Effect of N and Zn on 'Hamlin' sweet orange (*Citrus sinensis* Osbeck)*

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Summary

Effects of four nitrogen doses, i.e. 0, 500, 1000 and 1500 g/tree and zinc sprays (0.6% ZnSO_4) viz. water spray, spray in February, spray in April and spray in February and April on fruit yield, quality and leaf composition of 'Hamlin' sweet orange were investigated. Growth parameters in terms of girth, height and spread were not affected significantly by N, Zn or their combinations. Significant increase in the yield of fruits by N and Zn treatments was recorded.

Fruit weight and diameter were significantly decreased by N application, whereas they were improved by zinc spray. Percentages of juice and T.S.S. were significantly increased by N application alone. The percentage of acidity, reducing sugars and T.S.S./acid ratio were not significantly affected by N, Zn and their combinations.

Significant increase in N content and reduction in Zn content of leaves due to N application were observed. Spray of zinc in April or in February and April increased foliar zinc content. No significant variation of P and K contents of leaves was observed due to N, Zn or their combinations.

Introduction

Deficiency of nitrogen⁽⁵⁾ and zinc^(9,10) are found to be limiting factor for normal growth and fruit production of citrus in Punjab. Beneficial effects of N on growth parameters, fruit production and quality of fruits have been reported^(12,15,18,19,21). Similarly, the useful effects of zinc have also been observed^(6,20,22,23). In view of limited information available on the effects of nitrogen and zinc alone and in combinations, the present experiment was conducted to investigate their effects on fruit yield, quality and leaf composition of 'Hamlin' sweet orange (*Citrus sinensis* Osbeck).

Materials and Methods

The present study was conducted at Punjab Agricultural University, Ludhiana during 1976-77, on 14-year-old trees of 'Hamlin'

sweet orange (*Citrus sinensis* Osbeck) budded on Jatti Khatti rootstock. The trees of uniform health and vigour planted 6.6m apart in hexagonal system were selected. The soil of experimental plot was sandy loam having pH of 8.6 with organic carbon, P_2O_5 and K_2O content of 0.09%, 7.41 and 140 kg/ha, respectively. Four levels of nitrogen, i.e. 0, 500, 1000 and 1500 g/tree through urea, were applied evenly in the basin of tree into two split doses, i.e. half dose of N was applied in the 2nd week of February and remaining half in the 2nd week of April. Four zinc treatments, i.e. control (water spray), spray in February, spray in April and spray in February and April were given. For this, 0.6% solution of ZnSO_4 with half or more quantity of hydrated lime was used and trees were sprayed sufficiently. The experiment was laid out in randomized block design and treatments were replicated four times. Experimental unit consisted of a single tree and a basal dose of 100 kg well rotten farm yard manure/tree was applied in December, 1976. Five hundred grammes of P_2O_5 & K_2O through single superphosphate and muriate of potash, respectively, were also applied in

Received for publication August 3, 1980

* Part of M. Sc. thesis submitted to PA U by senior author.

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February.

Conventional methods were employed to record the growth parameters of trees and physical characters of fruits. Fruit yield and fruit weight were recorded by harvesting the fruits. Titratable acidity was determined by titrating the juice against 0.1N NaOH solutions using phenolphthalein as an indicator. T.S.S. were determined by hand refractometer and the values were corrected at 20°C. Ascorbic acid (Vit. C) in juice was estimated titrating against standard solutions of 2,6-dichlorophenol indophenol dye.

For leaf analysis, six-month old leaves of spring flush were collected from fruiting terminals in September, 1977, as recommended⁽⁷⁾. Leaf samples were dried in an oven at 68°C for 48 hours after thorough washing in soap water, 0.1N HCl tap water, distilled water double distilled water. The estimation of and finally rinsed with nitrogen by micro-Kjeldahl method⁽¹⁴⁾, phosphorus by Vanado molybdo phosphorus yellow colour⁽⁸⁾, potassium by flame photometer⁽¹⁶⁾ and zinc by Atomic Absorption spectrophotometer, were done.

Results and Discussion

Growth parameters

There was no significant effect of nitrogen, zinc and their combinations on trunk girth, tree height and tree spread. This was because trees were of full bearing age and the effect on growth parameter was not anticipated.

Fruit yield (kg/tree): It is quite evident from Table 1 that fruit yield of 'Hamlin' was significantly affected by N, Zn and interaction between N and Zn treatments. There was significant relationship ($r=0.788$) between N applied and fruit production of 'Hamlin' (Fig. 1). A significant increase in fruit production was noted up to 1000g N/tree over lower doses and further increase in dose of N did not enhance the fruit yield. Thus, the highest fruit production (32.45 kg/tree) was observed under 1000g N/tree and the lowest fruit production (22.89 kg/tree) was noted under control (Table 1). The significant increase in yield by application of N might be due to its effect on increasing the number of flowers, more fruit set and retention of fruits up to

Fig. 1. Relationship between nitrogen levels and yield of 'Hamlin' fruits

Table 1. Effect of N and Zn treatments on fruit production of 'Hamlin' (kg/tree)

g/tree	Zn ₀	Zn _{Feb.}	Zn _{April}	Zn _{Feb. and April}	Average
N ₀	19.02	19.76	26.88	25.89	22.89
N ₅₀₀	28.41	26.98	24.64	26.71	26.69
N ₁₀₀₀	31.92	31.47	31.42	35.00	32.45
N ₁₅₀₀	27.40	32.18	32.31	37.24	32.28
Average	26.68	27.60	28.81	31.21	

C. D. at 5% for N = 2.50
for Zn = 2.50
for N × Zn = 4.49

maturity. In grown-up trees applied N is mainly utilized for flower and fruit production. These results are also in agreement with the findings of Reese and Koo⁽¹⁷⁾ in 'Pineapple' orange and Suzuki *et al.*⁽²¹⁾ in satsuma mandarin.

Amongst different zinc spray treatments, only zinc sprayed in February and April enhanced the fruit production of 'Hamlin' significantly over other zinc treatments and recorded the highest fruit production (31.21 kg/tree). The fruit production from trees sprayed with zinc either in February, April or control did not differ significantly (Table 1). Significantly low yield in control seems to have resulted from its deficiency in citrus, which is confirmed by more yield under zinc sprays. The zinc sprays might have helped in increased number of flowers, fruit-set and retention up to maturity which is governed by auxin

level in the tree, which might have been influenced by zinc application. There is an appreciable translocation of the zinc from the application site to young shoots and developing leaves and fruits which act as strong sink⁽²⁾. These results are in conformity with Aiyappa *et al.*⁽¹⁾ and Sharma *et al.*⁽²⁰⁾ who reported an increase in yield, by foliar application of zinc.

The interaction between N and Zn exhibited large variation in fruit yield/tree. The highest fruit yield (37.24 kg/tree) was noted in treatment 1500 g N/tree and zinc sprayed in February and April followed by 1000 g N/tree and zinc sprayed in February and April (35.00 kg/tree) which did not differ significantly from the former. The lowest fruit production (19.02 kg/tree) was recorded from control trees (Table 1). This shows that the efficiency of both N and Zn was increased when applied together, which resulted in enhanced fruit production.

Physico-chemical composition of fruits

The data in Fig. 2 shows that with the increase in the level of nitrogen applied there was a progressive significant decrease in fruit weight and diameter except at lower N level (500 g/tree). The highest fruit weight (148 g) and diameter (6.63 cm) were obtained from control trees, whereas the lowest fruit weight (117 g) and diameter (6.04 cm) were obtained with higher N level (1500 g/tree). The inverse relationship between fruit yield and fruit weight and diameter was clear from Figs. 1 and 2. The increased yield of fruits due to

N application affected the fruit weight and diameter which might have resulted from strong competition for the components of fruit improvement. Koo and Reese⁽¹³⁾ also observed decreased fruit weight with N application. Zinc sprays, on the contrary, resulted in an increase in the fruit weight and diameter (Fig. 3). The highest fruit weight (146 g) and diameter (6.60 cm) were recorded with zinc spray in April, whereas the lowest (130 g) fruit weight and fruit size (6.32 cm) were recorded from control trees. The increase in fruit weight and diameter with zinc sprays might be due to important component for fruit growth and development which have been influenced via tryptophane by zinc sprays.

The data presented in Table 2 reveals that N application significantly increased the juice percentage of 'Hamlin' fruits. The highest juice percentage (56.8 per cent) was recorded under 1500 g N/tree and the lowest (50.7 per cent) under 500 g N/tree. Zinc alone or in combination with N did not exhibit significant effect on juice percentage of fruits.

It is clear from Table 2 that N application significantly affected the T.S.S. of fruits and with each increment in the N dose there was an increase in T.S.S. content. Hence, the highest T.S.S. (9.54 per cent) was observed at 1500 g N/tree, whereas the lowest (8.71 per cent) was observed in the fruits from control trees. These results are in conformity with Reese and Koo⁽¹⁷⁾. The highest T.S.S. (9.70 per cent) was recorded from treatment N₁₀₀₀ Zn_{Feb}

Fig. 2. Effect of nitrogen levels on fruit weight and fruit diameter

Fig. 3. Effect of zinc spray on fruit weight and fruit diameter

Table 2. Effect of N and Zn treatments on chemical composition of 'Hamlin' fruits

Treatments	Juice (%)	T. S. S. (%)	Acidity (%)	T. S. S./ acid ratio	Vit. C (mg/100g juice)
N ₀ Zn ₀	48.6	8.85	0.608	14.72	40.46
N ₀ Zn Feb.	52.9	8.70	0.555	15.71	42.61
N ₀ Zn April	51.3	8.95	0.575	15.43	41.68
N ₀ Zn Feb. & April	53.3	8.35	0.593	14.16	43.28
N ₅₀₀ Zn ₀	48.8	8.70	0.578	15.16	41.36
N ₅₀₀ Zn Feb.	52.0	8.85	0.595	14.90	42.50
N ₅₀₀ Zn April	52.7	8.70	0.638	13.78	41.57
N ₅₀₀ Zn Feb. & April	49.1	9.05	0.608	15.08	42.79
N ₁₀₀₀ Zn ₀	51.6	9.30	0.655	14.26	41.07
N ₁₀₀₀ Zn Feb.	54.4	9.70	0.610	15.92	42.86
N ₁₀₀₀ Zn April	52.6	8.65	0.655	13.21	42.82
N ₁₀₀₀ Zn Feb. & April	54.0	9.00	0.623	14.90	42.75
N ₁₅₀₀ Zn ₀	54.9	9.65	0.545	17.81	40.32
N ₁₅₀₀ Zn Feb.	57.3	9.30	0.608	15.53	41.79
N ₁₅₀₀ Zn April	58.2	9.60	0.640	15.08	42.22
N ₁₅₀₀ Zn Feb. & April	56.6	9.60	0.640	15.03	42.79
Averages for N ₀	51.5	8.71	0.583	15.01	42.00
N ₅₀₀	50.7	8.82	0.605	14.73	42.05
N ₁₀₀₀	53.1	9.16	0.636	14.57	42.37
N ₁₅₀₀	56.8	9.54	0.608	15.86	41.78
C. D. at 5%	2.8776	0.26	N. S.	N. S.	N. S.
Zn ₀	51.0	9.12	0.597	15.49	40.80
Zn Feb.	54.2	9.14	0.592	15.52	42.44
Zn April	53.7	8.97	0.627	14.38	42.07
Zn Feb. & April	53.2	9.00	0.616	14.79	42.90
C. D. at 5%	N. S.	N. S.	N. S.	N. S.	0.61

and the lowest (8.35 per cent) was recorded from treatment N₀ Zn_{Feb and April}. Zinc spray alone has shown no significant effect on T. S. S. content.

Leaf Composition: There was significant increase in N content of leaves with increasing levels of N applied, and 1500g N/tree resulted in the highest N content of leaves (2.7%) and the lowest (2.2%) was recorded under control. A positive correlation ($r=0.81$) was observed between applied N and foliar N content (Fig. 4) which shows clearly that there was more uptake of N in fertilized trees than control and consequently raised the leaf N under higher N doses. These results are in conformity with the findings of Azo and Dantur⁽³⁾, Khalidy and Nayyal⁽¹¹⁾ and Suzuki *et al.*⁽²¹⁾.

Zinc content of leaves exhibited negative relationship to the level of N applied (Fig. 5) and increasing dose of N reduced the foliar zinc progressively. Hence, the lowest foliar

Fig. 4. Relationship between applied nitrogen and foliar N.

zinc content (26.4 ppm) was observed under 1500g N/tree and the highest zinc content (34.1 ppm) in control trees which was significantly higher than the former. Khalidy and Nayyal⁽¹¹⁾ also noticed an inverse relationship between applied N and leaf Zn. Improvement in the growth of trees due to N application might have dilution effect on the

Fig. 5. Effect of nitrogen levels on zinc content of leaves of 'Hamlin'.

Fig. 6. Effect of zinc spray on zinc content of leaves of 'Hamlin'.

zinc content of the citrus leaves. There was no significant effect of N and Zn and their combination on P and K content of leaves.

Zinc sprays in April and February and April resulted in 32.4 and 37.6 ppm foliar zinc, respectively, which was significantly higher than either February spray (25.3 ppm) or control (21.8 ppm). Under Ludhiana conditions, the new flush of growth is put forth in the first or second week of March in citrus. Since in February, there were old leaves which were not efficient in absorbing the nutrients as the young leaves, hence, less zinc was absorbed by the old leaves in February (Fig. 6).

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* Original not seen.

ハムリンオレンジ (*Citrus sinensis* Osbeck cv. Hamlin) に対する N および Zn 施用の効果

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摘 要

ハムリンオレンジ 1 樹当たり, 0, 500, 1000, 1500 g の N 施用と, Zn 6% 溶液の 2 月, 4 月および 2 月と 4 月 2 回の各散布が, 果実の収量, 品質ならびに, 葉内要素含量に及ぼす影響について調査した. 幹径, 樹高および樹の横径で表わされる生長に対しては, N および Zn とそれらの組合せ処理は有意な効果を示さなかったが, 果実の収量は N と Zn の処理によって有意に増加した.

果実重と果径が N の施用によって有意な減少を示したのに対して, Zn の散布によってはそれらが増加した.

果汁歩合と可溶性固形物含量は, N の施用によってのみ有意な増加を示した. 果皮歩合, 滴定酸度, 還元糖および甘味比については, N および Zn とそれらの組合せ処理による有意な効果が認められなかった.

N の施用によって葉内の N 含量が有意に増加し, Zn 含量が有意に減少した. 4 月に 1 回の Zn 散布区と, 2 月と 4 月の 2 回 Zn 散布区で葉内の Zn 含量が増加した. N および Zn とそれらの組合せ処理は, 葉内の P および K 含量に対して有意な変化を与えなかった.