SIGNIFICANCE OF PHYTOHORMONES IN SIBERIAN LARCH-BUD GALL MIDGE INTERACTION

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INTRODUCTION

Interrelations of the bud gall midge and the Siberian larch are of scientific and practical interest because of the bud gall midge's role as a plant endoparasite. We know that attack by the gall midge sets off a reaction in the entire plant. Invasion by the insect results in a certain interaction between physiological mechanisms of the insect and the plant which leads to a complex range of interdependent shifts in the metabolism of the tree, the final result depending on the character of those shifts. The reactions of both the plant and the insect are determined both by genetic factors and by environmental conditions.

The bud gall midge has long been considered a pest of the larch in Siberia even though it does not cause significant mortality among the trees. Some papers have been written on the effect of the gall midge on morphological and physiological parameters of the larch (Isaev et al. 1988). Damage to the larch by the bud gall midge involves reduction of the assimilative apparata. The gall midge infests the buds of the brachyblasts. Where the eggs have been laid under the cover scales of the buds, a gall appears, functioning during one season in which the whole cycle of insect development takes place.

MATERIALS AND METHODS

The balance of phytohormones in the plant, which is upset by the insect, has not been studied enough, though hormonal changes in damaged plant tissue have been recorded. In our study, phytohormone dynamics were examined in the needles, buds, and galls from the time of needle initiation up to the time of their yellowing and fall in the autumn, taking into account insect development stages, and tree differentiation according to the rate of pest invasion. To study the phytohormones, we used a set of methods including extraction, purification, chromatography, and biological activity tests. Identification by bioassays was made according to the growth of pieces of wheat coleoptiles and larch and lettuce hypocotyls, the capacity to produce color reactions, luminescence in the UV-light, and rechromatographing in different systems of solvents.

RESULTS

If larch is chronically infested by the gall midge, an increase occurs in the quantitative and qualitative composition of indole compounds and in their biological activity. The levels of endogenous auxins depend on the ratio of their synthesis and inactivation rates. The activity of indoleacetic oxidase in different parts of the larch does not change considerably as a result of midge invasion. Activity of

BARANCHIKOV, Y.N., MATTSON, W.J., HAIN, F.P., and PAYNE, T.L., eds. 1991. Forest Insect Guilds: Patterns of Interaction with Host Trees. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. NE-153.

the gibberellin-like and cytokinin-like substances increases, however. The rise in the activity of these phytohormones correlates with the start of pathological growth of bud tissue in the infested trees. Their maximal activity coincides with the period of intensive growth and formation of the gall. A concomitant accumulation of abscisic acid inhibitors occurs during the ending of growth. Chronically infested trees complete their vegetation cycle with a minimum of growth-promoting substances, leading to retardation of needle flushing in the spring.

Gall tissue developing in response to insect infestation is characterized by a great variety and activity of growth-promoting substances. The greatest amount of natural activators is found in galls during the first 10 days of July, when the growing process is intensive. At the end of vegetative growth, the growth-promoting activity of the gall extract is reduced by nearly half. Gall tissue is hormone-dependent, i.e. it cannot synthesize phytohormones while in tissue culture, as is the case for tumor tissue. Formation of gall tissue is a response by the tree to the midge infestation and is a necessary condition for normal development of insect larvae. Mechanical destruction of the gall causes mortality of the insect larva.

Increases in the activity of phytohormones occur at definite times, corresponding to the first and second larval instars. Invading the tissue of the host plant, the larva changes the plant's metabolic pattern. By using the attractive capacity of auxins, the midge larva attracts and accumulates mobile metabolites in the gall tissue. Thus one can see that gall-forming insects can cause shifts in the hormonal balance of the host plant, changing the content of its natural regulators.

DISCUSSION AND CONCLUSIONS

Most believe that whatever agent has caused the pathological tissue to form (mutations, infections by fungi, bacteria, insects), does so by eliciting changes in the activity or synthesis and degradation of plant hormones. Increases in auxins can be related to the accumulation of auxin protectors in the tissues and organs of the larch tree. The role of protector is performed by the phenols of the ortho-diphenol type, which serve as inhibitors of IAA disintegration. At the same time, some authors suggest that in natural conditions, loss of resistance to pathological growth is connected with a drop in the level of endogenic gibberellic acid or decreased sensitivity to it. Cytokinins are found in various parasitic organisms and seem to play a role in the development of anomalous tissue. Growth promotion based on elevated cell division and/or growth and a rise in mitotic activity is regulated by phytohormones. The specific effect of the bud gall midge on the buds connected with the gall occurs through induction. Induction starts the process (under the influence of the phytohormone) and does not occur in cells in the absence of the requisite hormones. In the case of gall tissue formation, two mechanisms, induction and promotion, operate together. Induction of pathologic growth is caused by secretory exometabolites of the bud midge larva. In line with the classic theory of mechanisms of realization of genetic information in the bacterial cell, Bonner (1967) suggested that hormones function by activating the genes which have previously been suppressed. Experimental data however, do not support this hypothesis. Though accumulation of natural growth stimulators and inhibitors in the larch tree damaged by the midge does not constitute direct evidence for the participation of phytohormones in the induction of anomalous growth, it does indicate that a change in the hormonal status of the host plant has occurred under the impact of the insect.

One may conclude, then, that the network of protective reactions to the pathologic growth stimulated by the bud midge is based on a shift in the balance of natural stimulators and growth inhibitors, reflecting complex interrelations between the plant and the insect.

LITERATURE CITED

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