Central Potato Research Institute
Newsletter

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Research Highlights

Gene stacking for multiple disease resistance in potato

The Potato (*Solanum tuberosum* L.) is the most promising non-cereal food crop of the world that can ensure food and nutritional security in the developing countries. However, the potato productivity in India has remained almost static during the last two decades largely due to number of biotic stresses causing yield diminition. Among these, late blight, viruses and nematodes are the most devastating. Therefore, the present day cultivars need to be fortified with multiple disease resistances which so far was difficult to achieve through conventional breeding methods owing to the tetrasomic inheritance in potato. However, with the advent in molecular markers based research, it is now feasible to combine multiple resistance genes using Marker Assisted Selection (MAS) in the breeding programmes. Following this strategy at CPRI, Shimla molecular markers R1AS and R3a-1380 (SCAR) for late blight, RYSC-3 & 4 (SCAR) for potato virus Y, TG689 and Gro1-4 for *Globodera rostochiensis* pathotype Ro1, 4 and HC (SNP) for *G. pallida* pathotype *Pa 2/*3 were first validated in the respective germplasm accessions. Later, 165 genotypes consisting of parental lines, commercial cultivars and advanced stage hybrids were screened using these markers and 84 genotypes with late blight resistance genes (*R1* and *R3a*), 18 genotypes with Potato Virus Y resistance gene (Ry_{adg}) and 79 genotypes with cyst nematode resistance genes (*HC*, *H1* and *Gro1-4*) were identified.

Besides, sixteen potato genotypes were also identified possessing multiple resistance genes for late blight (*R1* and *R3a*), Potato Virus Y (Ry_{adg}) & cyst nematode (*HC*, *H1* and *Gro1-4*). These genotypes include, ten germplasm accessions (CP No's), three commercial potato cultivars (Kufri Jawahar, Kufri Sherpa and Kufri Alankar) and three advanced potato hybrids (MP/97-625, MP/97-921 and MP/04-578). These genotypes are being used as elite parental lines in resistance breeding programmes and the selections are being effected based on markers in the initial generations. Finally few selected hybrids will be challenge inoculated for confirming the resistances. Simultaneously, these elite parental lines have been intercrossed to combine multiple resistance genes into single host background. This programme is expected to produce superior parental lines with multiple disease resistances. The use of molecular markers has not only hastened the selection process but has also saved the costs of screening in each selection cycle.

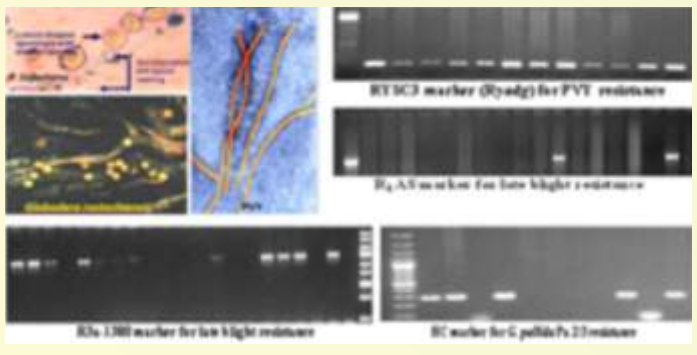

Fig. Gene stacking for disease resistance.

- Vinay Bhardwaj, Reena Sharma, Dalamu, SK Kaushik, BP Singh, Vinod Kumar, S Sundaresha, Jagesh Kumar, VU Patil and Naresh Thakur

Microarray: A tool for functional genomics study

Functional genomics is an important field of molecular biology that utilizes and validates the vast wealth of data produced by sequencing projects. In short, functional genomics helps to understand the relationship between genome and its phenotype. Functional genomics uses high-throuput techniques like DNA microarrays, proteomics, gene knock down by RNAi and many more techniques to describe the function and interactions of genes.

The desire to extend this information beyond the 'blueprint' to high-throughput analysis of molecular changes underlying macroscopic behaviour has made massive changes in biological information (DNA→ RNA→ proteins→ metabolites) by extension from genomics. High - through put analytical disciplines have emerged in the order of this information flow including: genomics, transcriptomics, proteomics and so on which are referred to as the

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'Omics cascade'. To study functional genomics, transcriptome analysis is primarily an important high-throughput approach using microarray technology. The *transcriptomics*- also referred to as expression profiling- examines the expression level of mRNAs in a given condition often using high-throughput techniques. Understanding the biotic and abiotic stress response and their interaction with different signalling pathways will help in devising strategies for sustainable crop production. Various potato transcriptomics resources and technologies have been generated including microarrays. Recent studies of plant development and environmental stresses responses have converged on the role of RNA and its metabolism as primary regulators of gene action.

In this context CPRI, Shimla has analysed the 70,083 ESTs for late blight resistance by using Microarray technology besides whole genome sequencing. Efficacy of microarray technique has been demonstrated successfully for transcriptional analysis of late blight resistance in highly resistant potato cultivar, Kufri Girdhari (2,344 resistance genes) (Fig.1) and susceptible cultivar, Kufri Bahar (2,318 susceptible genes) in response to *Phytophthora infestans* at pre and post infection, using cDNA microarray (70,073 EST). On the basis of gene ontology these functional genes were categorised/related (Fig.2) to metabolism (26%), signalling (10%), transcription regulation (10%) and plant defense (4%) involving the whole process of plant defense response to pathogens.

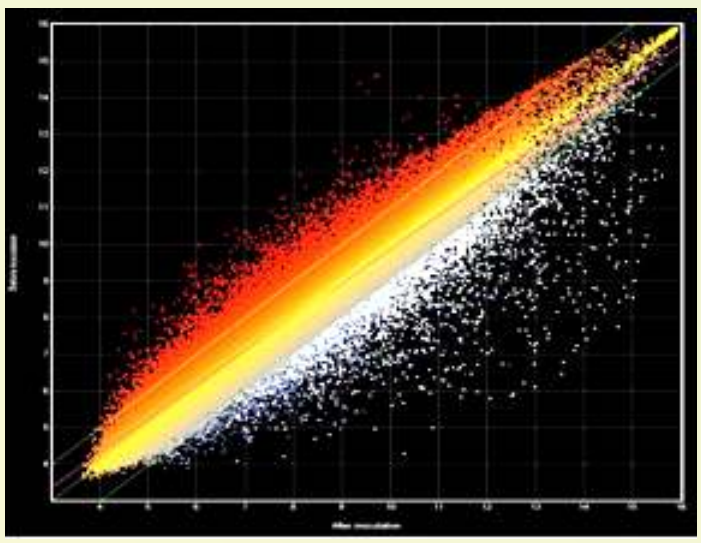

Fig. 1. Scatter plots of expression profiles of Kufri Girdhari before and after inoculation with Phytophthora infestans. Spot represents 2344 unigene transcript up-regulated by 2 fold at 99% T test confidence

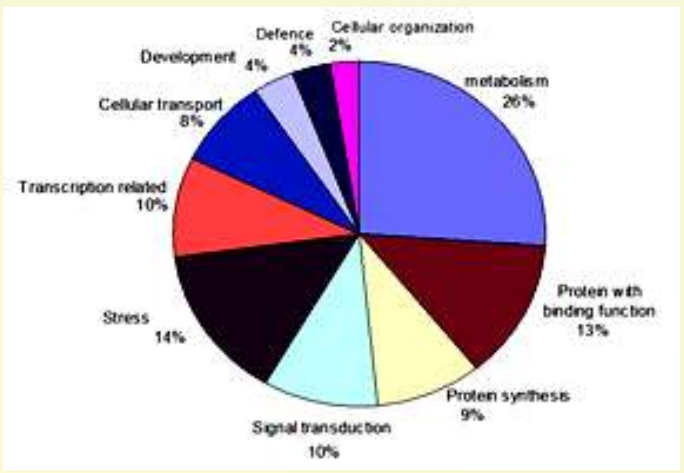

Fig. 2. Pie chart shows the proportion of P. infestans-induced genes in each of the functional categories described in Gene Ontology and uniprot website

- S Sundaresha, J Tiwari, Vinay Bhardwaj, Ritu Sindhu, VU Patil, Sanjeev Sharma and BP Singh

Successful potato micropropagation on the medium without plant growth hormones

Those using tissue culture for multiplication or transformation are concerned to produce microplants that are 'fit for the purpose', that is, free of specified diseases, vigorous, developmentally normal and genetically true-to-type. A number of well defined problems in physiological, epigenetic and genetic quality are associated with the culture of plant cell, tissue and organs *in vitro*, namely, absence or loss of organogenic potential (recalcitrance), hyperhydricity ('vitrification') and somaclonal variation. Variability expressed in microplants may be the consequence of, or related to, oxidative stress damage caused to the plant tissues during explant preparation, and in culture, due to media and environmental factors. Plant hormones implicated in hyperhydricity (vitrification) include cytokinins, auxins, and the auxin/cytokinin ratio; gibberellic acid and ethylene. In order to reduce the epigenetic changes caused by plant growth hormones an experiment was carried out with fifteen commercial cultivars under *in vitro* conditions.

Micropropagation with & without GR

Accordingly cultures were grown on the MS medium supplemented with GA_3 (0.29 µM) and NAA (0.05 µM) and without growth regulators. Observations on different morphological characters over the period of six sub-culturing cycles shows that cultures grown on the medium without growth regulator produced significantly maximum microplant height (8.1 cm), number of leaves (4.9) and number of nodes (5.0) as compared to MS medium supplemented with GA_3 (0.29 µM) and NAA (0.05 µM). Whereas, cultures grown on MS medium supplemented with GA_3 (0.29 µM) and NAA (0.05 µM) resulted in production of significantly maximum root length (6.7 cm). Therefore, we can grow the cultures successfully even on the medium without growth regulator which help in reducing the phenotypic changes.

- E P Venkatasalam, K K Pandey, Richa Sood, Vandana Thakur, Shilpa Sharma, Sumita Sharma and B P Singh

Training & Technology Transfer

Training Programmes Organised at CPRI and Regional Stations

- CPRI organized 2-day training programme sponsored by Uttarakhand Livelihood Improvement Project for Himalaya (ULPIH) for 18 farmers of Tehri Garhwal district of Uttarakhand from March 2-3, 2012. Another farmers training programme was organized for 3 days from 20-22 March 2012 for 25 farmers of HP. These trainings were given on the topic "Modern techniques for quality seed and table potato production".

Inauguration and Lecture during Farmer's Training

- Two one-day on farm trainings were conducted by the institute at Baldehan and Ghaini panchyats of Shimla district in which 72 potato growers participated. Besides, two on-farms and one on campus trainings under the project "Training entrepreneurial skills of farmer in potato based farming system of Himachal Pradesh" were organized during January-February, 2012 wherein 119 farmers participated.

Farmers' Training at Ghaini

- On-farm training was conducted at Mawplang village on "Improved potato production technology" on 15.02.2012 wherein 50 farmers' participated. Besides, trainings on "Improved potato production technology" were also organized at CPRS, Shillong on 29.02.2012 and 14.03.2012 in which 120 farmers' from Shora, Pingwait, Nongtraw and Mylliem villages participated.

Field Training at Shilong

- Organized a training programme on QBOL DNA barcoding to identify quarantine organisms in support of plant health in collaboration with CIP, New Delhi w.e.f 14-17 March, 2012.

QBOL Training at Shimla

Live Phone- in Prgrammes

- Several scientists of CPRI, Shimla participated in the Live-phone in programmes on Doordarshan and All India Radio (AIR) as experts from January to March, 2012 as given below:

Month	Title/Topics
January	Planting of potato in mid hills of Shimla and other districts of HP- Drs SS Lal & PM Govindakrishanan
February	Disease and Pest management in potato in mid hills of HP - Drs. SK Chakrabarti & Sanjeev Sharma
March	Potato varieties for lower hills of HP - Drs. NK Pandey & Vinay Bhardwaj

Human Resource

Promotions

Name	From	To
Technical		
Sh. RS Kapoor, Sh. Kusum Singh, Sh. Rajneesh Rajput, Sh. Kameshwar Sen, Sh. Om Pal, Sh. Dharminder Verma, Sh. Bhubneshwar Prasad	T-5	T-6
Sh. Jagat Ram and Sh. Vinod Kumar	T-4	T-5
Sh. DP Gautam	T-3	T-4
Sh. Ram Singh, Smt. Manjit Syal, Sh. Hari Kishore, Smt. Asha Thakur, Sh. Dharminder Kumar Gupta, Smt. Madhu Bala	T-2	T-3
Sh. P Roy Khungbuh		T-I-3
Administrative		
Sh. Roshan Lal Verma	PA	Private Secy.

Transfers/ Selections

Name	From	To
Scientific		
Dr. Jai Gopal, Head	CPRI, Shimla	DOGR, Pune as Director
Dr. SK Chakrabarti, Head	CPRI, Shimla	CTCRI, Thiruvanthapuram as Director
Sh. Baljinder Singh, T-4	CPRI, Shimla	CPRS, Jalandhar
Sh. Ashok Kumar, LDC	CPRS, Gwalior	CPRIC, Modipuram

Retirements/Dismissal

Name	Post	Retired on
Dr. Rajpal Singh	PS, CPRIC, Modipuram	29.02.2012
Sh. AS Soundharam	Scientist (Dismissed)	4.01.2012
Sh. RS Kapoor	T-5, CPRI, Shimla	31.01.2012
Sh. Raj Kumar	T-6, CPRS, Jalandhar	31.03.2012
Sh. Vijay Krishan Dhir	Private secretary, CPRS, Jalandhar	31.01.2012
Sh. Fakira Tanti	SSS, CPRS, Patna	31.01.2012
Sh. Flask Nongkynrih	SSS, CPRS, Shillong	29.02.2012
Sh. Roopu	SSS, CPRI, Shimla	29.02.2012

Foeign Visits

- Dr. BP Singh, Director, CPRI, Shimla participated as a resource person in the course on “Integrated disease management on potato” from 24.2.2012 to 01.3.2012 at Bangladesh.

- Dr. SP Trehan, Principal Scientist, CPRS, Jalandhar visited University of Gottingen, Germany w.e.f 6 – 19 March, 2012 under bilateral collaborative exchange programme of INSA.

- Dr. Vinod Kumar, Sr. Scientist, CPRS, Kufri underwent training on “ Genome resource and cryo preservation” at Leibniz Insititute of Plant Genetics and Crop Plant Research at Gaterseben, Germany w.e.f Jan. 9 to April 7, 2012.

From the Director's Desk

Potato is a new world crop and has been introduced in the old world only about 400 years ago. Because of its high productivity and nutritive value, it emerged as the third most important food crop in the world after rice and wheat. It has been projected that area and production of potato in India is likely to increase to approx. 2.55 million ha and ~ 70.00 million tonnes, respectively by the year 2030 (CPRI Vision 2030). Productivity of potato during 1993 to 2009 remained almost static (ACGR = 1.01%), which is a cause of grave concern. It indicates that new potato varieties developed during last 15-20 years failed to replace the existing varieties substantially, and as a consequence a yield plateau has been reached for the crop. Pests and diseases can potentially cause over 50% loss to attainable yield and therefore, a direct way to enhance yield is to reduce the losses caused by pests and diseases. India lacks a potato cultivar having multiple disease resistance to various biotic stresses. Stacking of resistance genes can be an alternative to improve both the level of resistance and durability. By exploiting Marker Assisted Selection (MAS) in the breeding programmes, it is now feasible to combine multiple resistance genes in potato. Recently, CPRI is expecting some superior parental lines with multiple resistance genes for late blight, Potato Virus Y & cyst nematode by using MAS. This will certainly help in reducing crop losses and thereby increasing the farm productivity and income.

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