UČINKOVITOST IN OMEJITVE PRI IZRABI SISTEMIČNO AKTIVIRANE ODPORNOSTI (SAR) PROTI RASTLINSKIM PATOGENOM

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IZVLEČEK

Številne glivične patogene zatiramo s fungicidi. Izraba SAR daje nove strategije v varstvu rastlin. Po tem konceptu patogeni s snovjo niso neposredno prizadeti, temveč ta razvije (pospeši) obrambne reakcije v okuženi rastlini. To pomeni povečanje obrambnih reakcij rastlin na višji stopnji. Potemtakem se pri tem izrablja naravni pojav. SAR inducirajo anorganski in biogeni elicitorji, kot tudi patogeni. Odpornost se izraža celo v rastlinah, ki nimajo genov za odpornost proti ustreznemu patogenu. Celo več, učinkovita je proti vsem patotipom nekega bolezenskega povzročitelja in jo moramo zato šteti kot horizontalno rezistenco.
Po kratkem uvodu o zgodovinskem razvoju bodo definirani temeljni principi SAR in prikazana učinkovitost z izbranimi zgledi. Obravnavane bodo prednosti in pomanjkljivosti tega koncepta. Dan bo tudi pogled v prihodnji razvoj te nove dimenzije v varstvu rastlin za sonaravno kmetijstvo.

ABSTRACT

EFFICACY AND LIMITATION IN THE UTILIZATION OF "SYSTEMIC ACTIVATED RESISTANCE" (SAR) AGAINST PLANT PATHOGENS

Many fungal pathogens are controlled by fungicides. The utilization of SAR offers a new strategy in plant protection. In this concept, the pathogens are not directly affected but contained thru an elevated defense in attacked plants. This means an increase of the defense reactions of plants to a higher level. Thus, a natural phenomenon is utilized. SAR is induced by inorganic and biogenic elicitors as well as by pathogens. Resistance is expressed even in plants without resistance genes against a respective pathogen. Moreover it is effective against all pathotypes of a causal organism and must therefore be considered as horizontal resistance.
After a brief introduction on the historical development, the underlying principles of SAR are defined and the efficacy is demonstrated with selected examples. Advantages and shortcomings of this concept are discussed, with an outlook on the future development of this new dimension in plant protection for sustainable agriculture.

UVOD

Uporaba odpornih kultivarjev in aplikacija fitofarmacevtskih sredstev sta dve poglavitni komponenti integriranega varstva rastlin. Videti je, da bi inducirana odpornost (rezistenca) lahko postala tretja komponenta. Ta pojav lahko opišemo takole. Po aplikaciji mikroorganizmov ali kemičnih snovi postanejo rastlinski deli dotlej občutljivih kultivarjev odporni. Obstaja več tipov inducirane rezistence, ki so jih v pregledih prikazali Kuc (1982), Schönbeck & Dehne (1986) in Hammerschmidt & Kuc (1995). Ta predstavitev se bo usmerila le na en tip, sistemično aktivirano odpornost (rezistenco) (SAR, systemic activated resistance), ker je najbolj obetavna (Schlösser, 1997).

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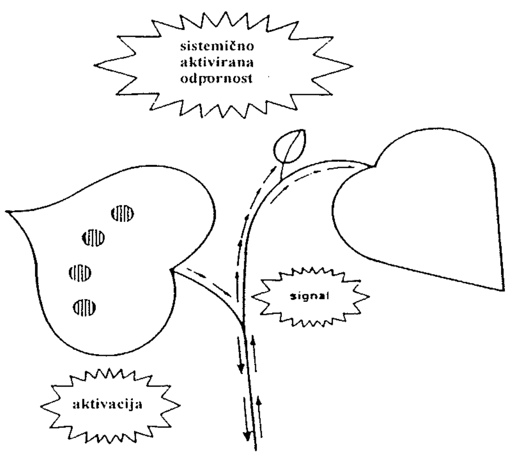
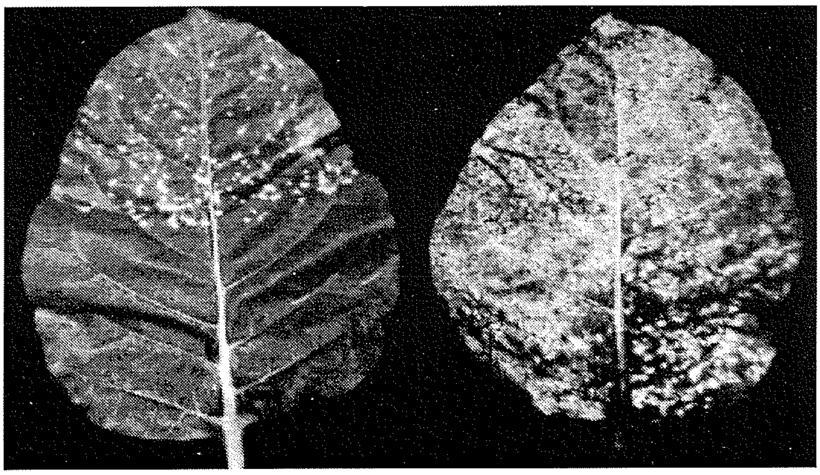
DEFINICIJA

SAR je definirana z naslednjim principom (slika 1).



Slika 1: Razvoj sistemično aktivirane odpornosti (po Kessmann *et al.*, 1995).

Po vzdraženju lista z mikroorganizmi ali kemičnimi snovmi nastane en ali več signalov neznane narave. Ti se prenesejo na nevzdražene listne dele in v vse druge netretirane liste. V njih povzročijo odpornostni odziv, če so ti deli izzvani z inokulacijo z rastlinskimi patogeni. Dva zgleda bosta ponazorila to reakcijo.
Prvi obravnava indukcijo odpornosti pri enem listu (slika 2).



Slika 2: Lista občutljivega tobakovega kultivarja 'Samsun NN' inokulirana s tobakovim mozaikom – *tobacco mosaic tobamovirus* (TMV) na zgornjem delu (levo) in neinokuliran (desno), oba inokulirana s TMV sedem dni pozneje. Spodnji del levega lista kaže popolno odpornost proti izzvani inokulaciji (po Ross, 1961).

Vidno je, da inokulacija z virusom tobakovega mozaika – *tobacco mosaic tobamovirus* (TMV) na zgornjem delu lista občutljivega kultivarja 'Samsun NN' zagotavlja popolno varstvo spodnjega dela lista proti sledeči inokulaciji z istim virusom.

Drugi zgled se nanaša na poskuse, ki sta jih opravila Carus & Kuc (1997). Ugotovila sta, da inokulacija prvega pravega lista kumar, lubenic in dinje z glivo *Colletotrichum lagenarium*, ki povzroča listno pegavost, varuje druge in tretje liste pred isto glivo na polju. Ta odziv je razviden na sliki 1.

OZNAČITEV

SAR je okarakterizirana s temile parametri:
- Izhaja iz aktivacije rastlinskih obrambnih reakcij in ne neposredno od zatiranja patogena.
- Ni odziv, ki bi bil odvisen od odmerka.
- Potrebna je aktivacijska doba 2-7 dni.
- Očitno lahko postane učinkovita le, če se induktor aplicira pred okužbo z nekim patogenom.
- Izraža se tudi v rastlinskih kultivarjih, ki nimajo genov za rezistenco proti določenemu rastlinskemu patogenu.
- Učinkuje tako na biotrofne kot tudi na obligatno biotrofne patogene.
- Izraža se proti vsem patovarom ali patotipom nekega patogena.
- Je očitno poligena in jo moramo zato obravnavati kot horizontalno rezistenco in zato trajno.
- Njeno izražanje je le začasno, zato nizek selekcijski pritisk ne pospeši selekcije odpornosti, ki bi premagala patogene.

V načelu SAR učinkuje z mobilizacijo rastlinskih virov za obrambo pred rastlinskimi patogeni

SPECIFIČNOST

SAR je sorazmerno nespecifična, kolikor se nanaša na induktorje in na odziv rastlin. Sprožijo jo rastlinski patogeni virusi, bakterije in glive kot tudi abiotične in biogene kemične snovi. Virusi lahko aktivirajo obrambo pred glivami, bakterije lahko sprožijo sintezo fitoaleksinov, ki niso učinkoviti proti njihovi okužbi, toda lahko omejijo razvoj gliv. Očitno je, da se aktivirajo vsi možni obrambni mehanizmi, neodvisno od vrste aktivatorja.

NAČIN UČINKOVANJA

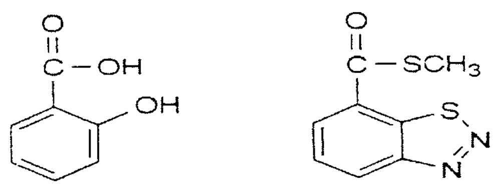
Mehanizmi, ki so temelj ekspresije SAR, še niso znani v celoti. Operativni tok dogodkov lahko opišemo v poenostavljeni verziji s temile koraki:
- Kompleksne interakcije na/v plazmalemi vzdražene rastlinske celice povzročijo nastanek ene ali več signalnih substanc.
- Ti signali se prenašajo znotraj celice, do sosednjih celic ali tkiv drugih nevzdraženih rastlinskih delov.

- Prizadeta rastlinska tkiva se odzivajo s kaskado multiplih obrambnih reakcij, ki so nespecifične in glede na vrsto aktivatorja neusmerjene.
- V celicah, ki so sprejele signal pred okužbo s patogenom se intenzivirajo odzivi, če so izzvani z inokulacijo. Ti odzivi vključujejo kopičenje protiglivnih fitoaleksinov, s patogenezo povezanih (PR) proteinov in lignina, kot tudi bolj poudarjeno tvorbo papil proti havstorijem biotrofnih glivnih patogenov.

V nekompatibilnih sistemih gostiteljev – patogenov se SAR vzpostavi. Ker je patogen ne more obvladati se kaskada multiplih obrambnih reakcij izrazi popolnoma in postane učinkovita proti vdirajočemu patogenu. To rezultira v preprečitvi razvoja bolezni (Schlösser, 1997). V kompatibilnih sistemih se SAR prav tako vzpostavi. Patogeni pa imajo možnost, da preprečijo nastanek obrambnih reakcij in s tem omogočijo razvoj bolezni v okuženih tkivih. Potemtakem je SAR naravni pojav obrambe pred rastlinskimi patogeni.

RAZVOJ

Koncept SAR, ki so ga včasih imenovali pridobljena fiziološka imunost je star približno sto let. Odkar je Chester (1933) objavil pregledni članek, so o tej tematiki izšle številne raziskave. Induktorji so bili rastlinski patogeni, kulturni filtrati bakterij in drugi biogeni materiali, ki jih je težko standardizirati. Da bi olajšali raziskave in da bi dobili reproducibilne rezultate je bil potreben standardni induktor. Po prerešetanju velikega števila kemičnih substanc, so identificirali tak induktor (Staub *et al.*, 1993). L. 1995 je bil na voljo za komercialno varstvo rastlin CGA 245704 (Bion) (Kessmann *et al.*, 1995). Bion, derivat benzotiadizola (slika 3) izpolnjuje vse zahteve kot učinkovit induktor SAR. V kompatibilnih sistemih gostiteljev in patogenov se prepreči oz. potlači povečanje salicilne kisline (slika 3), ene identificiranih signalnih substanc.



Slika 3: Kemična struktura salicilne kisline (levo) in Biona (desno)

Kot posledica se SAR v občutljivih kultivarjih ne izrazi. Strukturno soroden Bion nadomesti pomanjkanje salicilne kisline. To daje možnost indukcije SAR tudi v kompatibilnih sistemih, kjer bi patogen sicer preprečil njen pojav. Z vrsto poskusov z akro- in bazipetalno prenosljivim Bionom je bilo ugotovljeno, da ta posnema indukcijo SAR z rastlinskimi patogeni. Tako njegova aplikacija ne inducira ničesar drugega kot naravni pojav obrambe v rastlinah. Narava je kreirala koncept!

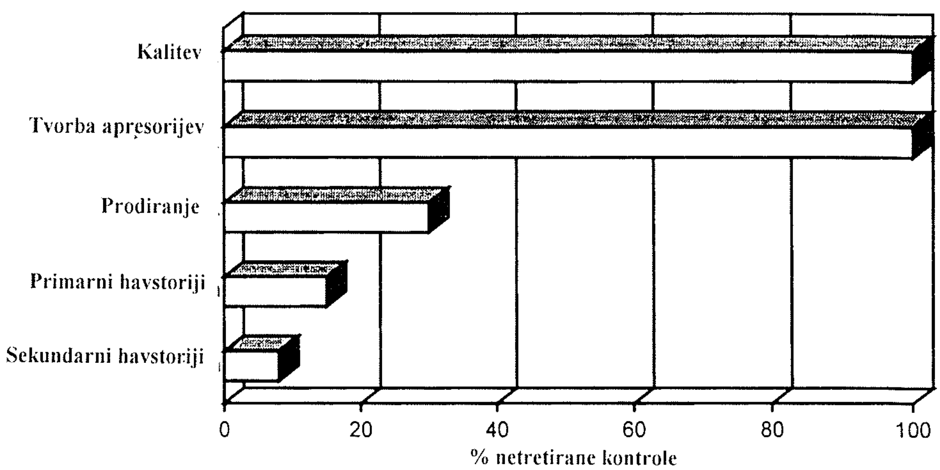
PRIZADETI RASTLINSKI PATOGENI

Zares je mogoče zatirati precej patogenov:
Oomycota (*Pseudoperonospora, Phytophthora, Bremia*)

Ascomycota (*Blumeria, Erysiphe, Cochliobolus, Magnaporthe, Mycosphaerella, Sclerotinia*)
Basidiomycota (*Corticicum, Puccinia*)
Mitosporne glive (*Alternaria, Colletotrichum*)
Bakterije (*Pseudomonas, Xanthomonas*)
Ta seznam je zelo verjetno nepopoln. Vendar pa ni mogoče pričakovati, da bi se dalo vse patogene zatirati s SAR.

UČINKOVITOST

Od številnih poskusov bi navedli le tri aspekte. Enkratno tretiranje s 30 g aktivne snovi/ha v rastnem stadiju 25-29 lahko zadostno varuje pšenične rastline za približno 60-70 dni proti žitni pepelovki *Blumeria graminis* f. sp. *tritici*. Ta učinek nastane zaradi oviranega razvoja havstorija (slika 4), zaradi povečanega pojava papil.



Slika 4: Razvojni stadiji *Blumeria graminis* f. sp. *tritici* na pšeničnih listih po preventivnem tretiranju z Bionom v primerjavi z netretirano kontrolo (po Görlach *et al.*, 1996)

Aplikacija Biona v obliki zrnc v setvene bokse riža je popolnoma varovala rastline po presajanju na polje približno 70 dni pred glivo *Magnaporthe grisea*, ki povzroča najhujšo bolezen na rižu. Poskusi v rastlinjaku (Falconi & Schlösser, neobjavljeno) so pokazali, da tretiranje semen kot tudi foliarna aplikacija lahko popolnoma varuje čičerko, fižol za stročje in lečo pred talno glivo *Corticium rolfsi*. Tako je tu upanje, da bo mogoče vsaj nekatere patogene, ki okužujejo podzemne dele rastlin uspešno zatirati s foliarno aplikacijo, s čimer bi se izpolnile sanje fitopatologov. Toda čeprav so ti rezultati impresivni, vendar ne nakazujejo, da je Bion zadostno učinkovit proti vsem rastlinskim patogenom.

RAZGLED

Kljub obetavnim perspektivam pa vendar ne smemo spregledati, da obstaja še vrsta odprtih vprašanj glede učinkovitosti SAR, ki jo povzroča Bion:
- Kateri patogeni so prizadeti in v kakem obsegu?
- Katere so optimalne koncentracije za različne sisteme in kateri odmerki so fitotoksični?
- Kateri rastni stadiji rastlin so najustreznejši za aplikacijo, da bi dosegli dolgotrajno varstvo?
- Kakšna je vloga rastlinskih genotipov pri stopnji izražanja odpornosti?
- Ali se ontogenetski stadiji rastlinskih delov razlikujejo v svojem odzivu?
- Kakšen vpliv imajo različni dejavniki, npr. klimatske razmere, vodni stres, zastajanje vode in prehranski status rastlin na stopnjo izražanja odpornosti?

Kljub tem kritičnim pripombam bo praktična izraba SAR vodila v novo dimenzijo varstva rastlin v trajnostno rastlinski pridelek. Poleg tega ta nova tehnologija daje dobrodošlo alternativo transgenim kultivarjem, ker je SAR učinkovita proti vrsti rastlinskih patogenov in kar je najpomembnejše proti vsem njihovim patotipom. Tako širok spekter varstva nikoli ni mogoče doseči s transgenimi rastlinami.
Razumljivo je, da je potrebno še veliko raziskav predno bo uporaba SAR postala splošno orodje v varstvu rastlin. Če bo ta nova razburljiva strategija dobila pozornost, ki jo zasluži, bo zaželeni cilj dosežen v bližnji prihodnosti.

LITERATURA

Caruso, F. / J. Kuc, 1977. Field protection of cucumber, watermelon an muskmelon against *Colletotrichum lagenarium* by *Colletotrichum lagenarium*.- Phytopathology 67: 1290-1292.

Chester, K. S., 1933. The problem of accquired physiological immunity in plants.- Quart. Rev. Biol. 8: 128-154, 274-324.

Görlach, J. / S. Volrath / G. Knauf-Beiter / G. Hengy / U. Beckhove / K.-H. Kogel / M. Oostendorp / T. Staub / E. Ward / H. Kessmann / J. Ryals, 1996. Benzothiadiazole, a novel class of inducers of systemic aquired resistance, activates gene expression and disease resistance in wheat.- Plant Cell 8: 629-643.

Hammerschmidt, R. / J. Kuc (eds.), 1995. Induced Resistance to Disease in Plants. Kluwer Academic, Dordrecht.

Kessmann, H. / J. Ryals / T. Staub / M. Oostendorp / P. Ahl Goy / C. Hofmann / L. Friedrich / T. Delaney / K. Lawton / K. Weymann / H. Ligon / B. Vernoij / S. Uknes, 1995. CGA 245704: mode of action of a new plant activator. Presented at the International Plant Protection Congress. The Hague.

Kuc, J., 1982. Induced Immunity to Plant Disease.- BioScience, 32: 854-860.

Ross, A.F., 1961. Systemic aquired resistance induced by localized virus infections in plants.- Virology 14: 340-358.

Schlösser, E., 1997: Allgemeine Phytopathologie, 2. Auflage, Thieme Verlag, Stuttgart.

Schlösser, E., 1997: Systemic Activated Resistance – A New Dimension in Plant Protection.- Arab J. Pl. Prot. 15: 147-149.

Zbornik predavanj in referatov s 4. Slovenskega posvetovanja o varstvu rastlin, Portorož, 3.-4. marec 1999 str. 7-12

EFFICACY AND LIMITATION IN THE UTILIZATION OF „SYSTEMIC ACTIVATED RESISTANCE" (SAR) AGAINST PLANT PATHOGENS

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ABSTRACT

Many fungal pathogens are controlled by fungicides. The utilization of SAR offers a new strategy in plant protection. In this concept, the pathogens are not directly affected but contained thru an elevated defense in attacked plants. This means an increase of the defense reactions of plants to a higher level. Thus, a natural phenomenon is utilized. SAR is induced by inorganic and biogenic elicitors as well as by pathogens. Resistance is expressed even in plants without resistance genes against a respective pathogen. Moreover it is effective against all pathotypes of a causal organism and must therefore be considered as horizontal resistance.
After a brief introduction on the historical development, the underlying principles of SAR are defined and the efficacy is demonstrated with selected examples. Advantages and shortcomings of this concept are discussed, with an outlook on the future development of this new dimension in plant protection for sustainable agriculture.

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Po kratkem uvodu o zgodovinskem razvoju bodo definirani temeljni principi SAR in prikazana učinkovitost z izbranimi zgledi. Obravnavane bodo prednosti in pomanjkljivosti tega koncepta. Dan bo tudi pogled v prihodnji razvoj te nove dimenzije v varstvu rastlin za sonaravno kmetijstvo.

INTRODUCTION

An utilization of resistant cultivars and the application of pesticides are the two major components of integrated plant protection. It appears that inducible resistance could become a third component. This phenomenon can be described as follows. After application of microorganisms or chemicals, plant parts of hitherto susceptible cultivars become resistant. There are several types of inducible resistance, which have been reviewed by Kuc (1982), Schönbeck & Dehne (1986) and Hammerschmidt & Kuc (1995). This presentation will focus only on one type, the systemic activated resistance (SAR), because it is the most promising (Schlösser, 1997).

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DEFINITION

SAR is defined by the following principle (Fig. 1).

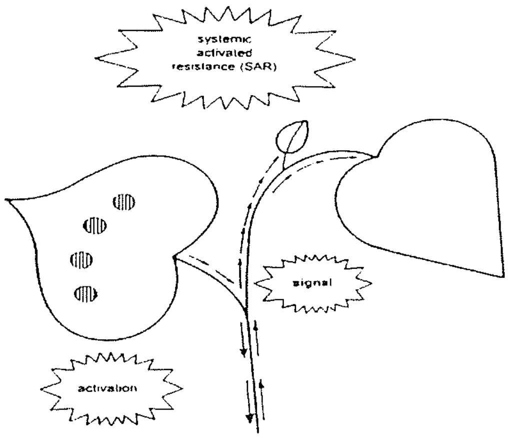

Figure 1: Development of Systemic Activated Resistance (after Kessmann *et al.*, 1995)

Upon irritation of a leaf by microorganisms or chemicals one or more signals of unknown nature are formed. These are than translocated to the non-irritated leaf part and to all other untreated leaves. There it conditions a resistance response, when these parts are challenged by an inoculation of plant pathogens. Two examples will illustrate this reaction.
The first deals with induction of resistance within one leaf (Fig. 2).

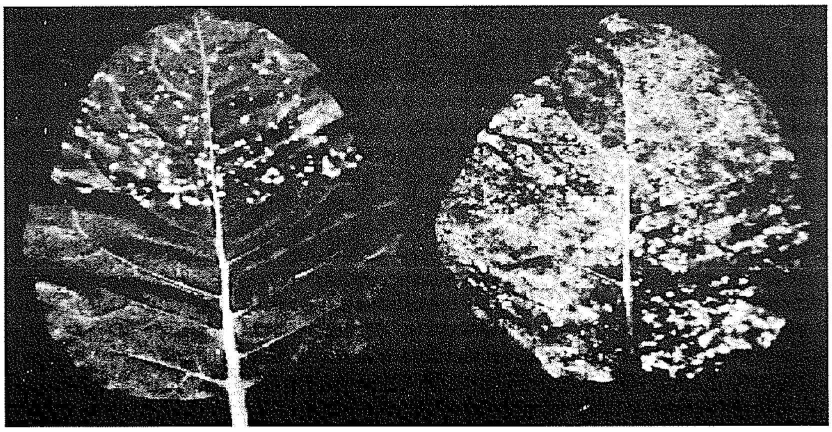

Figure 2: Leaves of the susceptible tobacco cv. Samsun NN inoculated with *tobacco mosaic tobamovirus* (TMV) on the upper part (lef) and uninoculated (right), both inoculated with TMV seven days later. The lower part of the left leaf exhibits complete resistance against the challenge inoculation (from Ross, 1961)

It shows that an inoculation with the *tobacco mosaic tobamovirus* (TMV) on the upper leaf part of the susceptible cv. Samsun NN provides a complete protection of the lower part against a subsequent inoculation with the same virus.
The second example concerns the experiments of Caruso & Kuc (1977). They reported that an inoculation of the first true leaf of cucumber-, water- and muscmelons with the leaf-spotting fungus *Colletotrichum lagenarium* protected the second and third leaves against the same fungus in the field. This response is reflected in Fig. 1.

CHARACTERIZATION

SAR is characterized by the following parameters:
- It results from an activation of plant defenses and not from a direct control of pathogens.
- There is no dosis-effect response.
- An activation period of 2-7 days is required.
- It can apparently become effective only when the inducer is applied before the attack of a pathogen.
- It is expressed also in plant cultivars with no resistance genes for a particular plant pathogen.
- Obligate biotrophic as well as non-obligate pathogens are affected.
- It is expressed against all pathovars or pathotypes of a pathogen.
- It is apparently polygenic and must therefore be regarded as horizontal resistance and thus durable.
- Its expression is only temporarily, therefore the low selection pressure will not enforce a selection of resistance over-coming pathogens.

In principle, SAR operates by a mobilization of plant resources for a defense against plant pathogens.

SPECIFICITY

SAR is relatively unspecific as far as inductors and plant responses are concerned. It is triggered by plant pathogenic viruses, bacteria and fungi as well as by abiotic and biogenic chemicals. Viruses can activate a defense against fungi, bacteria can trigger a synthesis of phytoalexins, which are of no use against their attack, but can limit fungal development. It appears, that all possible defense systems are activated, irrespective of the kind of activator.

MODE OF ACTION

The mechanisms underlying the expression of SAR are not yet fully understood. The operational flow of events can be described in a simplified version by the following steps:
- Complex interactions on and in the plasmalemma of irritated plant cells result in a formation of one or more signal substances.
- These signals are translocated within a cell, to adjacent cells or to tissues of other non-irritated plant parts.
- Affected plant tissues respond with a cascade of multiple defense reactions, which are unspecific and undirected with regard to the kind of activator.

- In cells which have received the signal (s) prior to pathogen attack, there are intensified responses when they are challenged by inoculation. These include an accumulation of antimycotic phytoalexins, pathogenesis-related (PR)-proteins and lignin as well as a more pronounced papillae formation against haustoria of biotrophic fungal pathogens.

In incompatible host-pathogen-systems the SAR is initiated. As the pathogen can not suppress it, the cascade of multiple defense reactions will be fully expressed and become effective against the invader. This results in an inhibition of disease development (Schlösser, 1997). In compatible systems the SAR is likewise initiated. The pathogens have, however, means to suppress the build up of the defense reactions, thus permitting a disease development in the attacked tissues. Thus, SAR is a natural phenomenon of defense against plant pathogens.

DEVELOPMENT

The concept of SAR, formerly called aquired physiological immunity, is about 100 years old. Since the review by Chester (1933) numerous papers have been published on this topic. The inducers were plant pathogens, culture filtrates of bacteria and other biogenic materials, which are difficult to standardize. To facilitate research and to obtain reproducible results a standard inducer was needed. After screening a large number of chemical compounds such an inducer was identified (Staub *et al.* 1993). In 1995 CGA245704 (Bion) was presented for commercial plant protection (Kessmann *et al.* 1995). The benzothiadiazole derivative Bion (Fig. 3) fulfills all requirements for an effective inducer of SAR. In compatible host-pathogen-systems, an increase of salicylic acid (Fig. 3), one of the identified signal substances, is suppressed.

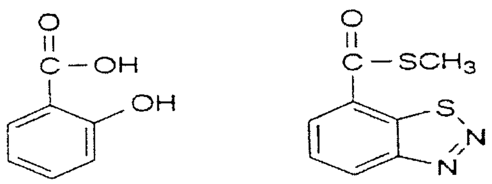

Figure 3: Chemical structures of salicylic acid (left) and Bion (right)

Consequently, there is no expression SAR in susceptible cultivars. The structurally related Bion can replace the lacking salicylic acid. This offers the possibility to induce SAR also in compatible systems, where the pathogens would otherwise suppress its induction. With a number of experiments the acro- and basipetally translocated Bion has been found to mimic an induction of SAR by plant pathogens. Thus, its application induces nothing else but a natural phenomenon of defense in plants. Nature created the concept!

AFFECTED PLANT PATHOGENS

Quite a number of pathogens can be controlled:
Oomycota (*Pseudoperonospora, Phytophthora, Bremia*)
Ascomycota (*Blumeria, Erysiphe, Cochliobolus, Magnaporthe, Mycosphaerella, Sclerotinia*)

Basidiomycota (*Corticicum, Puccinia*)
Mitosporic fungi (*Alternaria, Colletotrichum*)
Bacteria (*Pseudomonas, Xanthomonas*)
This list is most likely not complete. It can, however, not be expected that all pathogens can be controlled by SAR.

EFFICACY

From the many trials only three aspects will be cited. One application of 30 g a.i./ha at GS 25-29 can protect wheat plants sufficiently for about 60-70 days against the powdery mildew *Blumeria graminis* f. sp. *tritici*. This affect is due to an inhibition of haustorial development (Fig. 4) by increased papillae formation.

Application of Bion in a granular formulation to seed boxes of rice protected the plants after transplantation into the field for about 70 days completely against *Magnaporthe grisea*, the causal agent of rice blast. Glasshouse experiments have shown (Falconi & Schlösser unpublished) that seed treatments as well as foliar applications can give a complete protection of chickpeas, french beans and lentils against soilborne *Corticium rolfsii*. Thus, there is hope that at least some pathogens attacking underground parts of plants might be successfully controlled by foliar applications, which would fulfill a dream of plant pathologists. Though these results are impressive, they do not imply that Bion is sufficiently effective against all plant pathogens.

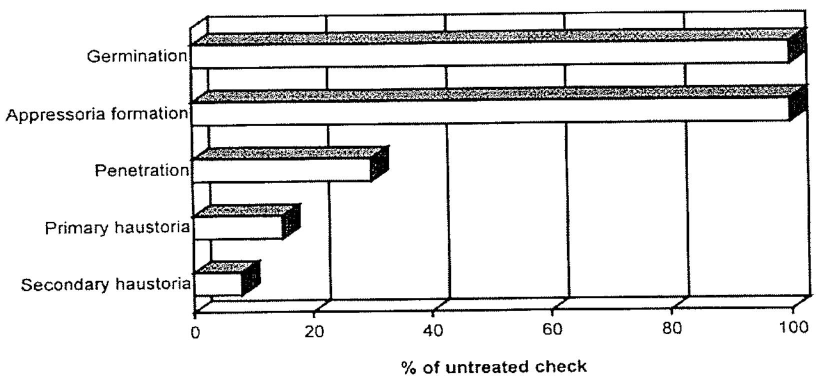

Figure 4: Developmental stages of *Blumeria graminis* f. sp. *tritici* on wheat leaves after protective treatment with Bion in comparision to the untreated check (after Görlach *et al.*, 1996)

OUTLOOK

Despite the promising perspectives, it must not be overlooked that there is a number of open questions with regard to Bion mediated efficacy of SAR:

- Which pathogens are affected and to what extent?

- What are the optimum concentrations for various systems and which dosages are phytotoxic?
- Which GS of plants is best for application to obtain a long lasting protection?
- What is the role of plant genotypes in the degree of resistance expression?
- Do ontogenetic stages of plant parts differ in their response?
- What impact do various factors, e.g. climatic conditions, water stress or logging and nutritional status of plants have on the degree of resistance expression?

Despite these critical annotations, a practical utilization of SAR will lead into new dimension of plant protection in sustainable plant production. Besides, this new technology offers a welcome alternative to transgenic cultivars as SAR is effective against a variety of plant pathogens, and most importantly, all their pathotypes. Such a broad spectrum control can never be achieved with transgenic plants.

It is obvious, that more investigations are needed before a use of SAR can become a common tool in plant protection. When this new exciting strategy receives the attention it deserves, the desired aim will be reached in the near future.

REFERENCES

Caruso, F. / J. Kuc, 1977. Field protection of cucumber, watermelon an muskmelon against *Colletotrichum lagenarium* by *Colletotrichum lagenarium*.- Phytopathology 67: 1290-1292.

Chester, K. S., 1933. The problem of accquired physiological immunity in plants.- Quart. Rev. Biol. 8: 128-154, 274-324.

Görlach, J. / S. Volrath / G. Knauf-Beiter / G. Hengy / U. Beckhove / K.-H. Kogel / M. Oostendorp / T. Staub / E. Ward / H. Kessmann / J. Ryals / 1996. Benzothiadiazole, a novel class of inducers of systemic aquired resistance, activates gene expression and disease resistance in wheat.- Plant Cell 8: 629-643.

Hammerschmidt, R. / J. Kuc (eds.), 1995. Induces Resistance to Disease in Plants. Kluwer Academic, Dordrecht.

Kessmann, H. / J. Ryals / T. Staub / M. Oostendorp / P. Ahl Goy / C. Hofmann / L. Friedrich / T. Delaney / K. Lawton / K. Weymann / H. Ligon / B. Vernoij / S. Uknes, 1995. CGA 245704: mode of action of a new plant activator. Presented at the International Plant Protection Congress. The Hague.

Kuc, J., 1982. Induced Immunity to Plant Disease.- BioScience, 32: 854-860.

Ross, A.F., 1961. Systemic aquired resistance induced by localized virus infections in plants.- Virology 14: 340-358.

Schlösser, E., 1997: Allgemeine Phytopathologie, 2. Auflage, Thieme Verlag, Stuttgart.

Schlösser, E., 1997: Systemic Activated Resistance – A New Dimension in Plant Protection.- Arab J. Pl. Prot. 15: 147-149.

Zbornik predavanj in referatov s 4. Slovenskega posvetovanja o varstvu rastlin, Portorož, 3.-4. marec 1999 str. 13-20

ZAKONODAJA NA PODROČJU VARSTVA RASTLIN IN PRILAGAJANJE EU

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IZVLEČEK

Področje varstva rastlin v Sloveniji urejajo številni predpisi, med katerimi je vsekakor najpomembnejši zakon o zdravstvenem varstvu rastlin, ki je začel veljati v začetku 1995. Pravno ureditev področja varstva rastlin dopolnjujejo podzakonski predpisi, ki podrobneje urejajo posamezne določbe navedenega zakona in mednarodni sporazumi ter konvencije s področja varstva rastlin, ki jih je sprejela Slovenija.
Prilagajanje EU pomeni prevzemanje pravne ureditve področja varstva rastlin, ki velja v državah članicah EU. Zakonodaja EU, ki posebej ureja področje varstva rastlin obsega regulative, direktive in odločbe. Prevzem EU predpisov pomeni za Slovenijo soočenje s številnimi novimi nalogami in obveznostmi. Med najpomembnejšimi so: vzpostavitev registra pridelovalcev, uvoznikov in distributerjev določenih vrst rastlin in rastlinskih proizvodov, vzpostavitev sistema potnega lista za rastline, uvedba sistema varovanih območij, uskladitev pristojnosti in postopkov za registracijo fitofarmacevtskih sredstev in zagotovitev državnega monitoringa nad ostanki (rezidui) fitofarmacevtskih sredstev in drugih pesticidov v rastlinah.
Uskladitev zakonodaje je ena prvih pomembnejših nalog v procesu prilagajanja. Vendar sama usklajenost predpisov ni dovolj, ampak je treba vzpostaviti tudi ustrezne strukture za izvajanje zakonodaje. Za Slovenijo to pomeni organizacijo državne službe za varstvo rastlin, vzpostavitev ustrezne infrastrukture na zunanjih mejnih prehodih in uskladitev sistema varstva rastlin v notranjosti države z zahtevami EU.

ABSTRACT

PLANT PROTECTION LEGISLATION AND ADOPTION TO EU

The field of plant protection is regulated by numerous regulations, of which the most important is Plant Protection Law, which came into force in the beggining of 1995. In addition to that there are also special regulations under the Plant Protection Law, which in details regulate particular provisions of the mentioned law and international agreements and conventions in the field of plant protection, which were accepted by Slovenia.
The adoption to EU means to contract the obligation of the acquis in the field of plant protection, which is valid in the Member States of EU. EU plant protection legislation includes regulatives, directives and decisions. The adoption of EU regulations means for Slovenia to be faced with many new tasks and responsibilities. The most important are: official register of producers, importers and distributors of certain plants and plant products, plant passporting system, protected areas regime, harmonisation of responsibilities and procedures for authorisation of plant protection products and the assurance of national monitoring program on pesticide residues in plants.
Harmonisation of legislation is one of the most important tasks in the accession process. But just harmonised legislation is not enough, also the proper structures has to be developed for implementation of legislation. For that purpose Slovenia needs to establish national plant protection service, to upgrade facilities on external border posts and to put plant protection system inside the country in line with EU requirements.

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