COMPARATIVE STUDY ON THE EFFECT OF α-NAPHTHYLACETIC ACID (NAA) AND OF 2,4-DICHLORO-PHENOXYACETIC ACID (2,4-D) AND OF THEIR NITRILES (NAN AND 2,4-DN) ON THE ROOT GROWTH

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(Received 16, June, 1958)

Introduction

Following the isolation (10, 11) of indolylacetonitrile (IAN), and the partial elucidation of occurence (1, 4, 5, 9, 12, 13, 14, 18, 21, 25, 26) the attention has been more and more turned to the biochemistry of the nitriles of auxins. Of the problems arisen, doubtlessly one of the most interesting is that the IAN regulates selectively (3, 6, 8, 19, 20, 22—24, 27.) This selective activity is manifested also in other cases than is that of IAN. VELDSTRA (27) found in 1944 that α-naphthylacetonitrile (NAN) — like IAN — does not stimulate the growth of the pea-stem sections whereas it proves to be a very active stimulator for other species. FAWCETT et al. (6) demonstrated that the auxin effect of nitriles of certain 2,4-dichlorophenoxy-derivatives may also be more or less selective.

In all probability the nitriles of auxins are in reality inactive compounds, and are able to exert auxin effect, merely because they possess the capacity of hydrolizing enzymatically into acidic auxin in the cells of certain species (2, 6, 7, 11, 21, 24, 27, 29). The species wherein the intensive hydrolizis of IAN can be demonstrated, are extremely sensitive to IAN (24). This process, however, is not found in every species presumably due to the absence of a suitable enzyme-system. In such a case the nitrile again is shown ineffective. The cause of the different activity may in all probability be that the intensity of transformation of the nitrile into acid in various plant species is considerably different.

This complex problem has not alone theoretical but also significant practical aspests; e. g. the question of applicability of NAN. It is known that NAN — perhaps due to ist more lipophilic property — in certain cases, is more active regulator than NAA itself (17). At the same time NAN can be

more readily produced than NAA; namely, according to several methods used at present it is an intermediary product (16). NAN seems to be usable in several relations especially when its activity is less selective.

In case of the 2,4-DN the requirement is quite contrary i. e. the definite selectivity. If the 2,4-DN — in the case of certain dicotyledonous species — is ineffective, while in other species, like the 2,4-D, it is highly active there seems to be a possibility to produce a new herbicide for dicotyledonous weeds from the dicotyledonous cultivated plants.

Eight dicotyledonous plant species belonging to eight different families were examined to clear up the following problems:

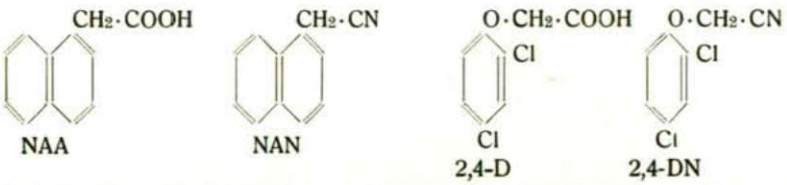
a) how sensitive are the seedlings to the nitriles compared to the corresponding acids;

b) whether the sensitivity of the various species to nitriles shows any significant difference;

c) if there are such differences, are they manifested in case of both nitriles examined.

Material and methods

The acids and their nitriles:



Taken into consideration the practical features of the problems discussed cultivated plants were selected for experiments: »*Beta vulgaris* L. »Beta C—242/53« *(Chenopodiaceae), Cannabis sativa* L. »Bologniensis« *(Moraceae), Cucumis sativus* L. »Kecskeméti hamvas« *(Cucurbitaceae), Lactuca sativa* L. »Május királya« *(Compositae), Linum usitatissimum* L. »Szegedi Olajlen« (Linaceae), *Medicago sativa* L. »Frank« *(Leguminosae), Raphanus sativus* L. »Saxa« *(Cruciferae), Solanum lycopersicum* L. »Lucullus« *(Solanaceae).*

In order to elucidate the questions the root growth test suggested by Bentle and Bickle (3) was used — apparently the most suitable test to compare the sensitivity of the various speciens — when observing the inhibitory and not the stimulatory intensity of the auxins.

The surface of seeds were sterilized, then germinated under sterile circumstances in dark on filter paper. Seeds germinating contemporaneously were place on culture medium, containing 1,5 % agar, of different auxin concentrations, 3 hours after the appearance of the radicula. So each culture had 20 seeds of every species and concentration. The incubation lasted 48 hours in dark at 26 C°. The lenght of the roots of the seedlings was measured in then-fold magnitude.

The extent of the selectivity is arbitrarily denoted by a differential number, »D-value«. At 10^{-6} M, i. e. at a concentration where the activity differences appear most strikingly, »D-value« means the difference of root-inhibition produced by the nitrile and corresponding acid *(Fig. 1).*

Examinations were three times repeated, so the data show the average of 60 measurements. The maximal deviation from the average is ±11,5 %.

Results and discussion

Data obtained with naphthyl compounds are shown in *Fig. 2.*

It may be stated, that NAN is in all cases — at 50 % inhibition in general ten times — less active than NAA. Comparing the curves, a more or less

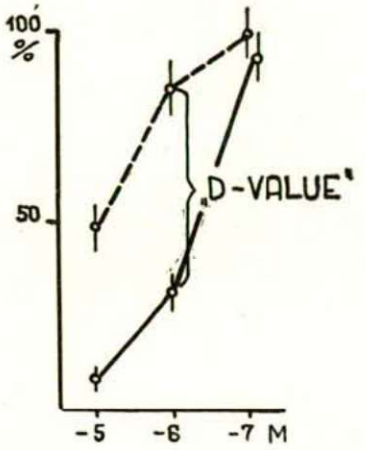


Fig. 1. Explanatory figure to express »D-value«.

similarity can be noted. As to the efficacy of the two compounds the greatest difference can be observed in the *Lactuca,* while the smallest in the *Raphanus.*

D-$_{\text{naphihyl}}$ -values: *Beta:* = 27, *Cannabis* = 38, *Cucumis* = 37, *Lactuca* = 57, *Linum* = 42, *Medicago* = 26, *Raphanus* = 16, *Solanum* = 37..

In root test NAA is more active than NAN, while in the coeloptile-test it is inverse. This holds true for the relation of the indolylacetic acid and indolylacetonitrile (3).

From practical point of view it is of primary importance that NAN proved to be relatively of high activity, though to some extent with different intensity, it affected, however, all the plants examined. Its applicability has been already shown in certain cases, it proved to be useful storing potatoes (28) and rose branches (15).

Fig. 3 shows results obtained with 2,4-D and 2,4-DN.

The close proximity of the results and the close paralellism of the curves of the acid and nitrile are at first sight striking. At the height of 50 % inhibition tenfold activity-difference is shown in none of the species.

D-$_{\text{phenoxy}}$ -values: *Beta* = 21, *Cannabis* = 14, *Cucumis* = 13, *Lactuca* = 23, *Linum* = 18, *Medicago* = 18, *Raphanus* = 15, *Solanum* = 16.

The activity of 2,4-DN is very near to that of the 2,4-D in all the eight species examined, also in the pea-stem test which, however, is insensitive to nitriles (6).

Thus the suggestion to use it as a superselective herbicide does not seem to be acceptable, only if the sensitivity of the organs above the soil is considerably differing from that of the roots. Examinations referring this are under way.

The questions comprised in the introduction may be answered as follows:

a) roots of the dicotyledonous seedlings are in general considerably sensitive to the nitriles examined, yet the intensity of the effect is weaker in every case than that of the corresponding acids;

b) comparing the effect exerted on the various species differences may be found;

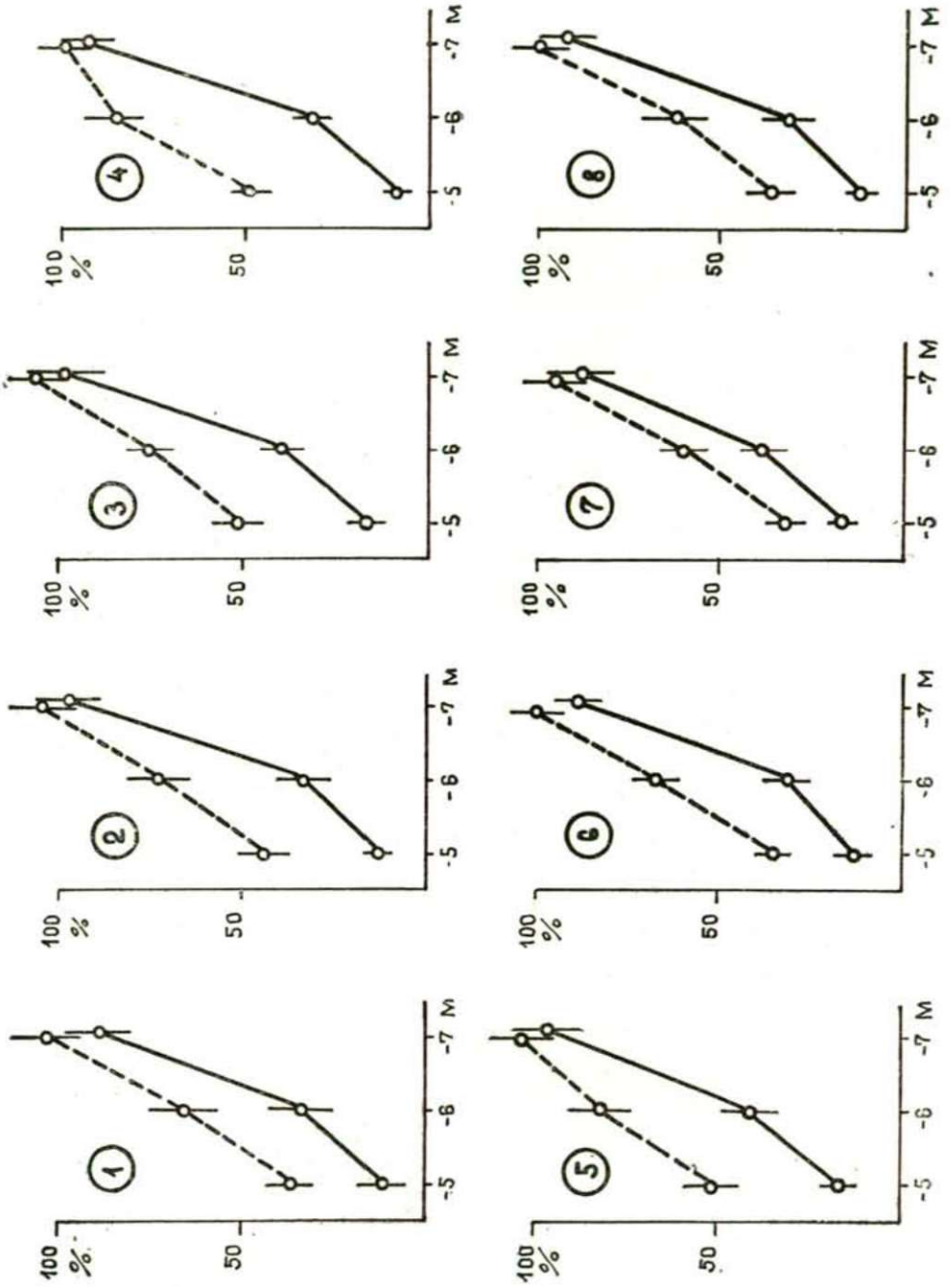


Fig. 2. Effect of NAA and NAN on root development. (Explanation of the Figure see at the Figure 3).

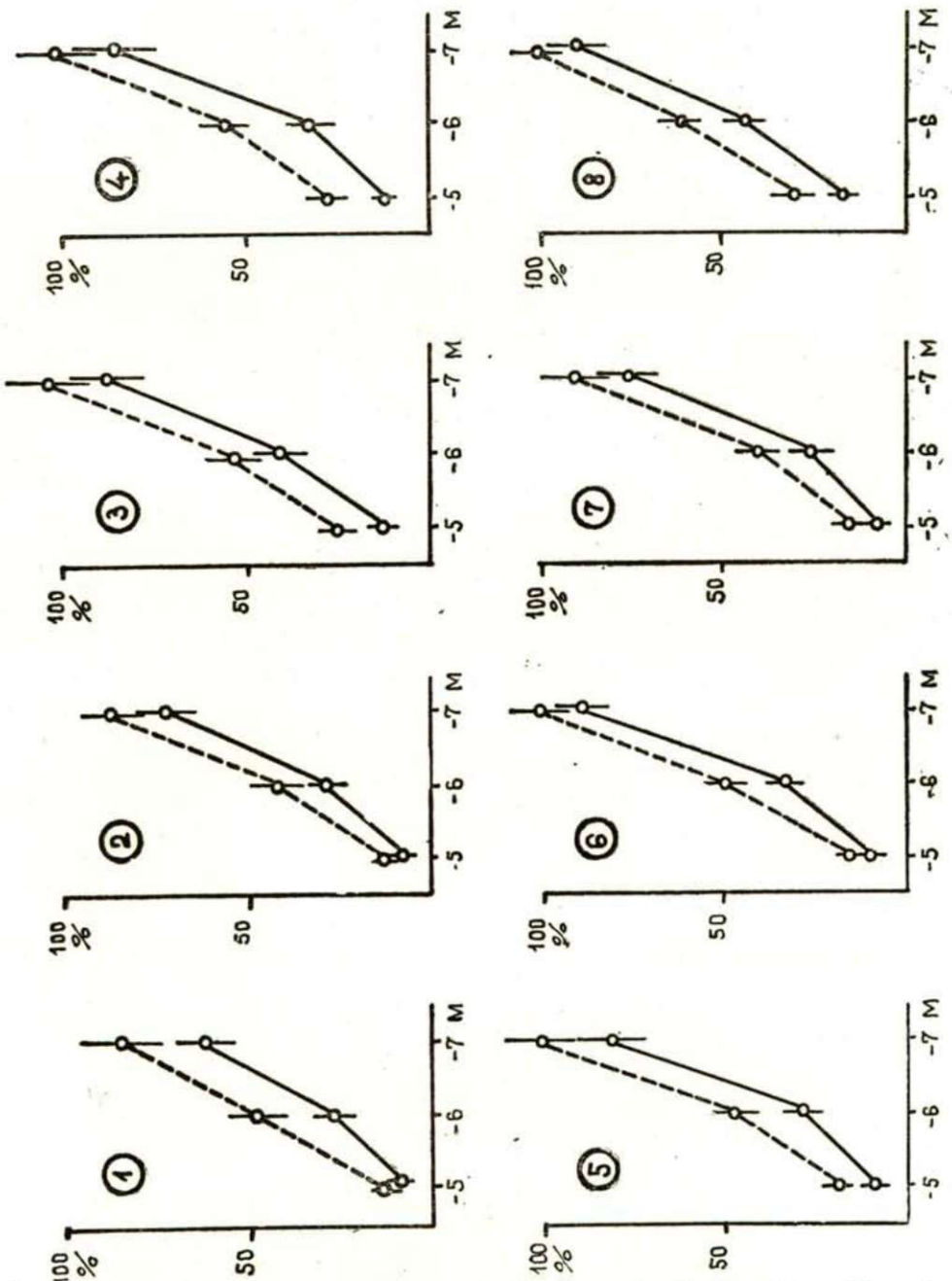


Fig. 3. Effect of 2,4-D and 2,4-DN on root development. Abscissa: Logarithm of concentration of medium. Ordinata: root lenght as per cent of control after incubation. Solid lines: data of root grown in acid medium. Broken lines: data of root grown in nitrile medium. 1. *Beta vulgaris*, 2: *Cannabis sativa*, 3: *Cucumis sativus*, 4: *Lactuca sativa*, 5: *Linum usitatissimum*, 6: *Medicago sativa*, 7: *Raphnus sativus*, 8: *Solanum lycopersicum*.

c) the discrepancies of sensitivity are greater in the relation of NAN and NAA while in the relation of 2,4-DN and 2,4-D are quite slight.

Summary

The activity of NAN and 2,4-DN on the root-growt of seedlings belonging to eight different species was observed and the intensity of the effect was compared wth the activity of the corresponding acids — Naa and 2,4-D.

The activity of the nitriles is considerable, but less than that of the corresponding acids. Comparing the effect exerted on the different species it was found that the differences on the activity are greater in the relation of NAN and NAA whereas in that of 2,4-DN and 2,4-D are quite slight.

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