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Effect of Mineral and Bio-organic Fertilizers on Sugar beet Growth under Semi-Arid Zone

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Abstract: ***The study was conducted in season 2015/2016 and 2016/2017 at the College of Agricultural Studies Farm, Sudan University of Science and Technology, Shambat, Khartoum State, Sudan. The main objective of this study was to improve the growth of sugar beet by using different types of minerals and bio-organic fertilizers application in a semi arid zone. The experiment was arranged in randomised complete block design (RCBD) with four replication and nine treatments. The experimental treatments were as follows: Control, Compost application 20 t/ha, nitrogen as urea 190 kg/ha, phosphorus as super phosphates 88 kg/ha, inoculation with Azotobacter spp. and Mycorrhizal fungi and their combinations with nitrogen and phosphorus. Statistical analysis (Mstat) was used to test the effects of treatments on different parameters. The results revealed that application of different fertilizer treatments in two seasons had effect on sugar beet leaves number, shoot fresh and dry weight, root fresh and dry weight and shoot to root ratio, without significant differences between the treatments. Application of compost and nitrogen treatments alone showed significant differences in sugar beet root fresh and dry weights compared to that of the control in first season. In the second season application of nitrogen and combination with phosphorus and mycorrhiza showed increase growth parameters compared to the control and other treatments.***

Keywords: *Azotobacter spp*, Mycorrhizal fungi, compost, sugar beet

1. Introduction

Sugar beet is a specialized type of ***Beta vulgaris*** which was first developed in Europe at the end of the 18th century from white fodder beet. It is a biennial plant which stores up reserves in the root during the first growing season so that it is able to grow over-winter and produce flowering stems and seed in the following summer (Draycott 1996). In Sudan, sugar cane is the main crop for producing sugar at the moment, and delivers about 50% of Sudan needs for sugar. There is a need to increase sugar production for self satisfaction and possible export of this strategic commodity. Sugar beet (*Beta vulgaris L.*) is an important alternative for sugar production; it needs less water and has a shorter cultivation period. Sugar beets will grow on the very alkaline cracking clays, although they will do far better on the more friable neutral silt soils found along the Nile River. (Norman, 1958). Nelson, 2005, reported that in some tropical and subtropical regions like Sudan and Pakistan, sugar beet processing can go from 270 to 300 days/year. Sugar beet with its relatively short season can well be accommodated in the crop rotation of large agricultural schemes such as Gezira in Sudan. Awad *et al*., 2015, found that the Oct. 20 sowing date was best in Sudan and maximum sucrose content was attained at ages 4.5 and 5 months, respectively. Salaheldin *et al*., 2014, indicated that growing of sugar beet in different summer sowing dates in Sudan showed no significant differences between treatments. However, tuber yield was relatively low in the two seasons. Negative factors affecting sugar beet growth can lead to the stress caused by drought, diseases, pests and weeds (herbicides). It should be noted that stress tolerant sugar beet varieties are less fertile under optimal growth conditions (Pidgeon *et al*. 2006). Nitrogen is a vital element for sugar beet growth. It is provided through the mineralization of organic matter derived from soil and crop residues, as well as by addition of mineral fertilizers and organic manures (Michel and Rémy 2006). The contents of phosphorous and potassium of beet plant were also significantly positively correlated with nitrogen amount used and nitrogen has obvious interaction effect with phosphorus and potassium. Sugar beet concentrations are decreased and amino nitrogen concentrations increased when crops take up large quantities of nitrogen from soil (Carter *et al*., 1976; Draycott & Christenson, 2003).

The main objective of this study was to improve the growth of sugar beet by using different types of mineral and bio-organic fertilizers application in the semi arid zone of Sudan.

2. Materials and Method

The experiment was conducted during the seasons of (2015-2016), (2016-2017) at the College of Agricultural Studies Farm, Sudan University of Science and Technology, Shambat, Khartoum State- Sudan. Latitudes 15° 40' 5" N and longitudes 32° 32' 1" E and altitudes (380 m) above sea level. The climate of the area is within the semi-desert with summer rains, and warm winter. The climate is hot almost throughout the year, except for the cooler short winter season (December, January). The soils of the farm belong to the Central Clay Plain of the Sudan that has been formed by alluvial deposit of the Nile, primarily of basaltic origin, which are largely Vertisols. The soils are variably affected by salinity and sodicity. Non-saline, slightly saline and moderately saline sub soil and non sodic to moderately sodic soil are all found in the farm.

Farm yard manure compost was added to soil, band application inside the ridges. The mycorrhiza (VAM) vascular arbuscular mycorrhizal spores were isolated by wet sieving and decanting method (Gerdemann, and Nicholson 1963), using one size of sieves 45 μm arranged in decending order of their mesh size. Sudan grass was planted and inoculated by VAM spores for propagation for three month before transfer once to the soil as a biofertilizer. *Azotobacter spp* was isolated from a rhizosphere soil under of sorghum plant from Shambat soil by using nitrogen free medium selective for Azotobacter growth referred to Russian scientist Mishustin and Shilinikova, 1972.

The land was prepared using disk plough tillage. The ploughing depth was (0 – 20) cm, followed by leveling and ridging. The plots were arranged in randomizal complete block design (RCBD) with four replication and 9 treatments. The experimental treatments were as follows; compost treatments 20 t ha^{-1}, nitrogen as urea 190 kg/ha, phosphorus as superphosphates 88 kg/ha., inoculation of *Azotobacter spp* and Mycorrhizal fungi and their combinations with nitrogen and phosphorus. Application of compost and phosphorus were done week before the sowing date inside the ridges. Nitrogen application and bio-fertilizers inoculation were done month after sowing.

Sugar beet *Beta vulgaris* seeds were sowing on 14th February 2016 for first season and 17th November 2016 for second season. Replanting was done once using seedling and seeds three weeks after sowing date. The growth traits were measured after three month and a half from sowing. The following traits were measured after crop harvest. A maturity stage was chosen to measure the average leaves number, shoot fresh and dry weights. Root fresh and dry weights and roots to shoot ratio. The average shoots and roots fresh weights were measured before the average air dry weight was determined. Statistical analysis was conducted using Mstatc.

3. Results

Figure (1) revealed that, all treatments increased the leaves number of sugar beet. However, Nitrogen as urea treatments gave the highest leaves number of plant significant (P≤0.05) increase followed by other treatments compared to control in two seasons.

Data given in (Figure 2) revealed that increase in shoot fresh weight of sugar beet crop was reported upon application of inorganic and bio-organic fertilizers. The result showed that nitrogen as urea treatment increased the shoots fresh weight with significant difference at (P≤0.05), and obtained the highest weight of shoots followed by other treatments compared to control.

Figure (3) showed that increased shoot dry weight in sugar beet crop as influenced by different fertilizer applications. However, nitrogen as urea treatment significantly increased the shoots dry weight at (P≤0.05), obtained the highest dry weight of shoots dry followed by compost at the rate 20t/ha, and other treatments compared to the control treatment in first season. In the second season, however, the result showed significant differences in shoots dry weight (P≤0.05), obtained by the application of nitrogen and their combinations compared to the control and other treatments.

The data in figure (4) application of inorganic and bio-organic fertilizers to sugar beet showed a significant increase in root fresh weight. However, Nitrogen as urea treatments gave a significant difference (P≤0.05), on roots fresh weight and highest weight followed by the compost treatment and the combination of Mycorrhiza and nitrogen treatments compared to control and other treatments in season one. Also there is a significant increased in roots fresh weight obtained by nitrogen and their combinations compared to the control and other treatments in Second season.

Figure (5) revealed that a significant increase in sugar beet roots dry weight between the treatments. Nitrogen as urea application showed a significant difference on roots dry weight followed by other treatments application compared to the control in both seasons.

Figure (6) showed that no significant differences between the treatments observed on shoot to root ratio. However, the trend showed that the application of compost gave the highest ratio of shoot to root followed by the combination of Azotobacter and phosphorus in first season, while the result in second season showed significant differences between phosphorus and compost compared to control and other treatments.

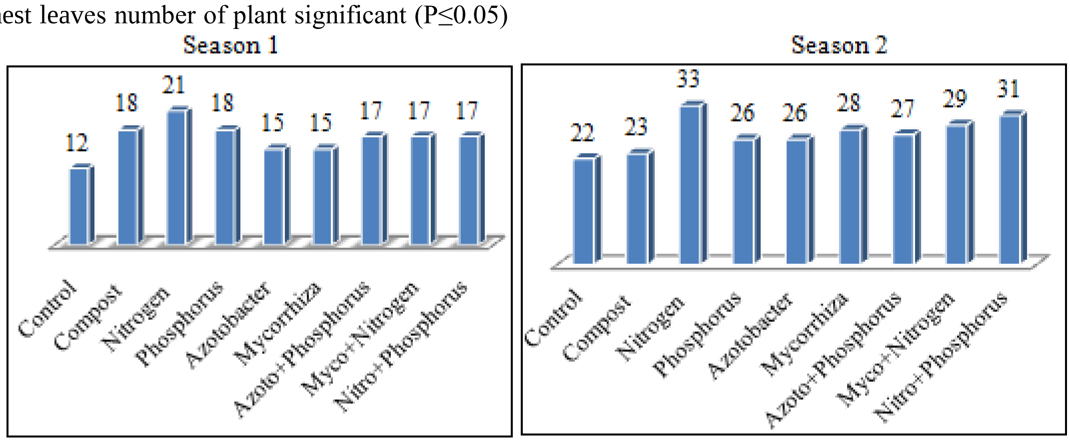

Figure 1: Effect of inorganic and bio-organic fertilizers on leaves number

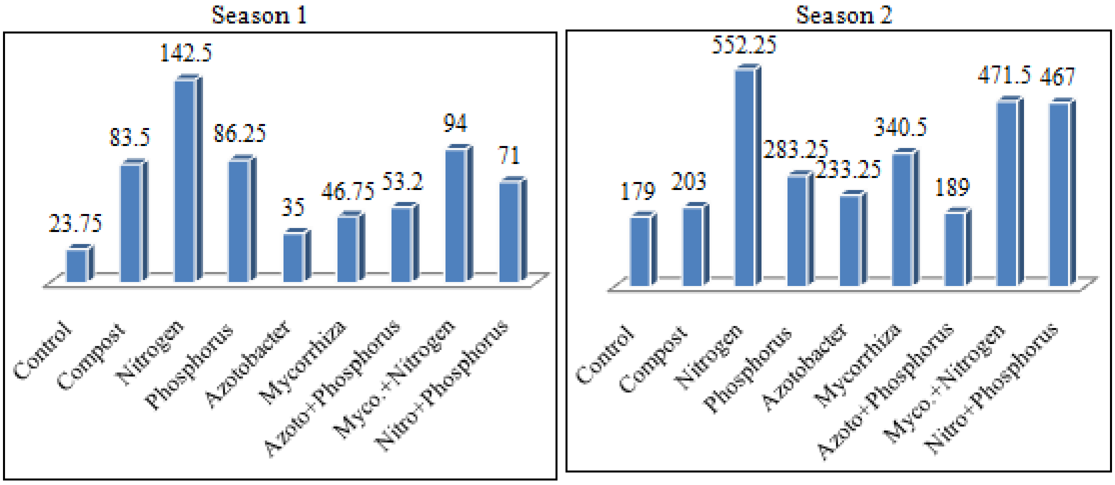

Figure 2: Effect of inorganic and bio-organic fertilizers on shoots fresh weight

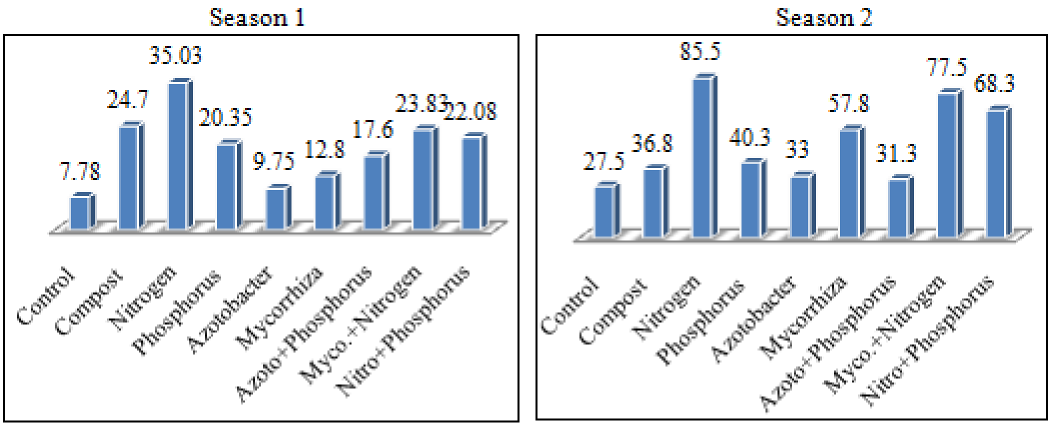

Figure 3: Effect of inorganic and bio-organic fertilizers on shoots dry weight

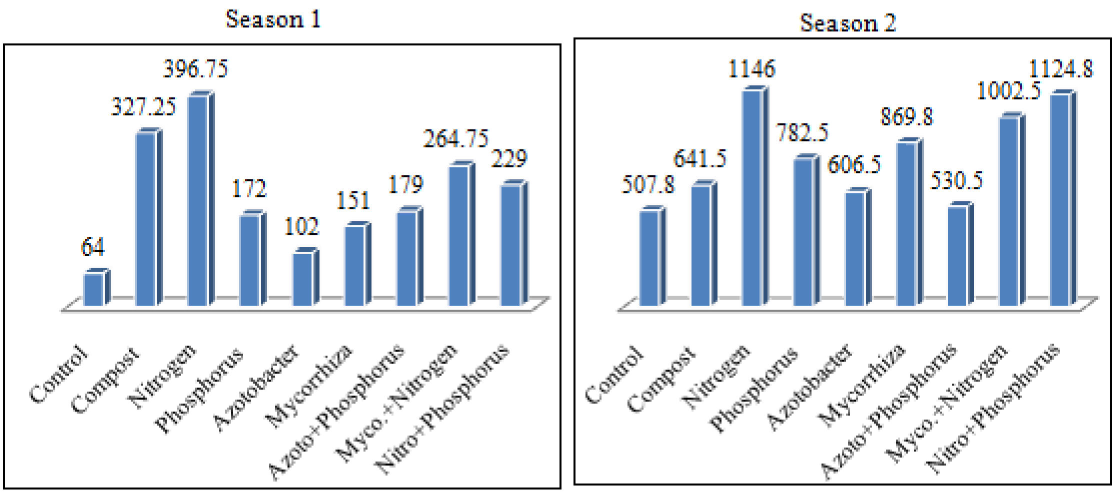

Figure 4: Effect of inorganic and bio-organic fertilizers on roots fresh weight

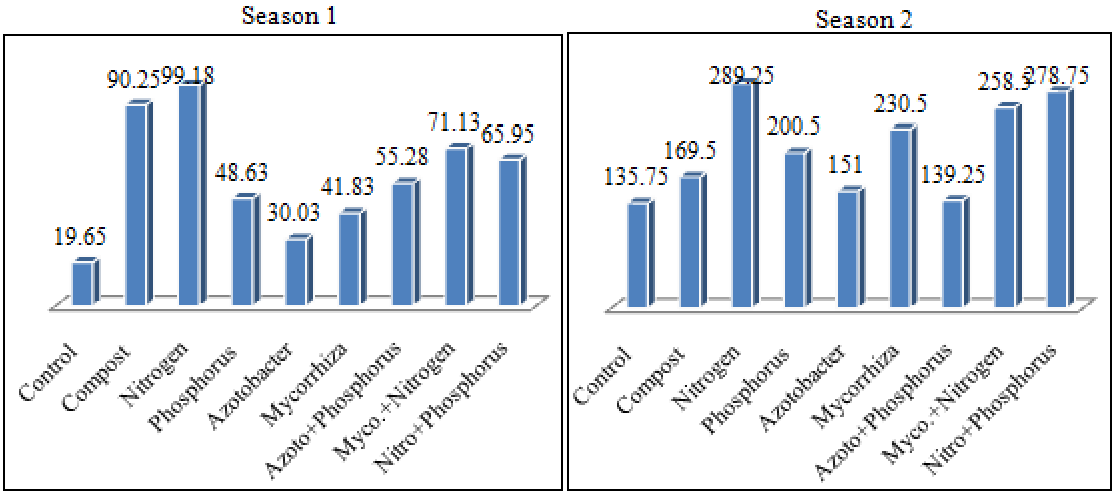

Figure 5: Effect of inorganic and bio-organic fertilizers on roots dry weight

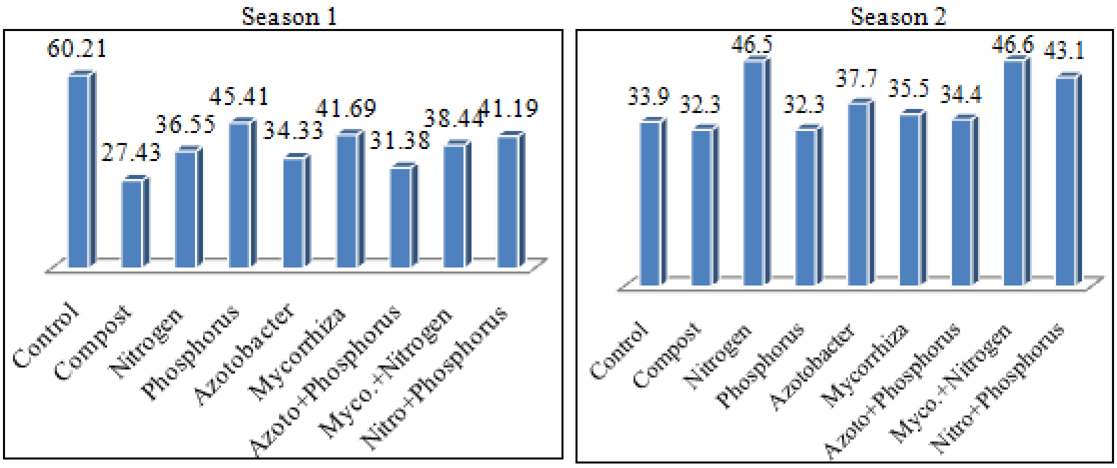

Figure 6: Effect of inorganic and bio-organic fertilizers on shoot to roots ratio.

4. Discussions

Organic manure application as compost increased the growth components of sugar beet crops including leaves number, shoot fresh and dry weight, root fresh and dry weight with significant differences compared to the control and some treatments and shoot to root ratio cannot affected in both season but the second season showed an increase in sugar beet growth components compared to the control. Nshimiyimana, 2012, stated that beet was evaluated by using cow dung as organic manure and NPK as mineral fertilizer; the differences among treatments were significantly, high for height and number of leaves after four weeks.

Application of inorganic fertilizers nitrogen as urea alone and their combinations increased the growth components of sugar beet crops including leaves number, shoot fresh and dry weight, root fresh and dry weight and shoot to root ratio with significant differences compared to the control and other treatments. Phosphorus when applied as superphosphate alone and their combinations with Azotobacter increased the growth of sugar beet without significant differences compared to the control except the shoots to root ratio. Nshimiyimana, 2012, indicated that vegetative growth of non-fertilized control plot had lower weights than fertilized plots. The fertilizer treatment consisting of mixture of organic and mineral fertilizer influenced growth of beets more than the other treatments. Nitrogen levels had a significant effect on number of leaves / plant, root, total plant weight, top yield and biological yield per hector in the two growing seasons. (Abdelrahman, 1996). Gehan *et al* 2013, observed that, sugar beet plants received 238 kg N/ha gave the highest values of root length, as well as, root diameter. However, the lowest nitrogen rate 119 kg N/ha gave the lowest values of root length, as well as, root diameter compared with the other treatments. Kurt, 2015, suggested that phosphorus application has been documented to increase root yields in soils that are low P (< 25 ppm) while not affecting sugar beet quality. Abdou, 2000, found that fertilizing sugar beet plants with 238 kg N/ha produced highest values of root and foliage fresh weights, root length and diameter, root, top and sugar yields/ha. Hussein *et al*. 2014, found that the decreased of beet: shoot ratio was associated with increasing in shoot yield because of P addition and K levels produced higher beet yield without any effect on shoot, resulted in higher beet: shoot ratio.

Application of *Azotobacter spp* as bio-fertilizers alone and their combination with phosphorus increased the growth components of sugar beet crops including leaves number, shoot fresh and dry weights, root fresh and dry weights without significant differences compared to control. Combined application of bio-fertilizer with 50% of chemical fertilizers (N and P) has significant effect on plant growth, plant height, number of branches, fresh and dry weights of safflower in comparison with chemical fertilizers alone. (Arjun *et al* 2015). Singhal *et al.* 2012. Found that inoculation of biofertilizers in combination with limited doses of rock phosphate or SSP produced higher and sustainable crop yield. Biofertilization treatments caused a significant effect on root length and diameter, root and shoot fresh weights of sugar beet (Abdelaal *et al*. 2015). Ramadan *et al*. 2003, showed that the effect of *Azospirillum sp*., *Azotobacter sp*. and phosphate dissolving bacteria (*Bacillus sp.*) on root quality, yield and yield components of sugar beet. They stated that, biofertilization treatments had a significant effect on root length and diameter, root, top and sugar yields/ha.

Mycorrhizal fungi (AM) inoculation alone and their combination with nitrogen increased the growth components of sugar beet crops including leaves number, shoot fresh and dry weight, root fresh and dry weight and shoot to root ratio without significant differences compared to the control and other treatments. These results are in compatible with that of Kandil *et al*. 2002, which confirmed that biofertilization treatments brought out significant effects on root and foliage fresh weights, root length and diameter, root/top ratio, root, top and sugar yields/ha.

5. Conclusion

Application of mineral and bio-organic fertilizers affected the sugar beet plant growth components under semi arid zone and the results showed that.

Compost at the rate of 20 t ha^{-1} application alone affects the growth of sugar beet plants without significant differences compared the control.

Application of nitrogen as urea and their combinations increased the growth components of sugar beet.

Phosphorus as superphosphates treatment and their combinations increased the sugar beet growth and their components compared to control.

Inoculation of *Azotobacter spp* in combination with phosphorus as superphosphates showed an increase in sugar beet plants growth components compared to control and *Azotobacter spp* alone.

Mycorrhiza applied to sugar beet plants alone or in combination with nitrogen as urea. Confirmed increased in plant growth components compared to the control.

References

[1] Abdelaal, Kh. A. A. and Sahar, F. T. 2015. Response of Sugar Beet Plant (*Beta vulgaris* L.) to Mineral Nitrogen Fertilization and Bio-Fertilizers. *Int.J.Curr.Microbiol.App.Sci* (2015) 4(9): 677-688.

[2] Abdelrahman, M. M. 1996. The effect on N, p and k fertilizers on growth, yield and some physioligical characters of sugar beet. (Beeta vulagaris L). Faculty of Agriculture, Banha University.

[3] Abdou, M.A. 2000. Effect of planting dates, plant population and nitrogen fertilization on sugar beet productivity under newly reclaimed sandy soils. Ph. D. Thesis, Fac. of Agric. Mansoura Univ.

[4] Arjun D. J.; Roshan B. O. and Sushma M. 2015. Role of Azotobacter in Soil Fertility and Sustainability – A Review. Advances in Plants & Agriculture Research. Volume 2 Issue 6 – 2015.

[5] Awad E. M., Ahmed O. A., Philip W., and Marchelod' R. 2015. Evaluation of Sowing date and Harvesting Ages of Some Sugar Beet (*Beta vulgaris* subsp. *vulgaris*) Cultivars under Guneid conditions, (Sudan). International Journal of Agricultural Research and Review: ISSN-2360-7971, Vol. 3(9): pp 421-424.

[6] Draycott A.P. 1996. Aspects of Fertilizer Use in Modern, High-Yield Sugar Beet Culture. Potash Institute P.O. Box 1609 CH-4001 Basel/Switzerland. LT~y 1996.

[7] Draycott, A.P. & Christenson, D.R. (2003). Nutrients for Sugar Beet Production: Soil Plant Relationships. CABI Publishing, Wallingford.

[8] Gehan A. A., Elham A. B. and Afifi M.H.M.. 2013. Root Yield and Quality of Sugar Beet (*Beta vulgaris* L.) In Response to Biofertilizer and Foliar Application with Micronutrients. World Applied Sciences Journal 27 (11): 1385-1389, 2013 ISSN 1818-4952.

[9] Hussain Z., Khattak R. A., Irshad M., and Mahmood Q. 2014. Sugar beet (Beta vulgaris L.) response to Diammonium phosphate and potassium sulphate under saline – sodic conditions. British Society of soil Science. Soil use and management.

[10] Kandil, A.A.; EL-Hindi M.H.; Said A.M. and Gomaa Y.Y.I. 2002. Response of sugar beet to levels and times of potassium fertilization under salinity conditions at Northern Delta. Egypt. J. Agric. Sci. Mansoura Univ., 27(11): 7237-7246.

[11] Kurt S., 2015. Sugarbeet Soil Fertility & Nutrient Management. Dept. of Plant, Soil, & Microbial Sciences. Research and educational advisory council. Michigan State University, 517-355-0271.

[12] Michel C., and Rémy D. 2006. Sugar Beet. Nutrition – Nitrogen. Blackwell Publishing Ltd. 9600 Garsington Road, Oxford OX4 2DQ, UK. www.blackwellpublishing.com.

[13] Norman E. T. 1958. Sugar Production Potentials in the Republic of the Sudan. International Cooperation Administration December 29, 1958 815 Connecticut Avenue, N. W. -Reference: TEC-234 Washington 25, D. C.

[14] Nshimiyimana M. 2012. Effect of organic and mineral fertilizers on growth and yield of beet crop (beta vulgaris). Beet production.

[15] Pidgeon J. D., Ober E. S., Qi A. 2006. Using multi-environment sugar beet variety trials to screen for drought tolerance. Field Crops Research, 95 (2–3): 268–279 http://dx.doi.org/10.1016/j.fcr.2005.04.010.

[16] Ramadan, B.S.H.; Hassan H.R. and Fatma, A. Abdou 2003. Effect of mineral and biofertilizers on photosynthetic pigments, root quality, yield components and anatomical structure of sugar beet (Beta vulgaris, L.) plants grown under reclaimed soils. J. Agric. Sci. Mansoura. Univ., 28(7): 5139-5160.

[17] Salaheldin A. M., Ahmed O. and Hayder A. 2014. Performance of Sugar beet Sown in Sudan under Comparatively High Temperatures (May-July). Conference on International Research on Food Security, Natural Resource Management and Rural Development organised by the Czech University of Life Sciences Prague.
[18] Singhal, S. K.; Sharma, V. K., Singh, R. D. 2012. Effect of Inorganic and Biofertilizers (VAM AND PSB) on yield of Maize and Wheat Cropping Sequence and Soil Fertility. Indian Journal of Agricultural Research; Jun2012, Vol. 46 Issue 2, p167.