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Role of Nicotinamide and Salicylaldehyde on Some Growth Parameters in Wheat

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With 3 Figures

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Summary

MOHAMED Y. A. H., SHARAF EL-DIN A. & FODA E. 1989. Role of nicotinamide and salicylaldehyde on some growth parameters in wheat. – Phyton (Austria) 29 (1): 33–40, with 3 figures. – English with German summary.

The effect of 10^{-4} and 10^{-5} M nicotinamide and salicylaldehyde was shown in favour of the increase in root and shoot length. The area of the leaf in plants treated with nicotinamide increased and the width decreased. Salicylaldehyde exerted neutral effect on leaf. Both growth regulators increased the level of total soluble carbohydrates and total soluble proteins throughout the overall age of the plant and in the different plant organs. As a result of these growth regulators application, DNA quantities decreased in the root and stem and increased in the leaf, while inhibition of RNA synthesis was observed.

Zusammenfassung

MOHAMED Y. A. H., SHARAF EL-DIN A. & FODA E. 1989. Der Einfluß von Nikotinamid und Salicylaldehyd auf einige Wachstumsparameter bei Weizen. – Phyton (Austria) 29 (1): 33–40, mit 3 Figuren. – Englisch mit deutscher Zusammenfassung.

10^{-4} und 10^{-5} M Nikotinamid und Salicylaldehyd begünstigten das Langenwachstum von Wurzel und Sproß. Die Blattfläche nikotinamidbehandelter Pflanzen nahm zu, während deren Breite abnahm. Salizylaldehyd verhielt sich gegenüber Blättern neutral. Beide Wachstumsregulatoren erhöhten die Menge der löslichen Kohlenhydrate und über die ganze Lebenszeit und in den verschiedenen Organen der Pflanzen. Als Folge der Wirkstoffgaben nahm der DNA-Gehalt in Wurzel und Stamm

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ab und in den Blättern zu, während eine Hemmung der RNA-Synthese beobachtet wurde.

Introduction

The plant physiologists know five types of chemical regulator systems (the auxins, the gibberellins, the cytokinins, the abscisic acids, and the ethylene gas). These "great five" have widely overlapping functions (WAREING & PHILLIPS, 1973). They act on basic processes of plant growth and development, either concertedly, consequentially or separately. It seems logical to study two substances which are plant products – shown to modify plant growth in various bioassay systems. These substances are nicotinamide and salicylaldehyde (BEARDER 1980, FODA 1987). The growth criteria include: the root and shoot length, the length, width and area of leaf, the pigment content, the total soluble carbohydrates and proteins and the nucleic acids.

Materials and Methods

The grains of wheat (*Triticum aestivum* L., cv. Sakha 61) were sown (20 November) in pots filled with acid-washed quartz sand. The pots were irrigated with Hoagland's nutrient solution (ARNON 1950). After 45 days from sowing (5 January), the growing plants were sprayed with 10^{-4} or 10^{-5} M solutions of nicotinamide or salicylaldehyde nicotinamide and salicylaldehyde respectively, a part of plants remained untreated for controls. Sampling took place monthly. Shoot and root length, and length, width and area of leaf were recorded. The photosynthetic pigments were determined by application of the spectrophotometric method recommended by METZNER & al. 1965. Carbohydrate content was determined by the method described by BROWN & al. 1957. Total soluble proteins were determined by using the method adopted by LOWRY & al. 1951. Nucleic acids (DNA and RNA) extraction were made by a method cited by MARMUR 1961 and MOHAMED & CAPESIUS 1980, and determination was carried according to DISCHE & SCHWARZ 1937 and SCHNEIDER 1957.

The least significant difference (I. S. D.) was employed to located the level at which the significant differences in plant response occur at $P < 0.05$ (SNEDECOR & COCHRAN, 1973).

Results

Table 1 indicates that 10^{-4} and 10^{-5} M nicotinamide and salicylaldehyde enhanced the root and shoot length. The enhancement effect was pronounced at the end of the growth season. 10^{-4} M nicotinamide increased the leaf area; while other leaf parameters did not change significantly as a result of different growth regulators application at different ages of the wheat plants.

Fig. 1 shows the following facts, concerning the photosynthetic pigments: The amount of chlorophyll a – as expected – exceeds the amounts of chlorophyll b and carotenoids; the amounts of chlorophyll b are more or less comparable to the amount of carotenoids; and the plants treated with both

Table 1: Effect of 10^{-4} and 10^{-5} M nicotinamide and salicylaldehyde on some growth parameters of wheat grown for different ages.

Treatment	Age (days)	Root length (cm)	Shoot lenght (cm)	Leaf			
				Length (cm)	Width (cm)	Length/ Width	Area (cm^2)
Control	75	8.8	52.3	21.0	0.7	30.0	16.1
	105	9.3	83.7	22.8	0.8	28.5	18.3
	135	9.7	85.5	25.4	1.3	19.5	28.0
Nicotin-	75	8.5	60.1	20.8	0.9	23.1	24.7
amide 10^{-4}	105	10.4	92.9	23.0	1.1	20.9	28.8
	135	10.6	93.8	25.1	1.2	20.9	28.9
Nicotin-	75	8.7	55.4	26.2	0.7	37.4	17.5
amide 10^{-5} M	105	10.0	81.1	28.6	0.9	31.8	19.1
	135	10.1	83.6	29.0	1.2	24.2	42.7
Salicyl-	75	10.2	54.1	24.8	0.8	31.0	18.0
aldehyde 10^{-4} M	105	11.2	95.7	28.2	0.9	31.3	24.2
	135	12.0	96.4	28.3	1.4	20.2	31.4
Salicyl-	75	10.6	64.5	20.1	1.0	20.1	19.6
aldehyde 10^{-5} M	105	11.1	97.2	23.3	1.3	17.9	20.9
	135	11.4	98.8	28.1	1.3	21.6	34.3
L. S. D. (at 5%-level)	–	–	9.0	–	0.2	–	6.6

concentrations of the growth regulators showed lower figures at the fourth growth month than the control plants. Only 10^{-5} M nicotinamide leads to an increase in chlorophyll a at the third growth month.

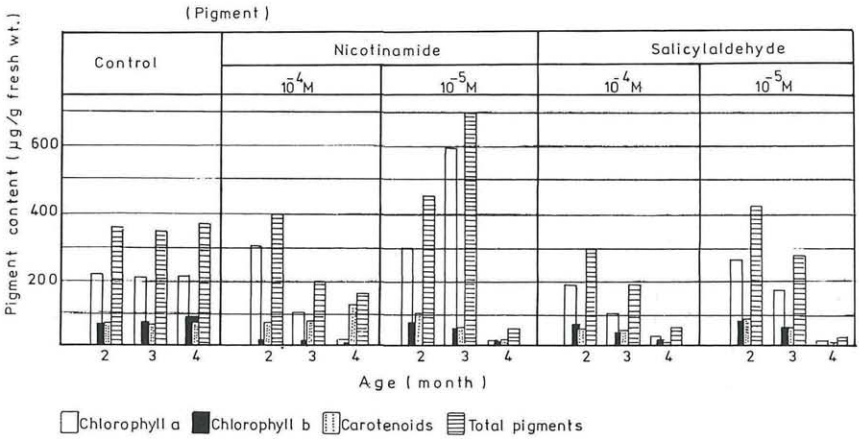

Fig. 1: The effect of nicotinamide and salicylaldehyde (10^{-4} and 10^{-5} M) on pigment content of wheat leaves grown for 2, 3 and 4 months.

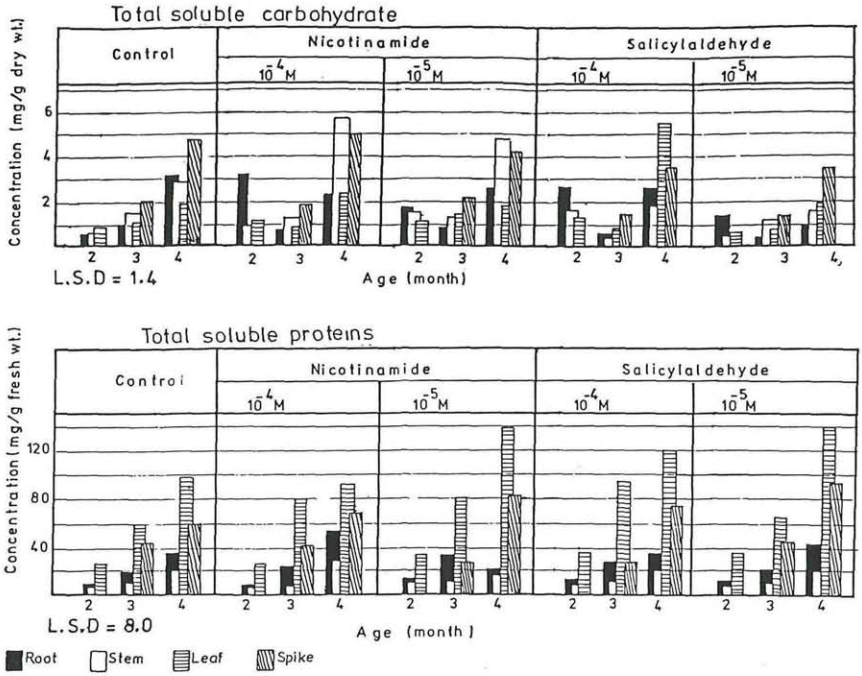

Fig. 2: The effect of nicotinamide and salicylaldehyde (10^{-4} and 10^{-5} M) on total soluble carbohydrates and total soluble proteins of different wheat organs grown for 2, 3 and 4 months.

Fig. 2 is a histogram showing the effect of both growth regulators on total soluble carbohydrates and total soluble proteins. From the figure it is clear to observe that the total soluble carbohydrates are found in amounts greater in the third and fourth growth months, but the amounts in the fourth growth month were greater than those in the third month. The treatments with nicotinamide causes an enhancement of total soluble carbohydrates in the stem of 4-month-old plants, while the treatment with salicylaldehyde causes an inhibition of the total soluble carbohydrate amounts in different wheat parts.

The previous figure shows that the most higher total soluble proteins are found in the 3rd and 4th growth months in the leaf and the spike. 10^{-5} M salicylaldehyde caused an increase in these total soluble protein amounts. The leaf contains more total soluble proteins than the spike. The stem contains amounts less than the root. The same concentration of nicotinamide causes an increase in these amounts in leaf and spike from 4-month-old plants.

Fig. 3 shows the amounts of DNA and RNA in wheat plants treated with nicotinamide and salicylaldehyde. It is evident that DNA content tends

to increase in all parts of plant with the progress of age except in spike. The amounts in control plant may reach values more than double the amounts at the beginning in root (9.0 and 25.7 µg/g fresh weight). In comparison between plants treated with 10^{-4} and those treated with 10^{-5} M nicotinamide, it can be observed that the DNA amounts increase gradually, but slightly, whilst the amounts of DNA are higher in case of 10^{-5} than 10^{-4} M, except in root. The amounts of DNA of leaf from treated plants are higher than those in control plants. The other growth regulator shows that the leaf-DNA content of plants treated with 10^{-5} M are much higher than those of other treatments.

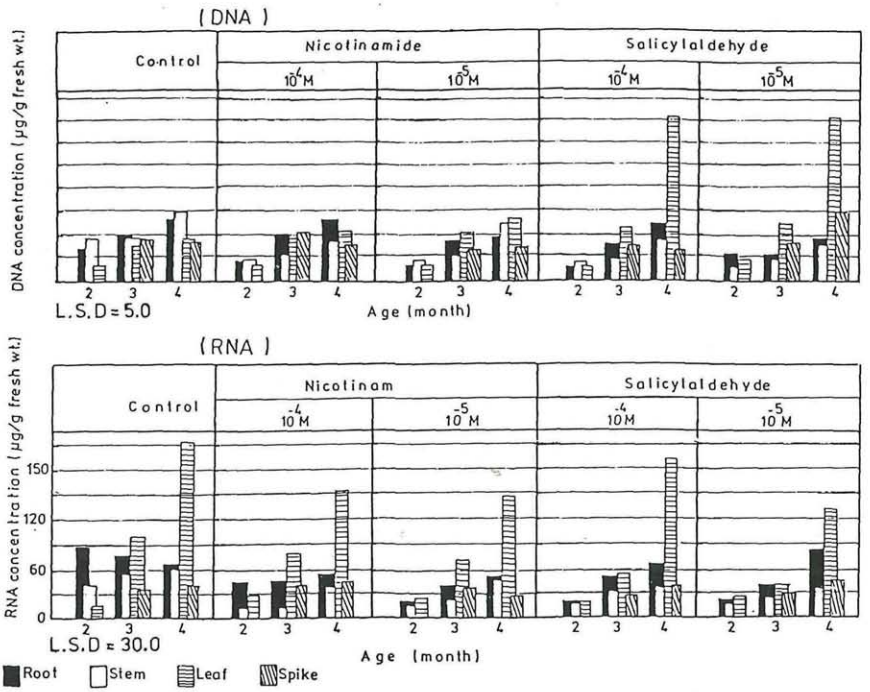

Fig. 3: The effect of nicotinamide and salicylaldehyde (10^{-4} and 10^{-5} M) on nucleic acids (DNA and RNA) from different wheat organs grown for 2, 3 and 4 months.

From the same figure which indicates clearly that the stem of 4-month-old plants contain the highest RNA amounts. The treatment with both concentrations of growth regulators cause an increase in RNA contents than the control plants.

Discussion

The improvement of wheat growth and productivity represents a continous goal of mankind. This necessitates the studying of different factors

affecting its growth. The nicotinamide and salicylaldehyde (10^{-4} and 10^{-5} M) were studied to throw some light on their actions on some growth parameters of wheat. Both were classified as N-containing and aromatic compounds (BEARDER 1980). Nicotinamide is an important derivative of nicotinic acid which is a precursor of two active biological compounds (NAD^+ and $NADP^+$). Nicotinamide and salicylaldehyde exerted differing growth-stimulating activities (CLELAND & AJAMI 1974, FODA 1987, SURGUCHEVA & al. 1970). The length of root and shoot was enhanced with the application of different regulators (10^{-4} M nicotinamide causes a depressive effect). A finding of many workers stated that many phenolic compounds inhibit the growth of plants or plant tissue which produce them (KEFELI & KADYROV 1971, VAN SUMERE & al. 1972, WHITTAKER & FEENY 1971). So, it could be detected and deduced that wheat could not synthesize these substances since both were enhanced for its growth. Both growth regulators showed a limited effect on the leaf parameters studied.

Nicotinamide causes an increase in chlorophyll a than that found in control plants of 2-month-old, then with the progress of age a decrease was observed, not only in chlorophyll a, but also in chlorophyll b and carotenoids. Chlorophyll content falls rapidly as senescence develops. It is possible that the decline was due to the deterioration of chloroplasts. Only 10^{-5} M exerted an enhancement effect in plants 3-month-old.

The highest carbohydrate content was found after 4 growth months. Nicotinamide seems to be more enhanced regulator than the other, and no general role could be detected for the action of both. A growth inhibiting activity, possibly due to salicylic acid and/or coumarin was seen on the beginning of wheat germination as detected by AHMED & SAWHNEY 1977. Also, phenolic compounds influences the growth rate of some algae (BERCEA & al. 1984). Some similar compounds like ferulic acid, p-coumaric acid, vanillic acid and p-oxybenzaldehyde were present in soil affected wheat growth (DZHUMALIEVA & al. 1976).

The application of both regulators seemed to increase the total soluble proteins in leaf and spike at the end of the growth season. It was mentioned by BERCEA & al. 1984 that the phenolic compounds caused a stimulation of protein metabolism in the green alga *Monoraphidium contortum*. The presence of somehow high protein content in the top of wheat plants being double the amounts in their bases was found by VIDAL & BERGARECHE 1983. These changes in the amounts of total soluble proteins with respect to age was found by KRISHCHENKO 1985.

Treatments with salicylaldehyde enhances the DNA and RNA in leaves of wheat plants. This may be explained on the basis that DNA and RNA in wheat leaves increased during the formation of pollen mother cells (KOZHUSHKO & CHERNYSHEVA 1975). The nucleic acid contents were higher in developing embryonic ears and spikelets of *T. aestivum* than in those of *T. monococcum* (MURASHEV & ERMAKOV 1976).

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