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Full Length Research Paper

Effect of foliar application of nutrients and biostimulant on nut quality and leaf nutrient status of pecan nut cv. "Western Schley"

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A field study on pecan nut (cv. Western Schley) was conducted in the experimental orchard of the Department of Fruit science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2008 to 2009. The study comprised of one experiment in which pecan trees under investigation were subjected to foliar spray of 0.5% urea, 0.1% boric acid, 0.5%, zinc sulphate, 5 ml/L supramino and their combinations. The results revealed that the foliar application of 0.5% urea, 0.1% boric acid, 0.5%, zinc sulphate and 5 ml/L supramino resulted in better nut quality in comparison to control. It was found that leaf nutrient contents (N, P, K, Ca and Mg) were also recorded maximum in trees treated with 0.5% urea+0.1% boric acid+0.5% zinc sulphate+5 ml/L supramino. Maximum leaf iron content was recorded in trees treated with 0.5% urea and 5 ml/L supramino whereas, trees sprayed with 0.5% urea, 0.1% boric acid, 0.5% zinc sulphate and 5 ml/L supramino was found to have highest leaf Zn, Mn and Cu contents.

Key words: Pecan nut, foliar sprays, leaf nutrient, nut quality.

INTRODUCTION

Out of the 20 species of the genus *Carya*, *Carya illinoensis* W. is extensively cultivated on commercial scale in united states of America, Australia, Canada and Western Europe. Pecan is considered as the "queen of nuts" in U.S.A because of its value both as a wild and cultivated nut (Woodroof, 1979). Its nuts have high nutritional and calorific value, so, pecan is most acceptable in comparison to other nuts. Pecan nut contains high content of proteins (12.5%), fats (71.42%), P_20_5 (0.46%), K_20 (0.23%) and is rich in oil content and some varieties have shown as high as 76% oil. Besides having large export potential as nut, its timber is also expensive and used in gun-stock, carving, cabinet manufacture of high class and many other uses. Pecan nut can be grown in areas having 450 to 1550 m elevation which are free from severe spring frost and excessive heat in summer and receive annual rainfall ranging from 750 to 2000 mm. It requires warm temperate climate. It requires 240 to 280 days growing under warm climate with a mean temperature of above 26.7°C. Although, it can be grown in a wide range of soils but deep friable soils rich in organic matter and having 5.5 to 6.0 pH are the most suitable for its cultivation. Pecan nut has a long tap root and good soil depth of 6 m is desirable for its successful cultivation (Hanna, 1987). Major problem faced with its cultivation is the pecan drop and kernel blankness that directly affects yield. Various reasons for premature pecan drop assigned are varietal

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character, poor pollination, water stress and nutritional problems. Nitrogen is the element that provides better tree growth, a higher percent kernel, and a healthier tree. When properly maintained, nitrogen can help to provide optimal year to year production. Nitrogen deficiencies result in poor growth and poor tree health. Pecan trees do not absorb zinc from the soil and trees do not make vigorous growth. So, the application of zinc is essential as it has also been reported to improve the nut quality. Also, boron is passively absorbed and transported through the transpiration stream, so deficiencies of boron may be transitory. Premature flower and fruit drop of tree crops has been attributed to boron deficiency. Foliar application of boron has shown to stimulate the normal flow of hormones and enhance pollen grain and pollen tube formation which thereby, increase fruit retention and fruit quality in a number of perennial tree fruit crops, including pecan (Wells et al., 2008). Supramino which is a combination of amino acids, hydrolysed proteins, organic carbohydrates, bioenzymes and organic micronutrients needs to be supplied to the plants as amino acids have a direct role in the regulation of growth and development. These amino acids also help in flower retention which directly affects yield. Also, a small insect pecan case borer makes small hole in the base of pecan which can easily be identified and controlled. Analysis of leaves for their mineral concentration is widely used to predict the nutrient needs of pecan trees. Therefore, our objectives were to study the effect of nutrients and biostimulant on nut quality and leaf macro and micro nutrient status of pecan nut.

MATERIALS AND METHODS

The experiment was conducted in the experimental orchard of the Department of Fruit Science, Dr. Y .S. Parmar University of Horticulture and Forestry, Nauni-Solan during the year 2008 to 2009. The experimental orchard is situated between 31° N latitude and 77° E longitude at an altitude of 1276 m above mean sea level. The experiment was designed in randomized block with three replications. Twelve treatments were used including urea (0.5%), boric acid (0.1%), zinc sulphate (0.5%) and supramino (5 ml/L), their combinations and control. The trees were given foliar application of these nutrients and biostimulant in two equal splits at bud swell stage and one month after fruit set.

The required amount of each nutrient was weighed with an electronic digital balance. The urea was dissolved in warm water, while $ZnSo_4$ solution was prepared by dissolving $ZnSo_4$ salt with half the amount of lime in water to avoid phytotoxicity. Boric acid solution was prepared by dissolving boric acid (17%) in warm water. Similarly, supramino was taken and was dissolved in water. Nutrient solutions were sprayed in the morning hours with a foot sprayer pump. Ten nuts were randomly selected from every treatment for data collection and the observations in respect of nut and kernel characters, leaf nutrient status (macro and micro) were taken. Ten selected nuts were weighed on digital balance and average was expressed in grams (g). The length and breadth of kernels extracted from 10 selected nuts was measured with the help of Vernier Calliper and averages were expressed in centimeters (cm). The Kjeldahl’s method as described by Kanwar and Chopra (1967) for estimation of crude protein in plant samples was followed. Oil content of the kernel was determined on the weight basis and expressed in percentage. The nuts were dried in the oven at 60°C until they were moisture free. Petroleum ether (40 to 60° B.P.) was used as a solvent for oil extraction in the Soxhlet apparatus (Ranganna, 1997).

Opposite leaf let pairs from middle of the terminal shoots were collected from pecan nut trees in the last week of July and analysed as per standard analytical method. The digestion of the samples for the estimation of nitrogen was carried out in concentrated sulphuric acid (AR grade) by adding digestion mixture. For the estimation of leaf P, K, Ca, Mg, Zn, Fe, Cu and Mn, digestion was done in diacid mixture prepared by mixing nitric acid and perchloric acid (AR grade) in the ratio of 4:1.

Total nitrogen content was determined by Micro kjeldahl’s method (AOAC, 1980) and the results were expressed in percentage on dry weight basis. Total phosphorus content was determined by Vanadomolybdophosphoric yellow colour method (Jackson, 1975) and the results were expressed in percentage on dry weight basis. Total potassium content was determined on Flame Photometer (Toshniwal, TMF 45) and the results were expressed in percentage on dry weight basis. Total calcium and magnesium contents were determined with the help of atomic absorption spectrophotometer and the results were expressed in percentage on dry weight basis. The micro nutrients zinc, iron, copper and manganese were also determined with the help of atomic absorption spectrophotometer and the results were expressed in parts per million (ppm) on dry weight basis.

RESULTS

The results revealed that the nut weight, kernel weight, kernel length and kernel breadth were significantly improved with combined foliar spray of 0.5% urea + 0.1% boric acid + 0.5% zinc sulphate + 5 ml/L supramino treatment (Table 1). Further, fruit size and weight was also significantly affected by foliar application of zinc. Maximum kernel length was recorded under urea + boric acid + zinc sulphate + supramino treatment. The maximum kernel percentage and minimum blankness percentage was recorded with combined foliar spray of 0.5% urea + 0.1% boric acid + 0.5% zinc sulphate + 5 ml/L supramino treatment. In the present study, zinc improved the nut quality. The data presented in Table 1 revealed that the maximum kernel protein was recorded with combined foliar spray of 0.5% urea + 0.1% boric acid + 0.5% zinc sulphate + 5 ml/L supramino treatment. Also, combined application of urea + boric acid + zinc sulphate + supramino treatment resulted in highest kernel oil (%). Data presented in Table 2 indicated that the maximum leaf N, P, K, Ca and Mg contents were obtained with treatment 0.5% urea + 0.1% boric acid + 0.5% zinc sulphate + 5 ml/L supramino.

The data presented in Table 3 revealed that the maximum leaf Zn , leaf Mn and leaf Cu contents were recorded with combined foliar spray of 0.5% urea + 0.1% boric acid + 0.5% zinc sulphate + 5 ml/L supramino treatment and maximum leaf Fe content (287.5 ppm) was obtained with treatment urea + supramino. Significantly higher leaf zinc content of pecan nut leaves was observed. Increased leaf copper content was also observed.

Table 1. Effect of nitrogen, boron, zinc and supramino on nut weight, kernel weight, kernel length, kernel breadth, kernel percentage, shell kernel ratio, blankness percentage, kernel protein and kernel oil of pecan nut cv. Western Schley.

Treatment	Nut weight (g)	Kernel weight (g)	Kernel length (mm)	Kernel breadth (mm)	Kernel (%)	Shell kernel ratio	Blankness (%)	Kernel protein (%)	Kernel oil (%)
Urea (0.5%)	6.21	3.65	32.94	13.13	57.38	0.83	6.82 (2.61)*	9.36 (3.06)*	67.23 (55.08)**
Boric acid (0.1%)	6.28	3.54	33.56	13.56	57.49	0.86	7.95 (2.82)	8.33 (2.89)	68.52 (55.87)
$ZnSo_4$ (0.5%)	5.54	2.97	31.41	11.99	55.31	0.84	9.06 (3.01)	8.44 (2.91)	62.55 (52.27)
Supramino(5 ml/L)	6.30	3.57	33.66	13.62	57.53	0.85	7.76 (2.79)	8.39 (2.89)	65.08 (53.78)
Urea+boric acid (0.5%+0.1%)	6.47	3.70	33.88	13.66	57.51	0.78	6.35 (2.52)	9.02 (3.00)	71.35 (57.65)
Urea+ $ZnSo_4$ (0.5%+0.5%)	6.11	3.59	32.74	12.58	57.06	0.75	7.31 (2.70)	7.66 (2.77)	67.32 (55.14)
Urea +supramino (0.5%+5 ml/L)	6.52	3.73	33.97	13.68	57.65	0.86	6.45 (2.54)	10.77 (3.28)	67.40 (55.19)
Boric acid+ $ZnSo_4$ (0.1%+0.5%)	6.64	3.58	33.91	13.63	57.52	0.81	8.44 (2.90)	8.47 (2.91)	65.11 (53.80)
Boric acid+supramino (0.1%+5 ml/L)	7.07	3.62	34.10	13.68	57.68	0.85	7.99 (2.83)	8.52 (2.92)	68.77 (56.03)
$ZnSo_{4+}$supramino (0.5%+5ml/L)	6.52	3.59	34.06	13.69	56.58	0.76	7.55 (2.75)	8.53 (2.92)	71.59 (57.79)
Urea+boric acid+$ZnSo_{4+}$supramino (0.5%+0.1%+0.5%+5 ml/L)	7.54	4.53	34.66	13.86	60.48	0.75	5.57 (2.36)	13.68 (3.69)	76.52 (61.02)
Control	5.24	2.54	31.35	11.66	55.24	0.88	10.16 (3.19)	5.77 (2.40)	56.06 (48.48)
$CD_{0.05}$	0.56	0.03	0.65	0.04	0.28	0.02	0.03	0.05	0.75
SEM	0.19	0.01	0.22	0.01	0.09	0.01	0.01	0.02	0.25

* Figures in parentheses are square root transformed values; **, figures in parentheses are arc sine transformed values.

DISCUSSION

This increase was observed due to the fact that N is extremely mobile and developing fruits act as metabolic sink for the nutrient elements. The increase in nut weight could be attributed to the central role of N in various metabolic processes in the plant. Further, N application prolongs the phase of fruit cell division resulting in greater number of cells (Hewitt and Smith, 1975). The possible explanation for increase in fruit size and weight was also due to faster movement of simple sugar into fruit and involvement in cell division and cell expansion (Brahmachari et al., 1997). In macadamia nuts, kernel recovery, kernel weight and percentage of first grade kernels were enhanced by foliar boron sprays (Stephenson and Gallagher, 1990). The minimum blankness percentage was recorded with combined foliar spray of nutrients because of the cumulative effect of nutrients on kernel weight resulting in higher percentage. Although, blankness is a varietal character but reduction in proportion of blank kernels was due to improved internal nutrient status of trees due to foliar application of nitrogen and zinc which increased growth and vigour associated with higher photosynthesis and trans location of assimilated products in nuts leading to minimum blank kernels. The decrease in shell kernel ratio has been attributed to production of kernels with heavier weight due to cumulative effect of foliar fertilization. Foliar application of urea increased total nitrogen in plants tissues, which led to higher protein content in pecan kernels due to the fact that nitrogen is a constituent of protein (Salisbury and Ross, 1992). Furthemore, these results are in line with Tous et al. (2005) who reported increased kernel size in ‘Negret’ cultivar of hazelnut by boron treatments. Same findings have also been reported by Bhatia and Yadav (2005), Bybordi and Malakouti (2006), Farid et al. (2007) in jackfruit and Tomar and Singh (2007). Furthermore, the combined spray of nutrients resulted in increased leaf nutrient status. This increase in leaf N content might have occurred due to the fact that nitrogen is highly mobile. Its efficient translocation and nutrient supply from root to tree leaves could have added to its enhanced accumulation in leaves (Smith, 1962). The increase in leaf calcium content was because of the direct positive relationship

Table 2. Effect of nitrogen, boron, zinc and supramino on macronutrient status of leaves of pecan nut cv. Western Schley.

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Urea (0.5%)	2.65 (1.63)*	0.18 (0.43)*	0.78 (0.88)*	1.55 (1.02)*	0.57 (0.75)*
Boric acid (0.1%)	2.27 (1.51)	0.15 (0.39)	0.75 (0.86)	2.09 (1.45)	0.51 (0.71)
$ZnSo_4$ (0.5%)	2.24 (1.49)	0.16 (0.41)	0.84 (0.92)	2.20 (1.48)	0.45 (0.67)
Supramino (5 ml/L)	2.49 (1.58)	0.17 (0.42)	0.86 (0.92)	2.16 (1.47)	0.51 (0.71)
Urea+ boric acid (0.5%+0.1%)	2.69 (1.64)	0.19 (0.44)	0.82 (0.90)	2.41 (1.55)	0.56 (0.75)
Urea+ $ZnSo_4$ (0.5%+0.5%)	2.55 (1.59)	0.18 (0.43)	0.91 (0.95)	2.32 (1.52)	0.52 (0.72)
Urea+ supramino (0.5%+5 ml/L)	2.69 (1.64)	0.17 (0.42)	0.82 (0.90)	2.37 (1.54)	0.58 (0.76)
Boric acid+ $ZnSo_4$ (0.1%+0.5%)	2.46 (1.56)	0.17 (0.42)	0.86(0.92)	2.25 (1.50)	0.56 (0.75)
Boric acid+supramino (0.1%+5 ml/L)	2.53 (1.59)	0.17 (0.42)	0.78(0.88)	2.27 (1.51)	0.60 (0.77)
$ZnSo_4$+supramino (0.5%+5 ml/L)	2.59 (1.60)	0.16 (0.41)	1.11 (1.05)	2.31 (1.52)	0.58 (0.76)
Urea+boric acid+$znso_4$+supramino (0.5%+0.1%+0.5%+5 ml/L)	2.88 (1.69)	0.22 (0.47)	1.14 (1.07)	2.44 (1.56)	0.63 (0.79)
Control	2.06 (1.44)	0.14 (0.37)	0.72 (0.85)	2.06 (1.43)	0.45 (0.67)
$CD_{0.05}$	0.02	0.03	0.02	0.43	0.02
SEM	0.01	0.01	0.01	0.14	0.01

*Figures in parentheses are square root transformed values.

Table 3. Effect of nitrogen, boron, zinc and supramino on micronutrient status of leaves of pecan nut cv. Western Schley.

Treatment	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)
Urea (0.5%)	224.70	246.80	277.20	38.38
Boric acid (0.1%)	192.80	174.20	249.10	28.73
$ZnSo_4$ (0.5%)	290.60	174.10	251.50	30.00
Supramino(5 ml/L)	284.50	212.40	262.50	33.13
Urea+ boric acid (0.5%+0.1%)	195.30	266.90	261.20	47.87
Urea+ $ZnSo_4$ (0.5%+0.5%)	264.00	212.40	269.70	36.40
Urea+ supramino (0.5%+5 ml/L)	196.50	263.20	287.50	47.44
Boric acid+ $ZnSo_4$ (0.1%+0.5%)	291.70	182.10	262.30	30.78
Boric acid+supramino (0.1%+5 ml/L)	277.80	222.3	250.30	38.03
$ZnSo_{4+}$Supramino (0.5%+5 ml/L)	290.80	223.7	247.80	30.82
Urea+boric acid+$znso_4$+supramino (0.5%+0.1+0.5%+5 ml/L)	294.10	267.4	287.30	48.47
Control	190.50	150.30	239.40	17.44
$CD_{0.05}$	5.16	12.55	3.21	1.98
SEM	1.72	4.18	1.07	0.66

Figures in parentheses are square root transformed values.

(synergysm) between leaf nitrogen and leaf calcium (Childers, 1983). Thus, the foliar sprays of urea might have increased the calcium mobility sufficiently during senescence, thereby increasing its calcium level later on. Increase in the concentration of zinc in plants tissues might be because of the effect of application of zinc. Under nitrogen application, the great availability of manganese might have led to greater uptake of manganese. This might be because of the fact that higher absorption, translocation and utilization of nutrients takes place in the plants which resulted in increased plant growth. Furthermore, Johnson and Amdris (2000) reported increased leaf nitrogen concentration after the foliar application of urea. Increase in leaf P content are in conformity with the findings of findings of Shashi (2003) and Raina et al. (2005) who also reported increased leaf phosphorus content with nitrogen application. These results are in accordance with the findings of Singh (2000) in pecan nut.

Conclusion

From the results, it is evident that the application of nutrients and biostimulant significantly improved nut quality (in terms of nut weight, kernel weight, kernel length, kernel breadth, kernel oil and protein) and leaf nutrient status. Hence, foliar application of urea 0.5% + boric acid 0.1% + zinc sulphate 0.5% + supramino 5 ml/L can be given first at pre-bloom stage and repeated after fruit set stage to enhance nut quality and leaf nutrient status of pecan nut.

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