northern Crop Science Laboratory, PO Box 5677, Fargo, North Dakota, USA, 58105-5677

A number of substituted naphthalenes reversibly inhibit potato sprout growth and may have potential as commercial sprout inhibitors. Sprout growth is also reversibly inhibited by ethylene treatment. The role of endogenous ethylene in naphthalene-mediated sprout growth inhibition was examined using a variety of ethylene biosynthesis and action inhibitors. Ethylene evolution from intact

potato tubers was stimulated following treatment with alpha-naphthalene acetic acid (NAA) but not 1,4- or 1,6-dimethylnaphthalene. An increase in ethylene production was observed 24 h after treatment, reached a maximum 48-72 h post-treatment and declined gradually thereafter. In addition to NAA, a variety of structurally unrelated auxins also stimulated ethylene production and inhibited sprout growth. Neither the non-competitive (Ag thiosulfate) nor the competitive (2,5-norbornadiene) ethylene antagonists affected NAA-induced growth inhibition. Simultaneous treatment with the ethylene biosynthesis inhibitor AVG blocked NAA-induced ethylene production but did not affect subsequent sprout growth inhibition. These results suggest that the sprout inhibiting effects of NAA, but not those of 1,4 or 1,6-dimethyl-naphthalene, are related to intrinsic auxin-like bioactivity and are not dependent on endogenous ethylene synthesis or action.

0800–0900

S03–P–102

STUDIES ON RECIPROCAL EFFECTS ON BERRY AND TRUE POTATO SEED (TPS) CHARACTERISTICS IN POTATO

Mahesh D. Upadha*, Rolando Cabello, Enrique Chujoy

International Potato Center (CIP), Av. La Molina 1895, La Molina, Lima, Peru, 12

Reciprocal crosses involving five highly fertile True Potato Seed (TPS) parental lines and cultivars were studied for average berry weight, number of seeds/berry, 100 seed weight and proportion of seeds in larger than 1.6 mm class. Simple correlations were calculated among the characters. Results indicate that only berry weight shows highly significant positive correlation (r = 0.082, $P < 0.01$) with the number of seeds/berry, whereas none of the characters had significant correlation among them. There were reciprocal differences among the lines for the type and degree of parental effects on these characters. Among the five lines the cultivar Desiree as male had the largest effect on berry weight increase with all the four female parents. Desiree and TPS-67 as the male parents in general increased the average number of seeds/berry, 100 seed weight and proportion of seeds in size larger than 1.6 mm as compared to the rest of the three lines. These results along with the estimates of general and specific combining abilities will be discussed to high light the importance of such studies in the selection of parental lines for the production of high quality and quantity of hybrid seeds of TPS varieties.

0800–0900

S03–P–103

DIGITAL IMAGING FOR EVALUATION OF POTATO AFTER-COOKING DARKENING

Gefu Wang-Pruski*[1], T. Richard Tarn[2]

[1]Dept. of Plant & Animal Sci, Nova Scotia Agricultural College, 50 Pictou Road, Truro, Nova Scotia, Canada, B2N 5E3; [2]Potato Research Centre, Agriculture and Agri-Food Canada, PO Box 20280, Fredericton, NB, E3B 4Z7, Canada

After-cooking darkening (ACD) phenomenon occurs when boiled or steamed potato tubers become grayish dark on exposure to air. The degree of darkening is controlled genetically and is strongly influenced by environmental factors. The pigment responsible for after-cooking darkening is a complex of chlorogenic acid and iron, which is formed during cooking and oxidizes during cooling to a colored ferric di-chlorogenic acid complex. The evaluation of ACD is thus based either on the amount of chlorogenic acid in tubers (destructive method) or on the determination of the degree of color intensity on cut tuber surfaces (non-destructive method). The destructive method is HPLC based, complicated, and time consuming, particularly when a large number of samples is being evaluated. Thus, despite its deficiency, non-destructive visual examination is routinely utilized in many breeding programs. The objective of this study was to determine whether digital imaging analysis can be adapted to the evaluation of ACD. The method is based on the direct capture of the cooked and cut tuber surface image using a cooled CCD camera attached to a digital imaging system. The degree of the dark color is then measured by pixels using an imaging acquisition software. The system is calibrated at 0-255 pixel levels (0 as black, 255 as white) as standard, therefore the read values directly reflect the degree of darkening. The measurement procedure is fast, reliable, simple, and particularly applicable for handling a large number of samples. The proposed method is currently being applied to several projects related to the investigation of environmental and genetic control of ACD. This is the first report on evaluation of ACD using a digital imaging system.

0800–0900

S03–P–104

COMPARISON OF SPECIFIC GRAVITY PROFILES INSIDE TUBERS OF POTATOES

Xingyao Xiong*, George C.C. Tai

Potato Research Centre, Agriculture & Agri-Food Canada, P.O. Box 20280, 850 Lincoln Road, Fredericton, New Brunswick, Canada, E3B 4Z7

Samples of marketable potatoes of 15 varieties harvested from breeding plots planted in 2000 at the Benton Ridge Potato Breeding Substation in New Brunswick were used to compare their specific gravity distributions inside the potatoes. Computerized images of all individual potatoes were taken and used to measure their longitudinal and vertical axes and volumes. A slice about 15mm thick was then cut through the center of a potato along the longitudinal axis. Six key sites were chosen on the slice. They represented different tissue areas of the potato. A cube (ca. 15mm3) was cut out from each site. The six cubes were scored for specific gravity by the weight-in-air and weight-in-water method. Regression analyses of specific gravity on positions of cubes were performed over samples of each of the varieties. The regression equations for all varieties had more than 80% of degree of determination and thus represented the specific gravity profiles inside the potatoes of the varieties. The profiles showed significant differences among the varieties and thus useful to assess their table and processing qualities. For example, area and percentage of specific gravity less than 1.070 inside potatoes of each of the tested varieties can be identified and calculated. The information is valuable to judge their merit as a processor.

0800–0900

S03–P–105

PHOSPHORUS RESEARCH ON POTATOES IN PEI

J.B. Sanderson*[1], B. Douglas[2], R. Coffin[3], J.A. MacLeod[1], Tom Bruulsema[4]

[1]Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, 440 Univ. Avenue, Charlottetown, PE, C1A 4N6; [2]PEI Soil and Feed Testing Laboratory, PO Box 1600, Charlottetown, PE, C1A 7N3; [3]Cavendish Farms, Research Division, PO Box 3500, Summerside, PE, C1N 5J5; [4]Potash & Phosphate Institute of Canada, 18 Maplewood Drive, Guelph, ON, N1G 1L8

Producers in PEI have typically applied phosphorus (P) fertilizer at 180 to 260 kg·ha^{-1} P205 and have built soil levels to where in 1999, 63% of samples submitted tested over 108 μg·g^{-1} (Mehlich-III). With the number of fields testing high in P, the time passed since recommendations were developed, and changes in varieties, a P study was initiated. The objective was to assess the effects of rates of diammonium phosphate (DAP) and monoammonium phosphate (MAP) and pH adjustment on P and Ca uptake, yield and processing quality of Shepody and Russet Burbank potato. Phosphorus rates ranged from 0 to 240 kg·ha^{-1} P205 applied with and without lime. In each of 1998-2000, the sites tested over 200 μg g-1 P with a pH of 5.7. Application of lime increased pH by 0.4 units in the autumn sampling. Lime treatments had no significant effect on soil test P levels in the fall sampling, petiole P content, or tuber yields. Soil Ca levels were increased significantly with lime but only small increases were observed in petiole Ca contents. Petiole P levels increased with rate of applied P for the early sampling times and declined to similar levels at the last sampling. Shepody maintained a higher petiole P content than Russet Burbank. Optimum Shepody yields were obtained with 75 kg·ha^{-1} P205 but higher rates were required for Russet Burbank. Rates and sources of P did not influence specific gravity or processing quality of either variety. In conclusion, Shepody requires less P than Russet Burbank, but both varieties must have some P banded at planting to stimulate early growth, even in soils testing high in P. Based on these and other results the P recommendations are now lower for Shepody than Russet Burbank.

0800–0900

S03–P–106

MICROPROPAGATION TECHNOLOGY IN EARLY PHASES OF COMMERCIAL SEED POTATO PRODUCTION

Kris Pruski*[1], Paul C. Struik[2], Jerzy Nowak[3]

[1]Dept. of Plant and Animal Science, Nova Scotia Agricultural College (NSAC), P.O. Box 550, 50 Pictou Rd., Truro, NS, Canada, B2N 5E3; [2]Dept. of Plant Sciences, Crop and Weed Ecology Group, Wageningen Univ., P.O. Box 430, 6700 AK Wageningen, The Netherlands; [3]Dept. of Horticulture, Virginia Polytechnic

Institute and State Univ., Blacksburg, VA 24061, USA

In vitro propagation has been introduced to seed potato programs for over two decades. Research was carried out 1995–2000 on possibilities of improvements to methods commonly used in commercial laboratories, predominantly in Western Canada. Seed potato growers in Canadian Prairie Provinces either produce the tissue culture plant material themselves and use it for production of minitubers (nuclear tubers) in their own operations, or acquire it prior to planting. The study included: 1) photoautotrophic micropropagation (1500 ppm CO_2); 2) short-term low temperature (<12 wks) storage of plantlets; 3) production; and 4) utilization of microtubers (in vitro tubers) in greenhouse production of minitubers and Pre-elite tubers in the field. An extensive study was conducted on effects of jasmonic acid (JA) and photoperiod on in vitro tuberization. Performance of microtubers was then examined in commercial production of nuclear and Pre-elite tubers in comparison to the industry standard, in vitro plantlets. Studies were performed on five commercially grown cultivars: Amisk, Atlantic, Russet Burbank, Shepody and Umatilla Russet. Potato plantlets produced photoautotrophically were either the same quality or better than conventionally grown cultures. Photoautotrophic system allows growers better contamination control compared to the traditional system and/or can speed up the rate of multiplication. Cultures stored for up to 12 wks in a cold room (4 °C) on media containing 30 $g \cdot L^{-1}$ sucrose under continuous, low red light (690nm) at 3 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPFD maintained high quality, vigour and re-growth capacity. In the most studies, JA conditioned plantlets produced more uniform and larger microtubers, especially under short days conditions, although the microtubers generated on JA supplemented media generally performed similar to controls. Results with JA obtained in the field production of Pre-elite tubers were also inconclusive. Microtubers of russet varieties performed the best and can be recommended for speeding up multiplication during greenhouse production of minitubers.

0900–0920

S03–O–107

1,4-DIMETHYLNAPHTHALENE TREATMENT OF POTATO SEED-TUBERS RESULTS IN HIGHER YIELDS OF SMALLER AND MORE UNIFORM SIZE SEED

Margo Haines*, Lisa Knowles, N. Richard Knowles

Dept. of Hort. & Landscape Arch., P.O. Box 646414, Washington State Univ., Pullman, WA, 99164-6414 USA

A cost-effective treatment that induces a higher yield of smaller size seed-tubers would benefit potato seed producers. To date, no reproducible method to achieve this result is available. 1,4-Dimethylnapthalene (DMN), an endogenously produced potato sprout suppressant registered by the U.S. Environmental Protection Agency, reduces apical dominance for some cultivars, resulting in more stems/seedpiece. This may in turn effect greater size uniformity and higher yield of smaller size tubers. To test this hypothesis, we conducted field and greenhouse studies to evaluate the effects of DMN on plant emergence, establishment, and tuber yield. Experiments consisted of 3 seed-tuber ages x 2 DMN treatments (treated and control) applied to Russet Burbank (RB), Ranger Russet (RR), and Umatilla (Uma) seed-tubers. Tubers were differentially aged by storage at 4, 7 and 9 C. In greenhouse studies, DMN treatment delayed emergence from older RB seed and all ages of Uma seed. Following 23 days of growth, plants from young DMN-treated RB seed had 13% more dry matter, reflecting a significant increase in plant vigor during early establishment. While emergence of older DMN-treated RR and Uma seed was delayed in the field, total tuber number was increased an average of 24%. More importantly, DMN treatment also effected a size shift from larger (>10 oz.) to smaller size tubers. The increase in yield of smaller tubers across all ages for DMN-treated RR seed was 140%, 100%, and 35% (< 4 oz., 4-6 oz., and 6-10 oz. size tubers, respectively); for RB, 52%, 24%, and 0%; for Uma, 53%, 31%, and 0%. The DMN effect, however, depended on tuber age, with younger seed-tubers showing less of a size shift than older seed-tubers. Our data indicate that DMN may be a suitable treatment to increase tuber number, reduce average tuber size, and increase size uniformity, without reducing total yield, for high quality potato seed production.

0920–0940

S03–O–108

ENVIRONMENTAL LIFE CYCLE ASSESSMENT (LCA) OF ORGANIC POTATOES

Berit Mattsson*, Erika Wallén

SIK, The Swedish Inst for Food and Biotechnology, P.O. Box 5401, SE-402 29 Gothenburg, Sweden

The objective of the study was to carry out an LCA of organic potatoes cultivated in southern Sweden. LCA is a method for analysis and assessment of the potential environmental impact caused by products (ISO 14040). In this study the production of inputs to agriculture, agricultural production, sorting and packaging, distribution and the household phase were included. The use of energy, water and other resources were included as well as important environmental impact categories like global warming, acidification, eutrophication, toxicity, ozone depletion and photo-oxidant formation. Major findings were that the agricultural production accounted for almost all the emissions contributing to eutrophication and acidification. Agricultural production, production of packaging materials and the household phase were the main contributors to global warming, while the energy use was rather evenly distributed between the life cycle stages. The organic potato yields are generally very low, typically about 60% of the conventional yield levels. Increased yields would be beneficial from an environmental point of view. The most important improvement options identified in the study were reduction of nitrogen emissions contributing to acidification and eutrophication and reduction of potatoe losses due to poor quality.

0940–1000

S03–O–109

EVALUATING VINE-KILL METHODS FOR PRODUCING SEED TUBERS OF CONTRASTING POTATO CULTIVARS ON THE CANADIAN PRAIRIES

Jazeem Wahab*, Greg Larson

Canada-Saskatchewan Irrigation Diversification Centre, P.O. Box 700, 901 McKenzie Street South, Outlook, Saskatchewan. S0L 2N0

Seed potato crops are top-killed to ensure proper skin set and to facilitate harvest operations. Vine-kill dates should be adjusted to maximize yields of target tuber size grades. This study examined the effects of vine-kill stage (100, 107, 114 days after planting) and methods (Flail & one Reglone application, and Two Reglone applications) for contrasting potato cultivars grown under irrigation on the Canadian Prairies. The cultivars included Norland (early maturing); Russet Norkotah and Shepody (mid-season); Alpha and Russet Burbank (very late-maturing). Harvests were taken on the day of vine-kill and approximately three weeks after vine-kill. Yield estimates and tuber size characteristics were determined for combined Canada-A and Canada-B seed grade tubers. The irrigated crop produced higher overall 'seed grade' yield than the dryland crop at all three harvest-dates. Norland produced the highest and Alpha produced the lowest yields under both irrigation and dryland during the three harvest dates. Tuber yields and tuber size characteristics were similar for flailing and chemical desiccation across all harvest dates both under irrigation and dryland growing conditions. During the 100-day vine kill, the three-week period between chemical desiccation or flailing and harvest resulted in a yield increase of 11% to 14% under irrigation, and 16% to 20% on dryland relative to the yield on the day of vine-kill. These yield responses were due to more A and B grade tubers rather than due to tuber size differences. When top-killed on 107 and 114 days after planting, the three-week period between top-kill and harvest did not affect seed grade yields, tuber numbers, or average tuber size for the various cultivars under both irrigation and dryland. This study indicates that flailing and chemical-desiccation are effective vine-kill methods for harvesting seed crops of contrasting potato cultivars grown under irrigation and dryland on the Canadian Prairies.

1000–1020

S03–O–110

IMPROVED INFRA-RED THERMOMETER (IRT) METHOD FOR MEASURING PLANT WATER STRESS

T. McBurney*

ADAS Rosemaund, Preston Wynne, Hereford, HR1 3PG, UK

Infra-red thermometer (IRT) methods for scheduling irrigation are used on the premise that leaves of droughted plants tend to be significantly warmer during the course of the day than those of fully irrigated plants. In UK conditions, the leaf temperature increase due to water stress may be small and hard to detect against background fluctuations arising from air turbulence. This has led to the development of an improved leaf water stress index (LWSI) in which the effects of such fluctuations were damped by the use of additional IRT measurements from

dry and wet reference leaves. Further work to achieve a more practical field method has developed the use of low-cost IRT sensors and artificial reference surfaces matched to the thermal properties of potato leaves. A simple procedure allowed corrections for a small offset in temperature readings with the low-cost IRT compared with measurements made using a type K thermocouple. LWSI values (ranging from 0 to 1 with increasing stress) were obtained from mid-day IRT readings in potato plants. They were closely correlated with soil moisture deficits (SMD) measured for plants grown in containers under conditions of controlled soil moisture. Field measurements confirmed that mid-day LWSI values decreased as the soils dried or evaporative demand increased (humidity decreased, temperature increased). Comparisons with standard irrigation guidelines based on SMD for potato crops provided a tentative irrigation threshold value for LWSI of 0.4 or above. The work confirmed that suitable reference surfaces could be fabricated for potato and that a low-cost IRT was suitable for use with the method. The main potential of the method is considered to be for on-site checks of water-balance methods for irrigation scheduling, which are prone to cumulative errors, or for mapping spatial variations of water stress within crops.

1020–1040
S03–O–110–A
TO BE ANNOUNCED

1400–1440
S03–O–111
DEVELOPMENTS IN THE INTERNATIONAL PROCESSING INDUSTRY

Laurie Jecha-Beard, Leigh Morrow*

McCain USA Inc, 2905 Butterfield Road, Oak Brook, IL, United States, 60523-0110

We gather together due to our common interest in our international potato marketplace. Our collective aim is to share information with potato growers, researchers, processors, traders and other industry people from around the world. The ultimate aim is to bridge the gap between science and practice (cultivation, industry, research and trade.) However, we are already bridging this gap through platforms such as global web sites, e-mail and the information super-highway. As a result, our world is a much smaller place. When you think about it, so much change has occurred so quickly. One thing for sure, change will occur even faster in the next ten years than it did within the past ten years. My purpose today is to communicate the changes and trends that we are experiencing today in our international potato processing industry and address what they mean to us for the future. Processing industry sectors to be discussed include french fries, chipping, dehydration and others. Discussion will include definition of the international potato processing global marketplace; details of potato processing sector parameters; description of regional cultures and their effect on processing trends; definition of current and future processing trends by region, discussion of how regional trends influence the international processing industry trends; and definition of vehicles of change. Geographical regions considered include Europe, North America, Far East, South America, Latin America, Asia, South Pacific, Africa and the Middle East.

1440–1500
S03–O–112
STORAGE CHARACTERISTICS OF NEW POTATO INTRODUCTIONS

Ann McSay*[1], Cecil Stushnoff[1], David Holm[2], Robert Davidson[2]

[1]Dept. of Horticulture, Colorado State Univ., Fort Collins,CO 80523; [2]Dept. of Horticulture,Colorado State Univ., San Luis Valley Research Center, 249 East Rd. 9, North Center, CO 81125

Release of new potato cultivars for grower production should be concurrent with cultural and storage recommendations to optimize economic returns. Estimation of tuber dormancy also raises an awareness for the need to have a rapid method to predict the stage of dormancy. This study characterized storage potential of several advanced selections and new potato cultivars by quantifying the number of days to 50% bud break for each of five storage temperatures following field harvest. The temperatures tested were 1.1, 2.2, 3.3, 4.4 and 6.7 C. Storage temperatures strongly influenced the length of storage life. The three higher temperatures reduced storage life about the same and were far less effective than storage at 1.1 and 2.2 C which prolonged time to 50% tuber sprout by 30-60 days. The cultivars were ranked longest to shortest storage life, using 50% tubers sprout at 2.2 °C as follows: Cherry Red, Russet Norkotah #8 (130 days), Russet Norkotah #3, Russet Nugget (125 days), and Keystone Russet (85 days). A rapid method to predict dormancy was developed based upon production of PNP (p-nitrophenyl). This assay uses p-nitrophenyl, alpha-D-galactopyranoside (PNPG) as a substrate for tuber tissue producing PNP, the result of cleavage of terminal galactose units from raffinose oligosaccharides (RFO) as an indication of alpha galactosidase enzyme activity. The PNP produces a yellow pigment which can be measured spectrophotometrically. Average correlation values for PNP production with dormancy over all storage temperatures was $r = 0.75$. Soluble sugar changes in the tubers during the storage interval and chilling injury observations will also be presented.

1500–1520
S03–O–113
RECONDITIONING RESPONSE OF RUSSET BURBANK POTATOES TREATED WITH CIPC AND ETHYLENE

B.J. Daniels-Lake*[1], R.K. Prange[1], W. Kalt[1], J.R. Walsh[2], R.H. Coffin[3]

[1]Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, NS B4N 1J5 Canada; [2]McCain Foods Limited, Florenceville, NB E7L 1B2 Canada; [3]Cavendish Farms, Summerside, PEI C1N 5J5 Canada

Fry colour of processing potatoes is paramount in the French fry industry. During long-term storage, elevated reducing sugars due to low-temperature sweetening, senescence, excessive CO_2 buildup, or ethylene from disease organisms or as a sprout inhibitor can darken fry colour. Reconditioning at 3-5 °C above the usual storage temperature is often employed to encourage the potatoes to respire away the accumulated sugars and recover a lighter fry colour. However sprouting and disease development can accelerate at warmer temperatures, and the reconditioning response is considered unpredictable by industry experts. Results range from improvement through no response to further darkening of fry colour. The factors which influence reconditioning are not clearly defined, prompting research into the reconditioning response in 'Russet Burbank' potatoes treated with either isopropyl chlorophenyl carbamate (CIPC; 1% dip in early December) or ethylene (4 $\mu L \cdot L^{-1}$ continuously) sprout inhibitors during two consecutive years. Potatoes were stored at 9 °C, and at 5-week intervals from January to July samples were reconditioned in ethylene-free air at 20 °C for 3 and 6 weeks (year 1) or at 13 °C for 3 weeks (year 2). Fry colour and sprout development of tubers before and after reconditioning were determined. The capacity of potato tubers to respond positively to reconditioning, measured by improvement (lightening) of fry colour, was found to decline during storage in a predictable manner. The response was positive at the beginning of the storage season, and declined progressively during the storage season to a negative response (darker fry colour after reconditioning). Tubers treated with ethylene responded positively for a longer portion of the storage season than CIPC-treated tubers. In ethylene-treated tubers, sprout development during reconditioning was significant, but both sprout mass and maximum sprout length remained well below that of untreated controls.

1520–1540
S03–O–114
DEVELOPMENT OF POTATO VARIETIES AS HEALTHY FOODS WITH HIGH BIOLOGICAL FUNCTION

Hak-Tae Lim*, Kuihua Li, Yilan Fang

Address Division of Applied Plant Sciences, Kangwon National Univ., Korea, Chunchon, Kangwon, South Korea, 200-701

Potatoes have been recognized for a long time as one of the major food crops as well as horticultural crops. Potato production as a table food has decreased in developed countries, while it has steadily increased in the third world countries in its importance as food source. It is a new trend to look at food, not only as a feeding crop but also healthy food. It is also time for potato producers to look for potatoes having high economic value as found in medicinal plants. There are great diversities in potato species, indicating that valuable compounds can be found in different amounts, depending on potato species. We screened cultivars, breeding clones, and germplasms based on Vitamin C, Vitamin E, antioxidant compounds, diverse sugar types, important amino acids, and other valuable compounds. We could select the breeding clones KC003, 98W117, 99J717, and Vally 8 (A group) due to their high levels of antioxidant compounds, and it can be said that most of the red and purple colored potato clones belong to the A group. Taebook Valley', 'Summer Valley' and other breeding clones were found to be high in essential amino acid content. We also made crosses between breeding

clones with high biological function and low agronomic traits and low biological function with high quality in agronomic characteristics. The patterns of genetic trends of these offspring in comparison with their parents also will be reported.

1540–1600

S03–O–115

EFFECTS OF BLANCHING CONDITIONS ON THE PHYSICAL PROPERTIES OF POTATOES

Robin Young*, M.G. Scanlon

Food Science Dept., Univ. of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

Potato texture and colour are two important characteristics when evaluating the quality of French fried potatoes. The effect of different blanching conditions on the peak force of solid and excoriated cylinders of potato was investigated using compression tests. The Hunterlab L-value (lightness) of the French fries was also monitored as colour is an important indicator of quality in French fry processing. French fries blanched under standard conditions had large L-values, while those blanched under low-temperature long-time (LTLT) conditions and high-temperature short-time (HTST) conditions had similar L-values. The peak force values of both types of potato specimens blanched by LTLT conditions were higher than those blanched by HTST conditions, which in turn were higher than those blanched by standard conditions. The average peak force values of the whole potato cylinders were greater than those of the excoriated potato cylinders. Therefore, LTLT conditions increased lightness and peak force of the material in comparison with the other blanching treatments.