Journal of Agriculture and Environment Vol. 12 No. 2, 2016: 139-148
ISSN 1595-465X

INFLUENCE OF BORON APPLICATION ON THE NUTRITION OF TOMATO (*Lycopersicon esculentum*) IN SOILS OF GERIYO AND CHOUCHI, ADAMAWA STATE

M.L. Bubarai, A.M. Saddiq, A. Ibrahim and A.M. Tahir

Department of Soil Science, Modibbo Adama University of Technology,
P.M.B 2076, Yola, Adamawa State, Nigeria

ABSTRACT

A pot experiment was conducted in 2009 and 2010 to study Boron nutrition in the soils of Geriyo flood plain (Yola north) and Chouchi flood plain (Yola south) of Adamawa State using tomato (*Solanum lycopersicum* L.) plant as test crop. The aim of this work is to study the effect of soil applied boron fertilizer on fruit and dry matter yields of tomato (Variety Roma VF) under graded B application (uptake) and some of its biochemical properties. Composite soils were collected from the two sites. The experiment was laid out in a completely randomized design, comprising five levels of boron (0, 2, 3, 4 and 5 mg/kg) in the screen house of Modibbo Adama University of Technology, Yola. Tomato plant growth parameters and quality were evaluated. Result of the data analysis revealed that plant height, fresh and dry matter yield were significantly ($P < 0.05$) affected by boron application. Highest dry matter yield of 41.7; 40.2; 10.9; 10.8; 33.7; 32.8; 5.33 and 5.25 were recorded by 5 mg/kg B application. The highest values of ascorbic acid (Vitamin C), 10.13; 10.1; 8.12 and 7.12 in Geriyo and Chouchi soils were recorded with 5 mg/kg B application.Also the highest values of titratable acidity, 9.67; 6.88; 4.80 and 5.12 in both soils were recorded with 5mg/kg B application. Highest values of total soluble solid 8.41; 9.70; 38.5 and 39.2 were recorded with 5 mg/kg B application in both soils, In general, the overall result showed that the growth parameters were influenced more by the 2mg/kg B treatments, whereas 5mg/kg B treatments greatly affected yield attributes and its uptake.

Keywords: Boron; Ascorbic acid; Plant height; Geriyo soils

INTRODUCTION

Boron is an important micronutrient required by vegetable crops such as tomato for proper growth (Naz *et al.*, 2012). Yield and yield components of crops could be affected positively and negatively by boron, depending upon soil status, type of crop and the doses used. Also differential response of crop varieties to B has been reported (Lombin, 1985; Onyinlola *et al.*, 1996). Like other nutrients, boron has a pronounced effect on the production and quality of tomato. The function of boron in the plant have been associated with water retentions, sugar translocation, cation and anion absorption, pollen viability and the metabolism of N, P, carbohydrates and fats (Onyinlola *et al.,* 1996). Its deficiency affects translocation of sugar, starches, nitrogen and phosphorus, synthesis of amino acids and proteins (Stanley *et* al., 1995). Boron is also needed by crop plants for cell division, nucleic acid synthesis, and uptake of calcium and transport of carbohydrates (Boseand Tripathi, 1996). It also plays an important role in flowering and fruit formation (Nonnecke, 1989).Deficiency of boron is more wide spread than the deficiency of any other micronutrient (Reisenauer *et al.,* 1973). Boron deficient soils include those which are inherently low in boron, calcareous and coarse textured soils and those high in clay (Lucas and Knezek, 1972). Boron deficiency was first observed in Northern Nigeria soil through field trials (Lombin, 1985). Under B deficiency, normal cell wall expansion is disrupted (Havlin *et al.*, 2006). Boron deficiency affects the growing points of roots and youngest leaves. The leaves become wrinkled and curled with light green colour. Crop response to application of B has been well documented (Lombin1985; Oyinlola and Chude, 2004)**.**

Tomato (*Lycorpersicon esculentum*) belongs to the family Solanaceae and is grown all over the country. It is particularly grown in commercial quantity in most fadama lands of Sahel Sudan, northern and southern Guinea Savanna. It is an economic vegetable crop and engages a large segment of the population in gainful employment especially during the dry season. Therefore the research findings will be useful in improving yield production of tomato, reduce poverty and improve the general well being of the society. The yield potential and quality can be improved by maintaining proper fertilizer application. Tomato crop requires sufficient amount of fertilizer for improved plant growth and development. It is well established fact that chemical fertilizers improve plant growth directly (Splittstoesser, 1990). Tomato is considered a heavy feeder of micronutrients and B in particular is important for its growth, fruit set, and disease resistance (Srinivasamurthy *et al*., 2003). The aim of this work is to study the effect of soil applied boron fertilizer on fruit and dry matter yields of tomato (variety Roma VF) under graded B application (uptake) and some of its biochemical properties. A review of existing literature showed that no work has been done on B requirements of horticultural crops like tomatoes in Adamawa state.

MATERIALS AND METHODS

Study Area

The study was conducted in the green house of the Modibbo Adama University of Technology Yola in 2009 and 2010. Soil samples were collected from two locations: Geriyo flood plain (Yola North) and Chouchi flood plain (Yola South). Geriyo lies between Latitude 9° 16’ and 9º 19’ N and Longitude 12º 22’ and 12º 28’ E. The major soil types consist of gleyic Cambisols, gleyic Luvisols and eutric Regosols (Usman, 2005).

Soil Sample Collection and Analysis

Soils were collected at the depth of 0 – 30cm from Geriyo and Chouchi sites using bucket auger and shovel. Samples collected were thoroughly homogenized and treated as a single sample. A total of 160kg of soil samples were collected, from the two sites Geriyo and Chouchi. The soils for routine analysis were thereafter dried in the sun, crushed using pestle and mortar and sieved through 2mm sieve. The treatments consisted of five levels (0, 2, 3, 4, and 5mgB/kg per pot) of B application. The treatments were arranged in a completely randomized design and replicated three times. Available B in the soils was determined using hot distilled water as the extractant and the extracted boron was reacted with curcumin to form an orange colored complex. The concentration of boron was then determined calorimetrically (Jaiswal, 2003).

Planting and Data Collection

Tomato (variety Roma VF) seeds were planted in two germination beds using a circular tray measuring 600inches in diameter. Each germination bedwas watered to field capacity after that, the seeds were broadcasted in the germination tray covered with soil and mulched. Watering was done twice (morning and evening) for four weeks. At four weeks after planting the seedlings were transplanted to already prepared plastic containers (12 inches in diameter) containing 5kg soil using hand trowel. Two seedlings were planted per pot and later thinned to one plant after fully establishment. Watering was done with deionised water. At week six of transplanting, boron was added at the specified quantities (0, 2, 3,4and 5mg/kg) according to treatments

Plant height per pot was measured using meter rule from the base of the plant to the base of the last leaf on the plant. Harvested plant was washed twice in distilled water and the leaves detached from the plant. Similarly, the stems and roots were cut separately and weighed. The plant samples were oven dried at 65ºC until a constant weight was obtained. Plants from the same site with similar treatments were combined together and ground with stainless steel mill. The finely ground plant sample parts were wetted with $CaOH_2$ solution and evaporated to dryness in the oven. Boron concentration was determined using the method described by Jaiswal (2003).

Harvested fruits from the plants were weighed and fruits from the same site with similar treatments were combined and made into a paste by a grinder. The ground sample was analyzed for ascorbic acid, titratable acidity and total soluble solid. The ascorbic acid content of the fruit (vitamin C) was determined by titration using the procedure described by Owuka (2005). Total soluble solid was determined by a refractometer. The percent fruit setting was determined by counting the number of flowers per plant and multiplying by hundred.

Data Analysis

Data obtained were statistically analyzed using analyses of variance (ANOVA). Means that were statistically different were separated using Duncan`s multiple range test provided by Duncan (1955).

RESULTS AND DISCUSSION

Soil Analysis

The results of the soil analysis are presented in Table 1. Soil of Geriyo is clay loam in texture. This is in line with the findings of Usman (2005) who reported that the dominant soil texture in Geriyo is clay loam. However, Chouchi soils were sandy loam in nature, the soil pH in water of Geriyo was moderately acidic in nature. Usman (2005) reported slightly acidic soil reaction in this study area. The decrease in pH observed may be due to the leaching down of basic cations resulting in acidification of the soil. However soil pH in Chouchi was slightly alkaline in nature. Shankara *et al.* (2005) reported that tomato plant thrive well under slightly to moderately acid soil reaction (pH) which improves boron availability while alkaline causes boron deficiency in soils. Soils of both Geriyo and Chouchi are non saline in nature. This concurred with the report of Usman (2005) who reported that soils of Geriyo are non saline. The organic carbon content of soils of Geriyo and Chouchi were moderate and low, respectively as classified by Aduayi *et al.,* (2005). Similar result was reported by Usman (2005); Saddiq *et al.*, (2007). The low organic carbon content of the soil may be attributed to high temperature in the study area which leads to rapid decomposition of organic residues as well as lack of fallow. Also the low organic matter may be attributed to erosion during the rainy season. The total nitrogen content of soils in both study areas was low which is similar with the result obtained by Usman (2005). It has been reported that there is direct relationship between organic matter and total nitrogen content in the soil. The low content of nitrogen in this area could also be attributed to sheet erosion during the rainy season which depletes the A horizon associated with organic matter that furnishes the soil with nitrogen (Brady and Well, 2004). Available P content of the two soils was low, lower value of available P may be due to greater P sorption in Geriyo as a result of the clay content of the soil than Chouchi (Table 1).

Table 1: Physico – chemical properties of the soils of Geriyo and Chouchi

Soil parameters	Geriyo	Chouchi	Mean
$pH(H_20)$	5.70	8.40	7.05
EC mmhos/cm	2.40	0.07	1.24
Organic carbon (g/kg)	14.00	9.00	11.5
Organic matter (g/kg)	24.13	15.51	19.82
Total N (g/kg)	0.88	0.53	0.705
Available P(mg/kg)	4.32	8.84	6.58
Available B(mg/kg)	0.22	0.12	0.17
Exch. bases (cmol(+)/kg			
Ca	4.00	4.20	4.01
Mg	0.80	1.15	0.98
Na	0.25	0.37	0.31
K	0.29	0.23	0.26
TEB	5.44	5.95	5.69
CEC	9.89	9.00	9.44
%BS	55.00	66.00	60.5
Sand %	32.00	38.00	35.0
Silt %	31.00	30.00	30.5
Clay %	37.00	31.20	34.1
Textural Class	Clay loam	Sandy clay loam	

Boron content of the soil was low as classified by Ewenzor *et al.* (1989). Cation exchange capacity of soils at both study area were low. This concurred with the study of

Ewenzor *et al.* (1989). They reported that most savanna soils have low cation exchange capacity values.

Effect of Boron on Plant Height

There was significant influence ($P<0.05$) of the treatments on the height of tomato plant at different sampling time (8WAT, 10WAT, 12WAT and 14WAT) in both soils (Geriyo and Chouchi) in 2009 and 2010. In 2009, at 8WAT, Geriyo soil produced the taller plant height (15.85cm) than Chouchi (11.85cm). The reasons may be due to the texture of the soil. The clay loam nature of the soil makes it easier to retain water and nutrient for plants absorption and growth. Application of 2 mg/kg of boron produced the maximum plant height in both soils (Geriyo and Chouchi). The increase in the height of tomato plant could be due to the supply of boron and enhanced nutrient absorption and uptake by the plants resulting in improved plant growth. This observation was noted by Meena (2010) who reported that tomato photosynthetic reactions were accelerated in the presence of boron. Similarly, Sathya *et al.* (2010) attributed increased plant height to enhancement of photosynthetic and other metabolic activities which increased metabolites responsible for cell division and cell elongation of shoot and roots. Plant heights were taller in the soils of Geriyo as compared to Chouchi this may be due to the fine textured (clay loam) nature of the soil of the study area which has the tendency to retain more moisture and nutrient (applied boron) and enhanced uptake of nutrients. Also, the soil reaction (pH) in Geriyo (5.70) favors the growth of tomato because at low pH, boron tends to be more available than at high. This is because boron adsorption by soils increased as a function of solution pH in the range of pH 3 to 9 (Barrow, 1989). Boron normally becomes less available to plants with increasing soil pH and decreasing dramatically above pH 6.3 to 6.5. The lowest plant height observed in the control pot might be due to boron deficiency. Gupta and Cutcliffe (1985) reported that stunted growth has been observed in B deficient conditions in tomato and several other crops.

Table 2: Effect of boron on plant height of tomato at Geriyo and Chouchi

Location	2009 (WAT)				2010 (WAT)			
	8	10	12	14	8	10	12	14
Chouchi Soil	11.85^b	33.75^a	54.40^a	73.50^b	12.15^b	40.00^b	72.60^b	74.00^b
Geriyo Soil	15.85^a	27.95^b	56.60^a	64.60^a	15.60^a	45.95^a	88.60^a	92.35^a
Mean	13.57	38.73	49.23	65.15	13.65	47.12	60.90	62.20
P<f	0.137	0.001	0.0001	0.0001	0.144	0.001	0.658	0.020
Treatment (mg/kg B)								
0	10.37^c	21.25^b	37.87^c	64.62^b	10.00^d	21.25^c	65.00^b	64.63^b
2	19.00^a	42.25^a	93.12^a	141.37^a	19.62^a	89.62^a	139.00^a	162.25^a
3	14.62^b	33.62^b	57.75^b	70.50^b	15.00^b	41.62^b	76.75^b	71.75^b
4	12.75^b	27.12^b	41.25^c	64.12^b	16.62^b	33.62^b	65.50^b	64.13^b
5	12.50^b	24.00^b	40.50^c	54.62^c	12.12^d	28.75^b	56.75^c	54.63^b
Mean	13.57	38.73	49.23	65.15	13.57	38.73	49.23	65.15
P<f	0.523	0.0001	0.0001	0.001	0.519	0.0001	0.0001	0.0001

Means within column of treatment followed by different letters are significant at 5% level of probability

Effect of Boron on Fresh and Dry Weight of Shoot of Tomato

Fresh and dry weight of shoot was significantly ($P<0.05$) influenced by the application of boron. Result obtained at both Geriyo and Chouchi soils revealed that application of 5 mg/ kg B recorded maximum fresh and dry weight in both growing seasons. The highest fresh weight of shoot (42.12g) and (41.50g) with application of 5 mg/kg B was recorded on the soils of Geriyo and Chouchi in 2009 and 2010 winter season respectively. Soils of Geriyo recorded the highest mean value of fresh weight of shoot (42.12g) than Chouchi (41.50g). Also maximum dry matter production of 19.9 and 20.59g for the two seasons were obtained with the soils of Geriyo with 5 mg/kg B application (Table 3).The result is in conformity with the findings of Gupta (1993) who reported that soil application of boron increases fresh matter production besides dry matter and ash. The synergistic influence could be attributed to the promotion of lateral branching and the growth of shootsand fruits by the boron application. Ahmad and Jabeen (2005) obtained similar result while working on cotton in Pakistan.

Fresh and Dry Matter Production of Fruit

Application of 5 mg/kg B recorded the highest mean fresh and dry matter yield for the two seasons in both Geriyo and Chouchi soils .The lowest fresh and dry matter yield for the growing seasons for the two soils were observed in the control pots.

Table 3: Effect of boron on fresh and dry weight of shoot and fruit per plant at Geriyo and Chouchi

Location	2009				2010			
	Fresh shoot weight (g/kg)	Dry shoot weight (g/kg)	Fresh fruit weight (g/kg)	Dry fruit weight (g/kg)	Fresh shoot weight(g/kg)	Dry shoot weight(g/kg)	Fresh fruit weight (g/kg)	Dry fruit weight (g/kg)
Chouchi Soil	41.50[a]	10.08[a]	32.08[b]	20.04[a]	28.10[a]	22.33[a]	20.01[a]	23.02[a]
Geriyo Soil	42.12[a]	19.09[a]	33.07[a]	28.06[b]	22.20[a]	20.59[a]	32.08[a]	20.01[b]
Mean	15.22	11.00	14.22	3.212	21.64	11.030	10.20	12.02
P<f	0.0001	0.0001	0.0001	0.0001	0.854	0.0001	0.0001	0.0001
Treat (mg/kgB)								
0	14.25[c]	13.57[b]	12.25[c]	11.20[c]	13.75[b]	12.70[b]	11.50[b]	12.30[b]
2	15.37	9.96[b]	15.26[c]	14.20[c]	2762[b]	12.65[b]	10.40[b]	11.40[b]
3	28.50[b]	11.58[d]	20.40[b]	20.41[b]	26.12[a]	14.59[b]	13.40[b]	10.40[b]
4	17.37[c]	15.87[b]	16.27[c]	15.22[c]	16.75[b]	17.00[b]	16.00[b]	14.20[b]
5	42.12[a]	19.09[a]	40.11[a]	35.11[a]	41.50[a]	20.59[a]	45.30[a]	35.30[a]
Mean	21.64	11.30	10.20	12.02	21.64	11.30	10.20	12.02
P<f	0.0001	0.0001	0.0001	0.0001	0.073	0.0001	0.0001	0.0001

Mean within column of treatment followed by different letters are significant at 5% level of probability

Balasubramanian *et al*. (1998) reported that dry matter content of tomato fruit was influenced by the application of boron and NPK. Soils of Geriyo recorded the highest mean value of fresh weight of fruits (33.7 and 32.8g) by 5 mg /kg B application while Chouchi recorded 32.8 and 20.1g (Table 3).

Fruit Weight

Application of boron significantly (P<0.05) increased the fruit weight of tomato, as boron rate increased, the fruit weight also increases. Highest fruit weights of 40.11 and 45.30g for the soils of the two locations were recorded by 5 mg/kg B application.Lowest fruit weight of 12.25 and 11.50g were recorded by the control pots. Sathya *et al*. (2010) obtained similar result and attributed the increased in fruit weight to the increased in total soluble solid of the fruit. As the result indicates there was a significant different between the two soils, Geriyo recorded higher tomato fruit weight (33.7 and 32.8g) in all the growing seasons than Chouchi (32.8 and 20.1g), this may be due to greater B use efficiency by tomato in soils of Geriyo than in the soils of Chouchi (Table 4).

Titratable Acidity

Titratable acidity increases with an increasing rate of boron. The fruits of tomato plant grown in the soils of Geriyo recorded higher titratable acid percentage than those grown on Chouchi soil. The highest titratable acidity (14.82 and 14.08%) was recorded by 5 mg/kg B application in both soils and in both growing seasons while control soil recorded the lowest values of 11.23 and 9.48%. This is in conformity with the findings of Salam *et al.* (2010). They obtained maximum increased in titratable acidity with the application of boron and NPK and recorded lower values with control (Table 4).

Ascorbic acid

Highest ascorbic acid content of 21.68 and 14.08mg/g was recorded by 5 mg/kg B application in 2009 and 2010 respectively (Table 4), while the lowest values of 9.67 and 10.06mg/g were recorded in control. Ascorbic acid content of tomato increased with increasing rate of boron in both soils and in both growing seasons (Table 4). This clearly showed significant influence of boron on the ascorbic acid content of tomato. Chude and Oyinlola (2001) obtained similar result and stated that optimum rate of boron increases the ascorbic acid content of tomato. Dube *et al.* (2004) also, opined that the ascorbic acid content of tomato improved with the addition of Borax.

Total Soluble Solid

There was a significant increase (P<0.05) in the total soluble solid (TSS) content of tomato with increasing rate of boron. Highest total soluble solid content of 11.23 and 10.80 (brix) were recorded by 5 mg/kg B application in the soils of both Geriyo and Chouchi irrespective of growing season (Table 4). Lowest values of 7.13 and 6.60 (brix) were recorded in the control pot. Geriyo soils recorded highest mean value of 8.97 and 9.12 (brix) than the Chouchi soils (5.33 and 6.11 brix). Sathya *et al*. (2010) obtained similar result on the quality of tomato fruit and reported that the TSS content of tomato fruit was significantly influenced by the application of boron. The soils of Geriyo recorded the highest numbers of all the biochemical properties in the two growing winter seasons. This can be attributed to the texture of the soil (clay loam) which retained the added boron for longer period and therefore efficient utilization by the plant thereby making the plant to utilize it for their growth.

Table 4: Effect of boron on some biochemical properties of Tomato Fruit

Location	2009				2010			
	Fruit weight g/kg	Titratable acidity (%)	Ascorbic acid (mg/g)	Total soluble Solid (Brix)	Fruit weight g/kg	Titratable acidity (%)	Ascorbic acid (mg/g)	Total soluble solid (Brix)
Geriyo Soil	33.07^{a}	14.31^{a}	14.90^{a}	8.97^{a}	32.8^{a}	14.41^{a}	14.53^{a}	9.12^{a}
Chouchi Soil	32.08^{b}	12.10_{b}	10.12_{b}	5.33_{b}	20.01^{b}	$11,20_{b}$	10.21_{b}	6.11_{b}
Mean	14,22	13.92	8.70	39.19	10.20	13.50	8.59	37.44
P<f	0.0001	0.0001	0.127	0.0001	0.0001	0.0001	0.0001	0.0001
Treatment								
0	12.25^{c}	11.23^{c}	9.67^{d}	7.13^{d}	11.50^{b}	9.48^{e}	10.06^{d}	6.60^{d}
2	15.26^{c}	11.61^{c}	10.47^{d}	7.50^{d}	10.40^{b}	10.98^{d}	10.75^{d}	7.84^{c}
3	20.40^{b}	13.50^{b}	12.30^{c}	8.50^{c}	13.40^{b}	12.57^{c}	12.10^{c}	8.57^{b}
4	16.27^{c}	13.92^{b}	15.52^{b}	9.16^{b}	16.00^{b}	13.50^{b}	15.32^{b}	9.15^{b}
5	40.11^{a}	14.82^{b}	21.68^{a}	11.23^{a}	45.30^{a}	14.08^{b}	19.26^{a}	10.80^{a}
Mean	10.20	17.03	8.70	39.19	10.20	16.36^{a}	8.59	37.44
P<f	0.0064	0.039	0.127	1.019	0.0001	1.050	0.0027	0.0065

All figures on the same column followed by the same letters are not significantly different from each other according to DMRT at 5% level of probability

CONCLUSION

Based on the findings of this research work it could be concluded that to improve the quality of tomato, application of Boron at 5mg/kg is congenial for Geriyo and Chouchi soils under green house investigation. It is also suggested that this finding be verified under field condition.

REFERENCES

Aduayi, E.A., V.O. Chude, O. Adebosoyo and S.O.Olayiwole (2002). Fertilizer use and management practices for crops in Nigeria. Federal mimistry of Agric and Rural Development.

Ahmad, R. andR. Jabeen (2005).Foliar spray of mineral elements antagonistic to sodium:a technique to induce salt tolerance in plant growing under saline conditions *Pak .Journal Bot.*,37:913-920

Balasubramanian, P., A.K. Mani,P.Duraisamy and M. Kandaswami (1998). Effect of organic and in organic nutrients on the yield and uptake of tomato. *South Indian Hort.*, 46(3-6): 143-147

Barrow, N.J.(1978).The description of phosphate adsorption curves. *Journal Soil Science*, 29: 447-462.

Bose, U.S. and S.K.Tripathi (1966). Effect of micronutrients on growth yield and quality of tomato cultiver Pusa Rugby. *Crop Res Hisar*, 12(1): 61-64.

Brady, N.C.and R.R. Weil (2004). *Element of the Nature and Properties of Soils*. 2nd Edition. Pearson Education Inc.,Upper Saddle River New Jersey; p 666-669

Chude, V.O. and Oyinlola, E.Y.(2001). Yield and nutritional qualities of two tomato varieties (*Lycopersicum lycopersicum Karst*) as influenced by boron fertilization in a tropical environment.*In*:Horst, W.J.,Schenk.M.K.Whittenmayer, L.Kluwer(Eds) Plant nutrition food security and sustainability of agric eco system. Academic Publishers: 358-359

Dube, B.K., S. Pratima and C. Chatterjee(2004). Effect of boron and zinc on the yield and quality of tomato. *Indian Journal Hort*. 61:48-52.

Ducan, D.B.(1955). Multiple Range and multiple F Tests.*Biometrica*, 11(1): 1-42

Ewenzor, W.O., E.J. Udo, E.J.,N.I.Usoroh,K.A. Ayotade,J.A. Adepetu,V.O.Chude, andC.I.Udegbe (Eds). Fertilizer use and management practices for crop in Nigeria (series no2) F.P.D.D Fed min of Agric. Water Res. and Rural Dev. Lagos, 162pp

Gupta, U.C. and J.A.Cutcliffe (1985). Boron nutrition of carrots and table beets grown in a boron deficient soils. *Commun.Soil. Sci. Plant. Anal*, 16: 509-511.

Gupta, U.C. (1993).*Boron: Its Role in Crop Production*.1stEditionU.S.A : C.R.C Press Inc. Boca Raton Florida USA, pp. 655-777

Havlin, J.L., J.D.Beaton, S.L. Tisdale and W.L. Nelson(2006). *Micronutrients,Soil Fertility and Fertilizers.An introduction to Nutrient Management*. New Delhi: Printice Hall of India, NewDelhi. pp. 27-280.

Jaiswal, P.C.(2003). *Soil,Plant and water Analysis*. India: Kalyani Publishers.Ludhiana and New Delhi. pp. 33-37

Lombin, G. (1985). Evaluating the micronutrients fertility of Nigerian semi- arid Savanna soils.Boron and molybdenum. *Soil Sci. and Plant Nutr*.,13:12-25.

Lucas, R. E. and B.D. Knezek (1972). Climate and Soil Conditions Promoting Micronutrient deficiencies in plants.*In*:Mortved, J.J., P.M.Giondoron and N.L. Lindsay(Eds). MadisonWisconsin USA: Soil Science Society of America.

Meena, R.S. (2010). Effect of Boron on growth, yield and quality of tomato (*Lycopersicon esculentum*). *International Journal of Chemical Engineering Research*, 167-172.

Naz, R.M.M., S.Muhammad., A.Hamid and F.Bibi. (2012). Effect of boron on the flowering and fruiting of tomato.*Sarhad J.Agric*.(1): 37-40

Nonnecke.I.B.(1989).Vegetable production. Avi BookpublishersNew York, USA: pp. 200-229

Oyinlola, E.Y., V.O.Chude and A.T.Adeyanju (1996). Response of irrigated tomato to Boron fertilizer, its yield and quality. *Nigerian Journal of Soil and Envt. Res*, 5:53-61.

Oyinlola, E. and V.Chude (2004). Effect of Boron Fertilizer on yield and oil content of three sunflower cultivers in the Nigerian Savanna. *Journal of Agronomy*, 6: 421-426.

Reisenauer, H.M., L.M.Walsh and R.G.Hoeft (1973).Testing Soils for Sulphur, Boron, Molybdenum and Chlorine.*In*: L.M. Wash and J.D. Beaton(eds).Soil Testing and Plant Analysis.Soil Science Society of America, pp173-200.

Saddiq, A.M., S.Mustapha and B.H.Usman (2007). Plants extraction of heavy metals (Pb and Co) from soils of Geriyo irrigation project, Yola. *Nigeria Journal of Environmental Science*, 11(1): 118- 936

Salam, M.A., M.A.Siddique,M.A. Rahim and M.G. Saha (2010). Quality of tomato (*Lycopersiconesculentum* Mill) as influenced by boron and zinc under different levels of NPK Fertilizers. *Bangladash Journal of Agric Res*, 35-56.

Sathya, S.,S.Mani, P.Mahandran and K.Arulmo (2010).Effect of application of boron on growth, quality and fruit yield of PKM1 variety of tomato. *Indian Journal of Agric Res.*, 44(4): 274-280.

Shankara, N., J.De Jeude, M.U. Gofface, andB.V.Van Dam(2005).*Cultivation of Tomato, Production and Processing*. Barbara, Published by Digiggrai,Wagenagen Netherland pp 45-50

Splittstoesser, W.E.(1990). *Vegetable Growing Handbook, Organic and Traditional Method*. 3rd Edition. VanNostrand Reinhod, NewYork, VanNostrand Reinhold.

Srinivasamurthy, A.A., S.Mruthuniya and R. Siddaramappa(2003).*Nutrition for Intensive Vegetable Production*. Krishivikas Publications,Bangalore310p.

Stanley, D.W.,M.C.Bourne, A.P. Stone and W.V.Wismer(1995). Low temperature blanching effects of chemistry,firmness and structure of canned green beans and carrots. *Food Science*, : 327-333.

Usman, B.H.(2005).The Soils of Adamawa State NE Nigeria.*In*: E.C. Igwe, S.I. Mshelia, M.Y. Jada (eds.). *Agriculture in Adamawa State.*Paraclate Publishers, Yola Nigeria.pp 62-83