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Effects of Zinc, Nitrogen and Variable Temperatures on Seedling Growth of Wheat

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A nutrient culture experiment was conducted to study the effects of Zn (0.0,2.5 and 5.0 mg l^{-1}, as a source of Zn SO_4 $7H_2O$), N (0.0,25 and 50 mg l^{-1} as a source of NH_4SO_4) and variable temperatures (25° and 28°C) on seedling growth of wheat (cv Mehran-89). The leaf tips burnt and yellowish green coloured leaves were observed irrespective of the treatments and temperatures. However, such deficiency symptoms were prominent at higher temperatures and at increasing levels of Zn and N. The shoot and root length and fresh and dry weight of shoot increased on the treatment of 2.5 mg l^{-1} Zn alongwith 25 mg l^{-1} of N at lower temperature whereas, the fresh and dry weight of root decreased on the similar treatments and temperature. At higher temperature, the root and shoot length and their fresh and dry weight decreased on treatments. It was concluded that at higher temperature alongwith higher levels of Zn and N, the seedling growth decreased, whereas at lower temperature with 2.5, mg l^{-1} of Zn and 25 mg l^{-1} N, the growth generally increased.

Key words: Growth, Zinc, Nitrogen, Temperature, Wheat.

Introduction

Plants are continuously exposed to natural environmental stresses throughout their life cycle. Seasonal fluctuations in temperature, moisture, salts and nutrients imbalanced often to the levels that are sub-optimal, affecting plant growth. Plant life exists across the whole range of atmospheric temperatures (Jones 1992; Nakamoto and Hiyama 1999). High temperature adversely affects plant growth and yield in many areas of the world (Dubey 1999; Joshi, 1999). Some plants can survive when the temperature exceeds even 20°C above ambient, whereas in most of the field crops, temperature above 40°C causes heat injury, severely limits photosynthesis and alters protein metabolism by causing protein breakdown, protein denaturation, enzyme inactivation and other effects. (Williams *et al* 1999). For instance, if annual precipitation occurs mainly as snow in the winter, plants may grow at cooler temperatures than in regions with abundant spring and summer moisture. Climatic temperature is often dominant in determining conditions for the growth of a particular species and thus its distribution worldwide (Jeffree and Jeffree 1994).

Bjorkman *et al* (1980) pointed out that high temperature retards the conversion of sucrose to starch in developing grains (e.g.wheat). Temperature generally affects many aspects of plant growth and development and has a primary influence on the distribution of plant species in the world (Harte *et al* 1995). In an experiment, wheat seedlings were grown in Hoagland nutrient solution at temperatures of 20, 25, 30, 35 and 40°C for ten days using NaCl (0, 8, 14 dsm^{-1}). The shoot and root growth was found to be similar between 20-30°C, showed inhibition at 35°C and the growth was completely inhibited at 40°C and no measurements were possible. Literature reveals the continuous use of nitrogenous fertilizer during the last few decades has also caused widespread deficiency of Zn, particularly in cereal crops. Ozanne (1955) reported severe deficiency of Zn in subterranean clover with increased N supply. Dev and Shukla (1980) reported a beneficial effect of N supply up to 400 mg l^{-1} N on shoot Zn concentration and an antagonistic effect on roots of corn. In the present study effects of two temperatures and different levels of Zn and N application on seedling growth of wheat were investigated.

Materials and Methods

A nutrient culture experiment was carried out to study the effects of Zn and N and temperature on wheat seedling growth. Zinc levels of 0.0, 2.5 and 5.0 mg l^{-1} and N levels of 0.0, 25 and 50 mg l^{-1} were added separately or in combination. Seven days old wheat seedlings of uniform height were transplanted at the rate of three seedlings per pot in 250 ml Hoagland solution and grown for two weeks in two incubators at temperatures of 25°C and 28°C, separately with a photo-period of 16/8 h, light and dark conditions. The nutrient solution was changed after one week and adjusted with distilled water. The visual observations on the growth of wheat

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Table 1
Temperature effect on Zn and N interaction in wheat at 25°C

Treatments Zn & N (ppm)	Shoot length (cm)	Root length (cm)	Fresh weight shoot mg/pot	Dry weight shoot mg/pot	Fresh weight root mg/pot	Dry weight root mg/pot
Zn-0 N-0	16.88 abc	15.63 ab	249 a	296 a	260 a	135 ab
Zn-0 N-25	16.75 abc	7.88 b	296 a	332 a	181 a	89 ab
Zn-0 N-50	18.50 abc	9.03 b	329 a	370 a	213 a	96 ab
Zn-2.5 N-0	12.58 c	13.45 b	200 a	224 a	240 a	116 ab
Zn-2.5 N-25	19.88 ab	11.38 b	351 a	424 a	207 a	109 ab
Zn-2.5 N-50	22.52 a	9.83 b	375 a	471 a	209 a	114 ab
Zn-5 N-0	16.28 bc	22.80 a	263 a	327 a	278 a	138 ab
Zn-5 N-25	18.68 abc	8.45 b	287 a	326 a	197 a	70 ab
Zn-5 N-50	15.00 bc	13.85 b	306 a	358 a	259 a	115 ab

Table 2
Temperature effect on Zn and N interaction in wheat at 28°C

Treatments Zn & N (ppm)	Shoot length (cm)	Root length (cm)	Fresh weight shoot mg/pot	Dry weight shoot mg/pot	Fresh weight root mg/pot	Dry weight root mg/pot
Zn-0 N-0	17.8 a	17.8 a	220 abc	360 a	260 a	128 a
Zn-0 N-25	19.6 a	10.1 b	250 ab	50 b	210 ab	134 a
Zn-0 N-50	14.0 a	8.3 b	150 cd	30 b	120 c	54 a
Zn-2.5 N-0	16.7 a	12.7 ab	200 abc	40 b	240 ab	121 a
Zn-2.5 N-25	15.30 a	9.3 b	220 abc	40 b	170 bc	68 a
Zn-2.5 N-50	15.4 a	8.6 b	90 a	30 b	160 bc	145 a
Zn-5 N-0	14.9 a	13.1 ab	180 bc	30 b	240 ab	146 a
Zn-5 N-25	15.4 a	10.9 b	180 bc	30 b	180 bc	147 a
Zn-5 N-50	14.9 a	11.8 b	260 a	40 b	170 bc	82 a

plants were recorded. The plants were harvested after two weeks of growth. Their shoot and root lengths, fresh and dry weights of shoot and root were recorded.

Results and Discussion

The leaf tips burnt and yellowish green leaves of wheat were observed at both the temperatures irrespective of treatments. Such symptoms were prominent at higher temperatures with higher Zn and N levels. The shoot and root lengths and fresh and dry weights of shoot increased at the treatment of 2.5 mg l^{-1} Zn alongwith 25 mg l^{-1} of N at lower temperature whereas, the fresh and dry weight of root decreased at the similar treatments and temperature (Table 1). At higher temperature, the root and shoot length and their fresh and dry weight decreased with higher Zn and N treatments (Table 2). This harmful effect of Zn could be explained by the serious deficiency of N which possible may be due to formation of insoluble reaction products of zinc and nitrogen compounds. Zn induced chlorosis occurred in vegetable crops when high levels of Zn were supplied with nitrate alone at pH 6.0 (Osawa and Ikeda 1985). Severe deficiency symptom has been reported in crop plants with Zn and increasing levels of N in the growth media (Kumar *et al* 1985; Ozanne 1955; Viets *et al* 1957). Temperature is also an important environmental variable which affects the rate of not only photosynthesis, but also of all cellular processes; as a result, it has a pronounced influence on the rate of plant growth. Perhaps, temperature was also exerting unfavourable effects on the growth of wheat under the present experimental conditions. It has been reported that formation of colouring matter is slowed down when air temperature exceeds the optimum temperature and higher temperature is invariable detrimental to the growth of most crop plants (Williams *et al* 1999). Factors such as toxins, water and nutrient elements availability may also interact with temperature to determine growth.

From the foregoing discussion, it can be inferred that in nutrient solution growth medium, the application of Zn alongwith N at lower temperature increased considerably the shoot, root lengths and their fresh and dry matter weights in wheat, if these two nutrients are applied in the proper amounts. The levels of 2.5 Zn and 25 mg l^{-1} N seem to be adequate levels in nutrient solution for the growth of wheat crop.

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