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EFFECT OF DIFFERENT CONCENTRATIONS OF NITROGEN AND ZINC ON THE GROWTH OF PECAN NUT SEEDLINGS

Nishat Lal Badshah[1] and Gohar Ayub[2]
[1]Potato Botany Section, Agriculture Research Institute, Tarnab, Peshawar, Pakistan
[2]Department of Horticulture, Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan
E-Mail: aleenazahoor24@gmail.com

ABSTRACT

An experiment "Effect of different concentrations of nitrogen and zinc on the growth of pecan nut seedlings" was carried out at Agricultural Research Institute, Tarnab, Peshawar during 2001. Four different concentrations of nitrogen (0, 1.25, 2.5, and 5%) and zinc (0, 0.12, 0.25 and 0.5%) were used as foliar application. The experiment was laid out in Randomized Complete Block Design (RCBD) with two factors. The foliar sprays of nitrogen (N) and zinc (Zn) were done on 1st June and 1st, July, 2001 on three months old pecan nut seedlings. Significantly maximum seedling height (48.04 cm), stem diameter (0.79 cm), number of leaves plant^{-1} (21.6), leaf area (99.19 cm^2) root diameter (0.83 cm), root weight (37.23 g) roots/seedling (76.08) and biomass weight (56.35g) were recorded when seedlings were sprayed with 5% N and minimum in control. Root length was maximum (45.78 cm) with 2.5% foliar application of nitrogen compared to the minimum of 41.34 cm in control (no spray). The seedlings sprayed with 0.25% zinc gave maximum seedling height (46.14 cm), number of leaves plant^{-1} (19.25), leaf area, root length (44.04 cm), root diameter (0.76 cm), root weight (35.40 g) and biomass weight (53.25 g) while all parameters were low in values without application of zinc. Stem diameter and number of roots were significantly more (0.76 cm, 74.95) with 0.5% foliar spray of zinc. In interaction foliar application of 5% nitrogen and 0.25% zinc significantly increased seedling height (52.56 cm), number of leaves (25.0), leaf area (119.20 cm^2), root diameter (0.91 cm), and number of roots (76.76) while non significant difference was found in root length, root weight and biomass weight in various interactions. The overall performance of pecan nut seedlings was best with foliar application of 5% nitrogen and 0.25% zinc under the agro climatic conditions of Tarnab, Peshawar.

Keywords: pecan nut (*Carya illinoensis*), foliar application, nitrogen, zinc, seedling growth.

INTRODUCTION

Pecan nut (*Carya illinoensis*) is a nut fruit, which are growing successfully in sub tropical regions. Pecan nut seedlings respond well to nitrogen and zinc. Deficiency of N cause light green colour in leaves, leaves become smaller, and premature defoliation occurs. Zinc, which is a micronutrient played an important role in pecan nut culture since the discovery that rosette is caused by this element (*Alben et al*., 1932). Its deficiency causes stunted growth, shortening of internodes and reduction in leaf size. In pecan nut, deficiency symptoms appeared when leaf zinc was 40 ppm or less. Foliar spray of $ZnSO_4$ caused inconsistent and temporary increase in leaf zinc. Bordiemi and Bodi (1966) found increase in girth shoot and canopy with nitrogen application. The Zn deficient plants adversely affected the chlorophyll content, stomata conductance and net photosynthesis (Hu and Sparks, 1991). Sharma and Chadha (1988) reported the work of Worley *et al.* (1976) who stated that pressure trunk injection of $ZnSO_4$ solution rapidly increase leaf Zn level of Zn deficient pecan trees. Injection of $ZnSO_4$ solution at 2270 g/tree killed foliage and twig terminals within a week and new foliage growth appeared normal but was high in zinc.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Institute Tarnab, Peshawar during 2001. The three (3) months old seedlings of pecan cultivar "'Mahan" were sprayed with 0, 1.25, 2.5 and 5.0% N; and 0, 0.12, 0.25, and 0.5% Zn two times at monthly intervals. Nitrogen and Zinc were sprayed in the form of urea and zinc sulphate respectively. Equal amount of $Ca(OH)_2$ was also used with $ZnSO_4$ to reduce toxic effect of zinc on leaves. The experiment was laid out as randomized complete block design with two factors. Experiment was replicated 3 times and the number of treatments replication^{-1} was 16. Number of seedlings treatment^{-1} was l0. Plants were regularly observed and the data on growth parameters of pecan nut seedling was recorded on seedling height, stem diameter, number of leaves, leaf area, root length, root diameter, root weight, roots plant^{-1} and biomass weight at the end of growing season i.e., in November.

RESULTS AND DISCUSSIONS

Seedling height (cm)

The maximum seedling height of 48.04 cm was recorded with 5% N spray as compared to the minimum height of 40.7 cm in control (Table-1). The maximum seedling height may be due to moderate supply of nitrogen which have shown positive response and let the seedlings to grow to their genetic potentials. Bordiemi and Bodi (1966) also recorded more growth with moderate application of nitrogen. Similarly high concentration of zinc (0.5%) foliar spray also increased the seedling growth to the maximum (46.14 cm) while the seedling sprayed with low concentration or without Zn gave the least growth. In interaction between N and Zn, maximum

seedling height (52.57 cm) was recorded with foliar spray of 5% N and 0.25 % Zn. Minimum seedling height (38.48 cm) was recorded in control.

Stem diameter (cm)

The maximum stem diameter (0.79 cm) were noted when seedlings were sprayed with 5% N, while minimum stem diameter (0.62 cm) was recorded in control (Table-2). The increase in diameter may be due to more number of bigger sizes of leaves. Goh and Haynes (1986), Bordiemi and Bodi (1966) also reported increase in girth by application of nitrogen. Similarly, the thickest stems (0.76 cm) were produced by seedlings sprayed with 0.5% Zn and the thinnest stems (0.62 cm) were produced in control. The high concentration of zinc foliar spray increased the leaves on seedlings, which may be responsible for the increase in diameter. Marchner (1995) also got the thickest seedlings with the application of Zn. The interaction of N and Zn concentrations showed that seedling diameter was significantly more (0.86 cm) by the foliar application of 5% N and 0.25% Zn as compared to the minimum seedling diameter (0.57 cm) in control. The increase in diameter of pecan nut seedlings may be due to more number of bigger sizes leaves which helped in more accumulation of photosynthates.

Number of leaves

With the increase in level of N and Zn, the number of leaves seedling^{-1} was also increased (Table-3). The highest number of leaves plant^{-1} (21.6) was counted on seedlings received 5% N, while the lowest number of leaves (14.49) was obtained in control. This might be due to the fact that N helps in the formation of chlorophyll resulted in more number of leaves while N deficiency resulted in poor growth and hence produced least leaves on the plant. In foliar application of zinc, the maximum leaves seedling^{-1} (19.25) was with 0.25% of Zn as compared to 15.88 leaves plant^{-1} in control. The application of zinc increased the vigour of the plants and hence increased the leaves. Goh and Hynes (1986) also found suppressed growth and minimum number of leaves on seedlings with low availability or deficient in zinc. Hu and Sparks (1991) reported adverse effect on photosynthesis with Zn deficiency. In the interaction between nitrogen and zinc concentrations the number of leaves seedling^{-1} (25.01) was significantly higher when the seedlings received 5% N and 0.25% Zn. The lowest number of leaves (12.87) was recorded in control.

Leaf area (cm^2)

The leaf area was significantly increased with foliar application of N (Table-4). The maximum leaf area of 99.19 cm^2 was obtained with 5% N spray, while the minimum leaf area of 53.38 cm^2 was in control. Nitrogen is the constituent of all proteins (Goh and Haynes, 1986) that is why with the increase application of N, leaf size increased due to accumulation of photosynthates. With foliar application of zinc, the maximum leaf size of 86.52 cm^2 was with 0.25% Zn spray as compared to the minimum leaf size of 59.29 cm^2 in control. The minimum leaf area in Zn deficient plants might be due to adverse affect on chlorophyll content, stomata conductance and net photosynthesis (Hu and Sparks, 1991). The interaction between N and Zn concentrations revealed that the maximum leaf area (119.20 cm^2) was obtained when the seedlings were sprayed with 5% N and 0.25% Zn, while the minimum leaf area (48.62 cm^2) was recorded in control. The maximum leaf area may be due to balanced fertilization that maximized photosynthesis. (Goh and Haynes, 1986).

Root length (cm)

Comparing the mean values of N, it was noted that the root length (45.78 cm) was produced by the seedlings supplied with 2.50% N (Table-5). Rest of the N concentrations produced statistically similar root length; however, the minimum root length (41.35 cm) was noticed in control. Levin *et al*., 1989; Olsthoorn *et al*., 1991 reported that the maximum root length might be due to the fact that moderate levels of N increases the shoot root dry weight ratio. This increase in shoot root ratio might even be larger in terms of shoot and root length. The decrease in root length beyond 2.50% N may be due to the reason that under high N supply, roots are short and well branched whereas under limited supply of N, roots are long and poorly branched (Chattopadhyay, 1988). With Zn foliar spray the highest root length (44.04 cm) were produced in seedlings with 0.25% Zn, however, it was statistically similar to those produced with 0.12% and 0.5% Zn. The lowest (41.41 cm) root length was noted in control. Marschner 1995 also observed longer roots with vigorous plant growth. Minimum root length may be due to the deficiency of Zn but shoot growth is more inhibited than root growth (Zhang *et al*., 1991).

Root diameter (cm)

The thickest (0.83 cm) and the thinnest roots (0.63 cm) were produced by the seedlings sprayed with 5% and 0% N, respectively (Table-6). The application of 2.5% and 1.25% N produced statistically similar root diameter. The maximum root diameter due to increased concentrations of N may be due to the reason that N being major nutrient and constituent of all proteins resulted in vigorous plant growth and hence thickest roots. Generally, root thickness was increased with increase in Zn concentrations up to 0.25%, but it significantly dropped beyond this level of Zn. The highest root diameter (0.76 cm) was noted in seedlings received 0.25% Zn; however, it was statistically similar to the root diameter obtained with 0.12% Zn. The lowest root diameter (0.66 cm) was recorded in control. The increase in root diameter by foliar application of 0.25% and 0.12% Zn may be due to more root and plant growth. Seedlings sprayed with 5% N and 0.25% Zn produced the maximum root diameter (0.91 cm) which was statistically similar to the root diameter of 0.84 cm and 0.83 cm obtained with 5% and 2.5% N and 0.5% and 0.25% Zn, respectively. The minimum root diameter was observed in seedlings received 0% N and 0% Zn (control). The results showed that better and regular availability of nutrients, light and moisture

produced better growth in terms of seedling height, seedling girth, number of leaves, leaf area etc. These all together caused increased photosynthetic activity and photosynthates accumulation and thus maximized root thickness.

Root weight (g)

Significant increase in root weight was observed with increased concentrations of N (Table-7). The maximum root weight (37.23 g) was recorded in seedlings received 5% N, while the minimum root weight of 30.37 g was obtained with 0% N which was statistically similar to the root weight produced with the application of 1.25% N. The seedlings produced vigorous roots also gave more root weight and vice versa. Goh and Haynes (1986) also found more root weight on plants with vigorous shoot and root growth. Comparing the mean values of Zn, the maximum root weight of 35.4 g was obtained with 0.25% Zn foliar application as compared to the minimum root weight of 29.76 g in control. Maximum root weight may be due to more roots of vigorous growth, while the minimum root weight may be due to suppressed root growth.

Number of roots

Foliar application of N has significant effect on number of roots seedling^{-1} (Table-8). The minimum number of roots (69.97) were on seedlings received no N. With increase in N levels the root number also increased and the maximum roots seedling^{-1} (76.08) were recorded with 5% N spray. The maximum number of roots may be due to the high N supply which produces increased number of leaves and larger leaf areas with enhanced photosynthetic activity and this resulted in vigorous protein synthesis utilizing the photosynthates produced by the leaves and increased number of roots. Foliar application of 0.5% and 0.25% Zn gave the maximum number of roots of 74.95 and 74.16 seedling^{-1} respectively as compared the minimum number of roots seedling^{-1} (70.00) in control (0% Zn). The maximum number of roots might be due to more vegetative and root growth as observed with foliar application of Zn, while the minimum number of roots without application of Zn might be due to poor vegetative and root growth. In the interaction significantly more roots seedling^{-1} (78.98) were on seedlings sprayed with 5% N and 0.5% Zn as compared to the minimum number of 67.0 roots seedling^{-1} in control. The increase in number of roots due to application of N and Zn might be due to vigorous growth of seedlings and subsequent vigorous growth of the roots.

Biomass weight (g)

It reveals from Table-9, that N and Zn have significant effect on biomass weight. The significantly maximum biomass weight plant^{-1} (53.36 g) was with foliar application of 5% N while the minimum biomass weight of 44.34 g plant^{-1} was in control. The increase in biomass weight with the application of N may be due to more growth of the seedlings, while the seedlings deficient in N, gave poor growth and hence the biomass weight was less. Similarly, with the application of zinc, the biomass weight was increased. The maximum biomass weight plant^{-1} (53.25 g) with 0.25% Zn spray and the biomass weight decreased with decrease in concentrations and minimum biomass weight plant^{-1} (44.25g) was in control (0% Zn). The maximum biomass weight due to zinc application might be due to major role of Zn in protein synthesis, which results in maximum plant growth (Marchner, 1995).

Table-1. Seedling height of pecan nut (cm) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (% age)	**Zinc levels** (% age)				**Means**
	0	0.12	0.25	0.50	
0	38.48	41.58	40.53	42.22	40.70 c
1.25	42.25	44.17	43.26	39.53	42.30 c
2.50	44.45	40.62	48.21	46.07	44.83 b
5.00	43.60	45.71	52.56	50.28	48.04 a
Means	42.19 c	43.02 bc	46.14 a	44.52 ab	

LSD value for nitrogen at 5% level of significance = 1.739
LSD value for zinc at 5% level of significance = 1.739
LSD value for interaction at 5% level of significance = 3.478

Means followed by the same letters are not significantly different at 5% level of significance.

Table-2. Seedling diameter of pecan nut (cm) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (% age)	**Zinc levels** (% age)				**Means**
	0	0.12	0.25	0.50	
0	0.57	0.58	0.61	0.70	0.61 d
1.25	0.62	0.58	0.67	0.74	0.64 c
2.50	0.59	0.68	0.81	0.74	0.70 b
5.00	0.68	0.84	0.73	0.86	0.79 a
Means	0.62 d	0.67 c	0.71 b	0.76 a	

LSD value for nitrogen at 5% level of significance = 0.02637
LSD value for zinc at 5% level of significance = 0.02637
LSD value for interaction at 5% level of significance = 0.05273

Means followed by the same letters are not significantly different at 5% level of significance.

Table-3. Number of leaves seedling^{-1} of pecan nut as influenced by foliar applicationof nitrogen and zinc.

Nitrogen levels (% age)	**Zinc levels** (% age)				**Means**
	0	0.12	0.25	0.50	
0	12.87	15.51	16.19	13.83	14.49 d
1.25	15.26	14.51	16.15	18.55	16.12 c
2.50	16.73	22.90	19.65	20.04	19.83 b
5.00	18.66	23.22	25.01	19.50	21.60 a
Means	15.88 b	19.04 a	19.25 a	17.87 ab	

LSD value for nitrogen at 5% level of significance = 1.442
LSD value for zinc at 5% level of significance = 1.442
LSD value for interaction at 5% level of significance = 2.884

Means followed by the same letters are not significantly different at 5% level of significance.

Table-4. Leaf area (cm^2) of pecan nut as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (% age)	**Zinc levels** (% age)				**Means**
	0	0.12	0.25	0.50	
0	48.62	49.68	65.21	50.01	53.38 d
1.25	50.31	85.40	67.37	77.39	70.12 c
2.50	63.45	70.10	94.27	80.64	77.12 b
5.00	74.75	95.97	119.22	106.80	99.19 a
Means	59.28 c	75.29 b	86.52 a	78.71 b	

LSD value for nitrogen at 5% level of significance = 6.156
LSD value for zinc at 5% level of significance = 6.156
LSD value for interaction at 5% level of significance = 12.31

Means followed by the same letters are not significantly different at 5% level of significance.

Table-5. Root length of pecan nut (cm) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (%)	**Zinc levels** (%)				**Means**
	0	0.12	0.25	0.50	
0	40.00	40.60	41.28	43.50	41.35 b
1.25	41.00	45.13	44.12	39.60	42.46 b
2.50	44.26	45.14	47.26	46.44	45.78 a
5.00	40.37	39.34	43.49	42.29	41.37 b
Means	41.41 b	42.55 ab	44.04 a	42.96 ab	

LSD value for nitrogen at 5% level of significance = 1.784
LSD value for zinc at 5% level of significance = 1.784

Means followed by the same letters are not significantly different at 5% level of significance.

Table-6. Root diameter of pecan nut (cm) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (%)	**Zinc levels** (%)				**Means**
	0	0.12	0.25	0.50	
0	0.59	0.70	0.60	0.63	0.63 c
1.25	0.65	0.77	0.70	0.60	0.68 b
2.50	0.61	0.65	0.83	0.70	0.69 b
5.00	0.79	0.80	0.91	0.84	0.83 a
Means	0.66 c	0.73 ab	0.76 a	0.69 bc	

LSD value for nitrogen at 5% level of significance = 0.04567
LSD value for zinc at 5% level of significance = 0.04567
LSD value for interaction at 5% level of significance = 0.09133

Means followed by the same letters are not significantly different at 5% level of significance.

Table-7. Root weight of pecan nut (g) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (%)	**Zinc levels** (%)				**Means**
	0	0.12	0.25	0.50	
0	27.26	30.61	31.78	31.85	30.37 c
1.25	29.52	32.16	33.30	30.22	31.30 c
2.50	28.67	35.13	37.27	34.48	33.89 b
5.00	33.58	38.77	39.27	37.29	37.23 a
Means	29.76 c	34.17 ab	35.40 a	33.46 b	

LSD value for nitrogen at 5% level of significance = 1.813
LSD value for zinc at 5% level of significance = 1.813

Means followed by the same letters are not significantly different at 5% level of significance.

Table-8. Number of roots of pecan nut as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (%)	**Zinc levels** (%)				**Means**
	0	0.12	0.25	0.50	
0	67.00	68.67	73.65	70.58	69.97 d
1.25	67.33	72.11	71.88	74.14	71.32 c
2.50	72.87	69.65	74.37	76.11	73.25 b
5.00	72.80	75.80	76.76	78.98	76.08 a
Means	70.00 c	71.55 b	74.16 a	74.95 a	

LSD value for nitrogen at 5% level of significance = 1.261
LSD value for zinc at 5% level of significance = 1.261
LSD value for interaction at 5% level of significance = 2.521

Means followed by the same letters are not significantly different at 5% level of significance.

Table-9. Biomass weight of pecan nut (g) as influenced by foliar application of nitrogen and zinc.

Nitrogen levels (% age)	**Zinc levels** (% age)				**Means**
	0	0.12	0.25	0.50	
0	40.50	43.38	47.40	46.08	44.34 c
1.25	42.82	47.99	49.86	44.64	46.33 c
2.50	43.53	54.62	55.34	51.88	51.34 b
5.00	50.15	58.85	60.39	56.02	56.36 a
Means	44.25 c	51.21 ab	53.25 a	49.65 b	

LSD value for nitrogen at 5% level of significance = 2.879
LSD value for zinc at 5% level of significance = 2.879

Means followed by the same letters are not significantly different at 5% level of significance.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of different results recorded, it is concluded that gradual increase in plant growth parameters occur with the increase in nitrogen and zinc concentrations. 5% N along with 0.25% Zn produces the best results with respect to growth of pecan nut seedlings. On the basis of the results it is recommended that Nitrogen i.e., 5% along with moderate dose of zinc i.e., 0.25% should be sprayed on pecan nut seedlings. The experiment should be repeated with nitrogen concentration more than 5% to further study the effect of nitrogen on the growth of pecan nut seedlings.

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