Int.J.Curr.Res.Aca.Rev.2020; 8(5): 60-67

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 5 (May-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.805.007

Response of Nitrogen Fertilizer Rates on Yield and Quality of Beetroot (*Beta vulgaris* L.) Varieties in Wolaita Zone, Southern Ethiopia

Birhanu Lencha[1,2]* and Dawit Dalga[1]

Wolaita Sodo University, College of Agriculture, P O Box 138, Wolaita Sodo, Ethiopia
Dawit Dalga , Wolaita Sodo University, College of Agriculture, P O Box, 138, Wolaita Sodo, Ethiopia

**Corresponding author*

Abstract

Beetroot (*Beta vulgaris* L.) is a good source of minerals, carbohydrates, protein and it has high levels of vitamin B1, micro nutrients and also referred as common vegetable in Ethiopia. However, its productivity is very low in comparison to national average yield in the study area due to lack of optimum nitrogen rate and ideal variety inline of agro-ecology. Hence, a field experiment was conducted to identity best performing beetroot variety and optimum rate of nitrogen (N) fertilizer in Wolaita zone, Southern Ethiopia. The treatments were consisted of four varieties (Dark red, Crimson globe, Samba and Farida) with four N fertilizer rates (0, 50, 100 and 150kg N kgha^{-1}) and laid out in randomized complete block design in factorial arrangement with three replications. All phenological, growth, yield components, yield and quality parameters were collected and analyzed procedurally. The result showed that interaction of variety and rates of N fertilizer significantly ($P < 0.05$) affected total yield, marketable root yield and significantly ($P < 0.001$) affected root length, root width. Numerically the highest marketable root yield (16.3 t ha^{-1}) was achieved from dark red coupled with rate of 100 kg N ha^{-1} followed by variety dark red at the rate of 50 kg Nha^{-1} (14.9 tha^{-1}). Whereas the lowest root yield was recorded from dark red at 0kg N ha^{-1}. Therefore, it could be recommended that variety Dark red at the rate of 50 kg N gave better yield and farmers could use in Kindo koyshsha district in Wolaita Zone, Southern Ethiopia.

Article Info

Accepted: 04 April 2020
Available Online: 20 May 2020

Keywords

Beetroot, Nitrogen, Root yield, Quality and Variety

Introduction

Beetroot (*Beta vulgaris* L.) is a member of the *Chenopodiacae* family that originated from Germany (Thompson, 2001) and includes silver beet, sugar beet and fodder beet (Deuter and Grundy, 2004). It is biennial although grown as annuals producing green tops and swollen roots during the first growing season. The different ways that beetroot are used is in salads, as a hot vegetable to accompany meat and fish, and in pies, in addition to methods for their preservation such as pickling and canning. Beetroot is a good source of minerals, carbohydrates, protein and it has high levels of vitamin B1 and micro nutrients (Cerne and Vrhovnik, 1999). Considered as a vegetable, beetroot may have many positive influences on human health.

Its Production and productivity governed by environmental conditions, genotypic trait and management of the crop. Determining appropriate crop density is therefore the management activities which improves the performance and productivity of plants. However, plant density of beetroot depends on variety and plant habit. Compact, upright-growing plants responded better to increased plant density than the spreading type (Deuter and Grundy, 2004).

Lack of high yielding varieties and rate of N fertilizer application are the major yield limiting factors (Grundy, 2017). There are some varieties in produce in Wolaita area, but their suitability with adequate amount of N fertilizer has not been recommended. Therefore, production of beetroot for growth, high yield, quality and resistant to pest and diseases in the existing agro-ecology has to be critically evaluated. There is a need of variety evaluation and nitrogen fertilizer recommendation as an issue of priority to utilize the crop potential in the area. By improving N fertilizer application and ideal variety to the specific agro-ecology might be contributes for sustainable beetroot production that subsequently increase income and improve livelihood. Thus, this study was initiated with the following objectives: to determine best performing beetroot variety in terms of growth, yield and quality and to determine the optimum rate of N fertilizer for beetroot production in the study area.

Materials and Methods

Description of the study area

A field Experiment was conducted during 2018/19 main cropping season at Kindo Koysha Woreda in Wolaita Zone, Southern Ethiopia. It is located an approximate geographical coordinates at 7^0 04”96’ N latitude and 37^o 41’’330’ E longitude and having an altitude of 1830 meter above sea level. The area is characterized with bimodal rainfall distribution pattern which extends from March to September receiving mean annual rainfall of 1659.1 mm. The mean annual minimum and maximum temperature of the site was 15 and 26^{o}C, respectively. Soil texture is sandy loam and major crops that are growing in the summer and winter are maize, haricot bean, teff, wheat, barley, taro, sweet potato, Irish potato, and vegetable and fruit crops (Woreda Agricultural office, 2019).

Treatments and experimental design

The experiment was consisted of four Beetroot varieties namely Detroit dark red, Crimson globe, Samba and Farida and three levels of nitrogen rates (0, 50, 100 and 150) N kgha^{-1}. The experiment was conducted using 4 * 4 factorial combinations (16 treatments) which were laid out in randomized complete block design with three replications. The plant spacing of 70 * 30 cm was employed between rows and plants, respectively. Each plot consisted of four rows and 10 plants per row with a total of 40 plants per plot with gross plot size of 2.8 m x 3.0 m (8.40 m^2). Space between plots and replication was 0.5 and 1m, respectively, for the management purpose. Urea (46% N) was used as source of nitrogen (N) and was applied by split application (half at planting and the remaining half was applied at 30 days after transplanting). NPS was used as a source of phosphorous and nitrogen. TSP was used as a source of phosphorous. The 250 kg ha^{-1} NPS (19% N, 38% P_2O_5 and 7% S) fertilizer was applied at the time of transplanting. All other cultural practices were done as per recommendation of Melkasa Agricultural Research center (EARO, 2004).

Data collection and measurements

Yield components and Yield

Number of roots per plant (No): - the number of root per plant was obtained by counting all beetroots produced and divided by the number of sample plants. Marketable roots per plant (No): - the average number of roots free from diseases, insect pest and other defects was obtained by counting from sample plants. Unmarketable root per plant (No): - the average number of roots which have no local or national market value was sorted by subjective judgment and recorded as unmarketable pod number per plant. Marketable root yield (t ha^{-1}): - the marketable yield of sample plants was determined by sorting roots according to color, shape, and size and free of any mechanical or disease injuries and acceptable by the market, weighted and converted to tons per hectare. Total Root Yield (t ha^{-1}):- total sum of marketable and unmarketable root yield of plants measured and the yields obtained from plots were converted to hectare base. Total Root dry weight (t ha^{-1}): - it was recorded from fresh ripe roots selected from the sample plants taken and allowed to be dried in an oven at 105^{o}C until constant weight was reached and converted in to hectare basis. Number of Root per plot (No): - The average number of roots counted from ten sample roots collected during second harvest was recorded. Root Length (cm): average root length measured from tip of root to basal end of ten ripe sample roots of the second harvest were measured using venire caliper and recorded. Root width (cm): average root width of ten ripe roots of the second harvest was measured at the widest point of the roots were measured using venire caliper.

Statistical data analysis

All collected data were subjected to analysis of variance (ANOVA) of RCBD in factorial arrangements using SAS software (SAS, 2002) version 9.1. All significant mean separation was compared using Least Significant Difference (LSD) test at 5% probability level.

Results and Discussions

Yield components and yield

Number of roots per plot

Number of Root per plots was mainly significant influenced by variety and rates of nitrogen fertilizer whereas there was no significant interaction effect (Table 1). The result indicated that the introduced variety Detroit dark red showed highly significant yield advantage over Farida by 52.86 % in root number per plant with significant variation between introduced and the locally released one. This variation might be due to genetic characteristics of varieties in production of the highest plant height, the largest leaf area, leaf area index and the widest canopy diameter. Similarly, Refay(2010) reported that there was significant difference among four cultivars of beetroot in number of roots per plot ranged from 46.2 to 113.2 in 2013 and 35.56 to 53.56 in 2014. On the other hand, increasing the rate of N from 0 to 50 kg ha^{-1} significantly increased total root number per plot. However, further increases in the rate of N from 50 to 150 kg N ha^{-1} reduced number of root per plot linearly with no significant difference between 50 to 100 kg N ha^{-1}. The result revealed, 50 kg N ha^{-1} showed highly significant yield advantage over both extremes (0 kg N ha^{-1} and 150 kg N ha^{-1}) by 114.1% and 50.17%, respectively. Numerically the highest (47.44) was recorded in 50 kg N ha^{-1}, but the smallest (28.53) number of root per plot was obtained from 0 kg N ha^{-1} (Table 1). This could be due to optimum (50N kg ha^{-1}) rate of N for enhanced number of beet root production and increasing the rate of the nutrient beyond that could have the negative impact on the production of number of beet root per plant. Similarly, Aminifrad *et al.,* (2012) who reported that increasing N applied to beetroot plants from 0 to 100 kg N ha^{-1} was accompanied by highest root initiation number (19.26) for 100 kg N ha^{-1} and 150 kg N ha^{-1} resulted in decreasing root number (18.09) per plant and showed further significant decline (17.34) at 0 kg N ha^{-1}. The increase in number of root per plot in response to increasing the rate of N at the lower rate signifies that the nutrient prompted production of larger numbers of roots. The result observed decrease in number of root per plot in response to increasing N fertilizer might due to over application of N fertilizer, fast vegetative growth, succulent vigorous vegetative growth and reuse of the stored food from roots to support growth. In-line with this finding Mukkun *et al.,* (2001) reported that excess N reduced the number roots per plant from 32.41 at 46 kg N ha^{-1} to 29.32 at 69 kg N ha^{-1} and to 27.15 at 92 kg N ha^{-1} in carrot crop.

Marketable Beetroot number per plot

As the analysis of the result showed that there was significant difference among variety and rates of nitrogen fertilizer but there was no interaction effect. Variety dark red gave significantly higher number of marketable root number (36.17) per plant as compared to the lowest marketable root number produced by Farida (22.07) (Table 1). This might be due to the variation of inherited characters of the varieties. This could be attributed to the early days to root initiation and first harvest attributed due to optimum rates of N, which resulted higher in number of marketable roots due to optimum environment. The maximum marketable number of beetroot per plot (38.54) was obtained at the rate of 50 kg N ha^{-1}, whereas the smallest number of root per plot (15.74) was obtained from 0 kg N ha^{-1}.

The marketable beetroot number per plot increased levels of N from 0 to 50 kg N ha^{-1} although 50 kg N ha^{-1} and 100 kg N ha^{-1} were no significant but decreased with further N application. This shows that the optimum rate of nitrogen for enhanced marketable number of beetroot per plot was already reached at 50 kg N ha^{-1}. The increase in the number of marketable root per plot in response to increasing the rate of N at the lower rate signifies that the nutrient promoted production of larger numbers of roots. Application of N at the rate of 50 kg ha^{-1} showed highly significant advantage of marketable root number per plot over 0 kg N ha^{-1} by 144.85% and by 60.85% over 150 kg N ha^{-1}.

Decreasing or increasing the rate of the N fertilizer beyond optimum level negatively affected the marketable number of beetroot per plot. In-line with this finding Aminifrad *et al.,* (2012) who reported that increasing N applied to beetroot plants from 0 to 100 kg N ha^{-1} was accompanied by highest beetroot initiation number.

Unmarketable Beetroot number per plot

The main effect of variety on unmarketable beetroot number per Plot was significantly affected (Table1). crimson globe had higher mean unmarketable pod number (9.8) per plot of under sized, not uniform and defected roots, attacked by birds and diseases that lead to unmarketable during harvesting, whereas numerically the lowest unmarketable beetroot number (6.47) per plot from variety of samba which was statistically similar compared with introduced variety Detroit dark red (Table1). In this study unmarketable beetroot number was influenced by genetic characteristics of the varieties which showed variation in disease resistance under field condition. In line with this study, Aminifard *et al.,* (2012) reported that there was significant difference among five varieties of root in marketable yield which ranged from 1.2 - 3.8. On the other hand, nitrogen had non-significant effect on unmarketable beetroot number per Plot and weight per hectare. The result has implied the lower contribution of N fertilizer for unmarketable root number that could be attributed to growing condition and varieties response.

Total Beetroot yield per hectare

Statistically total root yield per hectare was highly significantly affected by variety and rates of nitrogen fertilizer and significantly by the interaction effect (Table2). The highest total yield (16.83t ha^{-1}) was attained by the introduced variety dark red coupled with the rate of nitrogen at 100 kg ha^{-1}, which was statistically similar compared with the same variety at 50 kg N ha^{-1}. The result revealed that increasing rate of N fertilizer up to 50 kg ha^{-1} increased total yield on released variety Farida and crimson globe. Whereas total yield of introduced varieties dark red and samba increased with increase of rate of N up to 100 kg ha^{-1}. However, there was no significant difference between 50 kg N ha^{-1} and 100 kg N ha^{-1} on root yield per hectare in all varieties. This result revealed that varieties of beetroot responding significant variation to rate of N application. Increasing N fertilizer beyond optimum was significantly decreased total yield per hectare of all varieties. Hence optimum rate of N fertilizer was coupled with genetic traits which might had better response to better production of total yield. This also might be due to the highest plant growth and reproductive organs that responded to photosynthetic capacity and better utilization of nutrients towards highest number of roots per plot, root length and root width. Similar results was reported by (Mohammad *et al.,* 2012) that significant variation was recorded by increasing N applied up to 100 kg N ha^{-1} accompanied with the highest yield per plot than 150 kg N ha^{-1} in carrot crop. This might be due to genetic effect coupled with N response that promotes vegetative growth as a result of which would increase plant height, canopy diameter, leaf area, leaf area index were response to high marketable root and quality of root due to light interception for photosynthate would enhance the physiological activity leading the production of more assimilates which resulted in higher root yield. This finding was also in line with Akoumianakis *et al.,* (2011) who reported that nine cultivars of beetroots had showed significant differences in total root per plant performance.

Marketable Beetroot yield

Analysis of variance revealed that marketable beetroot yield per hectare was highly significantly affected by variety and rates of nitrogen and significantly affected by interaction effect (Table 2). The highest (16.33 t ha^{-1}) marketable root yield per hectare was obtained from Detroit dark red variety at the rate of 100 kg N ha^{-1}. Whereas the lowest (1.6 t ha^{-1}) marketable root yields per hectare was recorded by the variety crimson globe when applied at the rate of 0 kg N ha^{-1}. Increasing N level from 0 to 100 kg N ha^{-1} increased marketable root yields per hectare, but increasing of the N to 150 kg N ha^{-1} in both crimson globe and Farida decreased the yield. The decrease in marketable root yield in response to increasing N fertilizer might be due to over application of N fertilizer, which resulted in negative response to marketable root yields. Thus, over and under application of N fertilizer beyond optimum rate was clearly shown a negative impact on marketable root yield in all varieties. In this regard, the highest amount of marketable root weight might be due to genetic effect coupled with N response that promotes vegetative growth as a result of which would increase plant height, canopy diameter, leaf area, leaf area index that might have contributed for higher yield. In line with this study, Nemeat (2001) reported that increased marketable yield attributed to the enhanced root length, root width, quality of root and root wall thickness. Similarly, Boroujerdnia and Ansari (2007) also reported that large canopy width, inherited traits of beetroot on varieties determines yield potential of beetroots.

Total dry weight yield of beetroot

The result revealed that variety and rates of N fertilizer were significantly affected total dry weight of Beetroot yield per hectare but their interaction effect was shown (Table 3). The highest total dry root yield per hectare (5.46 t ha^{-1}) was obtained from variety Detroit dark red; whereas the lowest (2.88 t ha^{-1}) dry root yield was recorded from variety Crimson globe, which was statistically non-significant with compared with variety Farida. This variation might be attributed to the genetic potential of the crop. In line with this finding, Mohammed *et al.*, (2012) reported that similar variations in beetroot dry weight among varieties. Nitrogen rate has a significant yield merit on total dry root weight over control. The maximum total dry root weight (5.37 t ha^{-1}) was obtained at 100 kg N ha^{-1}, but the smallest (2.10 t ha^{-1}) was due to rate of N at 0 kg ha^{-1}. The result indicated that lower and over application of N fertilizer significantly affected dry weight yield. On the other hand, decreasing dry root yield from 100 kg N ha^{-1} to 150 kg N ha^{-1} by 62.73% might be due to the lowest root length and width. The highest dry root yield variation might be due to the highest marketable root weight, root length, root width and root wall thickness from optimum N. Similarly, Pervez *et al.*, (2004) reported that significantly lower total dry root yield recorded from pepper plants grown in plots with no N fertilizer application.

Table.1 Number of Roots per plot, Marketable and Unmarketable Root number per plot as affected by varieties and nitrogen fertilizer rates in 2018 main cropping season in Wolaita Zone, Southern Ethiopia

Treatments	NPP	MRN	UMRN
Variety			
Crimson globe	28.53^{c}	22.06^{c}	6.47^{b}
Farida	35.78^{bc}	25.99^{cb}	9.79^{a}
Detroit dark red,	43.61^{a}	36.17^{a}	7.44^{b}
Samba	37.66^{ba}	29.53^{b}	8.13^{ba}
LSD (0.05)	6.91	6.28	1.94
Rate of N (kg ha^{-1})			
0	22.44^{c}	15.74^{c}	6.7
50	47.44^{a}	38.54^{a}	8.9
100	44.11^{a}	35.51^{a}	8.6
150	31.59^{b}	23.96^{b}	7.63
LSD (0.05)	6.91	6.28	NS
CV (%)	22.77	26.54	29.34

LSD (0.05) = Least Significant Difference at 5% level; CV= coefficient of variation. Means in column followed by the same letters are not significantly different at 5% level of significance. Where, NPP=number of root per plot MNpp= marketable number of root per plot and UMPPN=unmarketable root number per plot

Table.2 Total and marketable Beetroot yield as affected by Interaction effect in 2018 main cropping season in Wolaita Zone, Southern Ethiopia

Variety	**Marketable root yield** (t ha^{-1})				**Total root yield** (t ha^{-1})			
	Nitrogen Rate (kg ha^{-1})				Nitrogen Rate (kg ha^{-1})			
	0	50	100	150	0	50	100	150
Farida	2.77^{ij}	8.23^{d-f}	6.77^{e-h}	3.87^{h-j}	3.30^{gh}	8.97^{de}	7.23^{ef}	4.23^{f-h}
Crimson globe	1.60^{j}	7.40^{e-g}	5.60^{f-i}	3.74^{h-j}	2.07^{h}	8.17^{e}	6.37^{e-g}	4.25^{f-h}
Detroit dark red	6.20^{e-h}	14.93^{ab}	16.33^{a}	8.70^{de}	6.60^{ef}	15.47^{ab}	16.83^{a}	9.27^{de}
Samba	4.40^{g-j}	11.00^{cd}	12.83^{bc}	11.19^{cd}	4.83f^{-h}	11.57^{cd}	13.47^{bc}	11.68^{cd}
LSD (0.05)		2.86				9.92		
CV (%)		21.86				20.87		

LSD (0.05) = Least Significant Difference at 5% level; CV= coefficient of variation. Means in column followed by the same letters are not significantly different at 5% level of significance

Table.3 Total dry weight of beetroot yield and total number of Beetroot weight as affected by variety and nitrogen fertilizer rate in 2018 main cropping season in Wolaita Zone, Southern Ethiopia

Treatments	Total Dry weight Yield (t ha^{-1})	Total Number beetroot Weight per Plot
Variety		
Farida	3.1c	105.58a
Crimson globe	2.88c	70.55b
Detroit darkred	5.46a	94.33a
Samba	4.21b	91.41a
LSD (0.05)	0.77	15.32
Rate of N (kg ha-1)		
0	2.10c	86.65
50	4.88a	91.89
100	5.37a	94.01
150	3.30b	89.32
LSD (0.05)	0.77	NS
CV (%)	23.68	20.34

LSD (0.05) = Least Significant Difference at 5% level; CV= coefficient of variation. Means in column with similar letter(s) are not significantly different.

Table.4 Beetroot length and width as affected by interaction effect of variety and rates of N fertilizer rate in 2018 main cropping season in Wolaita Zone, Southern Ethiopia

Variety	Rate of N (kg ha^{-1})							
	Root length (mm)				Root width (mm)			
	0	50	100	150	0	50	100	150
Farida	80.90^{h}	83.17^{h}	99.63^{d-f}	88.43^{gh}	14.47^{ef}	17.93^{b}	17.43^{bc}	16.33^{cd}
Crimson globe	93.37^{fg}	103.6^{b-d}	94.20^{e-g}	84.27^{h}	9.37^{i}	12.60^{h}	12.80^{fgh}	10.55^{i}
Detroit darkred	102.73^{c-e}	115.03^{a}	113.43^{a}	109.7^{a-c}	14.23^{f}	17.73^{b}	18.27^{ab}	18.30^{ab}
Samba	100.20^{d-f}	111.00^{a-c}	112.07^{ab}	117.17^{a}	15.63^{de}	18.50^{ab}	19.60^{a}	14.05^{fg}
LSD (0.05)	7.56				1.18			
CV (%)	4.51				4.56			

LSD (0.05) = Least Significant Difference at 5% level; CV= coefficient of variation. Means in column followed by the same letters are not significantly different at 5% level of significance.

Beetroot quality

Root length

Root length was significantly affected by variety, rates of nitrogen fertilizer and their interaction effect (Table 4). The longest root length (117.17 mm) was attained by variety Samba at 150 kg N ha^{-1} followed by variety dark red (115.03 mm) at 50 kg N ha^{-1}, (113.43 mm) at 100 kg N ha^{-1} and (109.77 mm) at 150 kg N ha^{-1} and variety Samba (112.07 mm) at 100 kg N ha^{-1} and (111.00 mm) at 50 kg N ha^{-1} which were statistically non-significant. Whereas; the shortest root length (80.90 mm) was attained from variety Farida with 0 kg N ha^{-1} (Table 4). This difference might be attributed to the superior genetic potential of introduced varieties over that of the locally available variety. In line with result, Ali (2011) reported that the highly significant differences in root length with respect to the interaction effects of variety, nitrogen and phosphorous fertilizers in beet root crop. And also Pervez *et al.*, (2004) reported that root length of beetroot was influenced significantly due to application of nitrogen fertilizer. This might be due to the amount of nutrient taken and the vegetative status of the plant which is directly related to root length.

Root width

The result of analysis indicated that variety, rates of nitrogen fertilizer rate and their interaction effect were significantly affected the root width (Table 4). The highest root width (19.60 mm) was attained from the introduced variety samba at 100 kg N ha^{-1} followed by the same variety while N applied at 50 kg N ha^{-1} (18.50 mm). Whereas; the narrowest root width (9.37 mm) was measured from Crimson globe at 0 kg N ha^{-1}. Similarly, Nemeat and Alla *et al.,* (2002) reported that increasing nitrogen rate to 100 kg N ha^{-1} resulted in about 74% increase in root width compared to nil nitrogen rate treatment. And also Albayrak and Yuksel (2010) reported that beetroot root diameter can also be influenced by variety or the nutrient supply in the growing environment.

In conclussion, beetroot is most important vegetable crop that ranks second after tomato and used as fresh, dried, vegetable, spices and condiments. It is an important cash crop for smallholder farmers in Ethiopia which serves as household income. Its production and productivity is limited by lack of improved varieties for wider adaptation, limited research outputs in agronomy, protection and postharvest managements. Moreover, there is no valid research recommendation for fertilizer application, varieties for better yield, quality and disease resistance in Wolaita Zone, southern Ethiopia. Hence this experiment was designed to identify the best performing beetroot variety in terms of growth, root yield, quality and evaluates the rates of N fertilizer rate for beetroot production. The data on crop phenology, growth, root yield and quality were collected and subjected to analysis of variance using SAS statistical software and mean separation was done using LSD at 5% probability level. Results of yield and yield components revealed that total root yield, marketable root yield, dry root yield, number of roots per plot, number of roots weight per plot and marketable root number per plot were significantly affected by variety and rates of nitrogen fertilizer in most cases and the interaction effects were significant for total root yield and marketable root yields per hectare only. Based on the analysis, the highest total root yield (16.83 t ha^{-1}) was attained from variety dark red coupled with the rate of N at 100 kg ha^{-1}, while the maximum marketable root yield, 16.33 t ha^{-1}, was obtained from dark red variety at the rate of 100 kg N ha^{-1} followed by 50 kg N ha^{-1}, which gave 14.93 t ha^{-1}; whereas the lowest marketable root yield 1.6t ha^{-1} was achieved by the variety crimson globe when applied at the rate of 0 kg N ha^{-1}. The highest total dry root yield per hectare (5.46 t ha^{-1}) was obtained from variety dark red whereas significantly the lowest (2.88 t ha^{-1}) total dry root yield per hectare was achieved from variety Crimson globe. Generally, beetroot varieties responded differently for variable rates for nitrogen fertilizer rates in terms of yield and quality. Therefore, it could be recommended that the variety dark red with 50 kg ha^{-1} nitrogen rate was ideal variety and efficient fertilizer rate with the minimization of nutrient loss to the environment and improves income of beetroot at Kindo Koysha District in Wolaita Zone, Southern Ethiopia.

Acknowledgements

The authors thank the Areka Agricultural Research Center and Wolaita Sodo University for providing necessary facilities, and the budget for this research and research materials respectively.

References

Akoumianakis, K.A., Karapanos, I.C., Giakoumaki, M., Alexopoulos, A.A. and Passam, H.C., 2011. Nitrogen, season and cultivar affect radish growth, yield, sponginess and hollowness. *Int. J. Plant. Prod.* 5 (2): 112-120.

Albayrak, S. and Yuksel, O., 2010**.** Effects of nitrogen fertilization and harvest time on root yield and quality on fodder beet (*Beta vulgaris* var. *crassa* Mansf.). *Turk. J. Field. Crop.* 15 (1): 59-64.

Ali, I. and Ali, A., 2011. Effect of nitrogen levels and sowing methods on the growth and yield of swiss chard cv. Kalam selection. *Int. Res. J. Plant Sci.* 2 (7): 2141-5447.

Aminifard, M. H., H. Aroiee, H. Nemati, M. Azizi and M. Khayyat, 2012. Effect of nitrogen fertilizer on vegetative and reproductive growth of pepper plants under field conditions. *J. Plant Nutr.* 35: 235–242.

Boroujerdnia, M. and Ansari, N.A., 2007. Beetroot commercial production and processing. Food and Agricultural Research Council, Reduit, Mauritius. Acta Hort.14:259-263

Cerne, M. and Vrhovnik, I., 1999. Effect of nitrogen fertilization on quality and yield of red beet. Agricultural Institute of Slovenia, Slovenia.

Deuter, P. and Grundy, T., 2004. Beetroot commercial production and processing. Food and Agricultural Research Council, Reduit, Mauritius. *Acta Hort.* 14: 259-263.

EARO (Ethiopian Agricultural Research Organization), 2004. Released crop varieties and their recommended cultural practices. Progress report. Addis Ababa, Ethiopia. 28-29p.

Mohhamad, H.A., Hossein, A., Atefe, A. and Hamedi, F., **2012.** Effect of plant density and nitrogen fertilizer on growth, yield and fruit quality on sweet pepper (*Capsicum annum* L.). Department of Horticultural Science, College of Agriculture, Ferdowsi University of Mashhad, Islamic Republic of Iran.

Mukkun, L., Singh, Z. and Phillips, D., 2001**.** Nitrogen nutrition affects fruit firmness, quality and shelf life of strawberry. *Acta Hort*. 553: 69-71.

Nemeat Alla, E.A.E., Mohammed, A.A.E. and Zalat,.S. 2002. Effect of soil and foliar application of nitrogen fertilization on sugar beet. *J. Agric. Sci.* Mansoura University. 27(3): 1343-1351.

Nemeat, A.E.A.E. 2001**.** Yield and quality of sugar beet as affected by sources levels and time application of nitrogen fertilizer. *J. Agric. Res.* Tanta Univ. 27: 450-462.

Nemeat-Alla, E.A.E., Zalat, S.S. and Badr, A.I., 2002. Sugar beet yield and quality as affected by nitrogen levels and foliar application with micronutrients. *J. Agric. Res.* Kafrelsheikh Univ. 35 (4).

Pervez, M.A., Ayub, C.M., Saleem, B.A., Virk, A.A. and Mahmood, N., 2004. Effect of nitrogen levels and spacing on growth and yield of radish (*Raphanus sativus* L.). *Int. J. Agric. Biol.* 6 (3): 504-506

Refay, Y. A. 2010. Root yield and quality traits of three sugar beet (*Beta vulgaris* L.) varieties in relation to sowing date and stand densities. World Journal of Agricultural Sciences, 5:589-594.

Statistical Analysis System (SAS). 2002. SAS Version 9.1 © 2002-2003. SAS Institute, Inc., Cary, North Carolina, USA.

Thompson, J.K., 2001. Yield evaluation of Beetroot varieties. J. Agri. Tech. 4: 5-9.

How to cite this article:

Birhanu Lencha and Dawit Dalga. 2020. Response of Nitrogen Fertilizer Rates on Yield and Quality of Beetroot (*Beta vulgaris* L.) Varieties in Wolaita Zone, Southern Ethiopia. *Int.J.Curr.Res.Aca.Rev*. 8(5), 60-67.
doi: https://doi.org/10.20546/ijcrar.2020.805.007