INDUCED CHANGES IN THE CHEMICAL COMPOSITION OF OILSEED RAPE VEGETATIVE TISSUE IN RESPONSE TO ARTIFICIAL AND TURNIP ROOT FLY (*Delia floralis*) DAMAGE

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ABSTRACT

Damage to brassica roots caused by turnip root fly (*Delia floralis*) larval feeding induces specific changes in host plant glucosinolate metabolism. In roots neoglucobrassicin concentration is increased by up to 88%. Root damage can also induce alteration of stem and leaf glucosinolate profiles, but these systemic effects are influenced by plant genotype, type and timing of tissue damage and environmental factors. The possible importance of wound induced changes in glucosinolate metabolism on insect-plant interactions and on crop quality are discussed.

INTRODUCTION

Many pests and pathogens of brassica crops (family Cruciferae) are affected by a group of sulphur-containing secondary metabolites called glucosinolates. However, in many cases the mechanisms operating are poorly understood. The effects of these chemicals on plant-pest interactions can differ greatly, depending, for example, on whether an insect pest is a "generalist" or Crucifer "specialist". The nature of the interaction may also be dependent on the perceived concentrations of glucosinolates and their breakdown products and consequently be affected by changes in the spatial distribution of these compounds during plant maturity, as well as by environmental/stress factors influencing plant growth and metabolism.

Our studies are focussed on understanding the role of glucosinolates and other plant chemicals in determining the host preferences (during adult egg laying) and host status for development (during larval feeding on roots) for the turnip (*Delia floralis*) and cabbage (*D. radicum*) root flies. Both species are important pests of many vegetable brassicas and can build up large population reservoirs on oilseed rape. In addition, root flies can induce multiple chemical changes (e.g. of glucosinolates, sugars, lignin) in their host plants following root damage, that potentially alter the host status for insects and the quality of the agricultural product(s) from the crop. The work reported here summarises part of our studies on root damage-induced modification of glucosinolates in vegetative tissues of several brassicas compared against oilseed rape genotypes.

EXPERIMENTAL

Several brassica genotypes, selected to represent a range of susceptibility to root fly attack, were grown under glasshouse conditions. The glucosinolate responses to root damage, caused either by feeding larvae (after plant inoculation with known numbers of *D. floralis* eggs) or artificial wounding, were measured using standard techniques (Birch *et al.*, 1992; Griffiths *et al.*, 1994).

RESULTS AND DISCUSSION

In the first investigation (Birch *et al.*, 1990) attack by turnip root fly larvae considerably modified both concentrations and relative proportions of individual glucosinolates in roots of three forage rapes (B17, Hobson, Samo) and two winter oilseed rapes (Ariana, WRG35). The total glucosinolate content of roots decreased for all genotypes except WRG35. However, in all cases the ratio of aromatic to aliphatic glucosinolates increased, when measured 6 weeks after initiating attack. This response was largely due to an average increase of 88% in a single indole-based compound in attacked roots, 1-methoxy-3-indolylmethyl glucosinolate (neoglucobrassicin).

In the second investigation, comparing a wider range of brassicas (swede, kale, forage rape) with winter oilseed rape (Ariana), larval root damage again induced an increase in root indole glucosinolates, particularly neoglucobrassicin, in all plants following 8 weeks larval damage. Under these experimental conditions root damage did not significantly induce changes in stem glucosinolate profiles, but did alter the leaf composition. Despite plant genotypic variation in the induced changes of leaf aliphatic glucosinolates, all six brassicas had reduced levels of indole-based glucosinolates relative to controls. Individual leaf glucosinolates were not quantified as the low levels found were close to minimum detection thresholds for the HPLC system (Birch *et al.*, 1992).

Subsequent experiments have investigated the effects of type (larval feeding, artificial root wounding) and timing of damage to oilseed (Ariana) and forage (Hobson, Bonar) rapes. Larval damage increased total root glucosinolate content whilst artificial wounding had the opposite effect. Larval damage also significantly increased the proportion of indole glucosinolates (neoglucobrassicin) in roots, but artificial wounding did not. The timing of both types of damage also influenced plants' responses; e.g. the proportion of neoglucobrassicin also increased in stems following early (6 weeks before harvest) but not following later (4 weeks before harvest) larval damage. Root damage could also induce changes in leaf glucosinolate profiles, but were genotype-specific. Under these experimental conditions both larval and artificial root damage induced a significant increase in the proportion of indole glucosinolates (glucobrassicin) in leaves of Ariana but not in the other rapes studied (Griffiths *et al.*, 1994).

From these and other studies (see review, Bennett & Wallsgrove, 1994) it is now apparent that plant genotype, type of damage and its timing (involving rapid factors can interact in complex ways to produce a range of inducible glucosinolate responses in brassicas to insect and other pathogen attack. The apparent systemic responses in plant tissues other than at the site of direct wounding could suggest the involvement of cellular signalling involving elicitors. Recent studies (reviewed in Bennett & Wallsgrove, 1994) have shown that application of salicylic acid (soil drench) or methyl jasmonate (vapour) to oilseed rape induce mainly 2-phenyl ethyl or 1-methoxy-3-indoylmethyl glucosinolates in leaves respectively. Neither chemical elicitor could fully mimic the effects induced by insect feeding or pathogen attack and their possible role in natural defence signalling, involving inducible changes in glucosinolate metabolism, remains to be elucidated. Because of the importance of glucosinolates and their breakdown products in host recognition by root flies (Roessingh, *et al.*, 1992) and other insects, in pest and pathogen resistance mechanisms and in influencing the quality of crop-derived products, this remains a fascinating and important area of research into brassica chemical ecology.

ACKNOWLEDGEMENTS

This research is funded by the Scottish Office Department of Agriculture and Fisheries.

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