Int.J.Curr.Res.Aca.Rev.2022; 10(01): 73-80

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 10 Number 01 (January-2022)

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

doi: https://doi.org/10.20546/ijcrar.2022.1001.008

Response of Coffee (*Coffea arabica* L.) Seedling Varieties to Inorganic N Source (UREA) Fertilizer, Time of application and N uptake

Ewnetu Teshale*, Gebreslassie Hailu, Obsa Atnafu, Adugna Bayeta and Bikila Takele

Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, Ethiopia

**Corresponding author*

Abstract

Nitrogen is an important component of many of the nutrients needed for coffee seedlings growth and development is necessary for carbohydrate consumption, growth and development. The importance of nitrogen in a coffee nutrient depends largely on its presence found mainly in the dry matter of the protoplasm, or living constitute, of plant cells. In coffee seedlings growing soil media, nitrogen is also one of the most susceptible macronutrients to environmental loss, such as ammonia volatilization (NH_3), nitrous oxide (N_2O) emissions, and nitrate leaching (NO3). Any form of N losses from the soil systems can be major limitations for crop production, soil fertility. A nursery experiment was conducted to evaluate the response of coffee (*Coffea arabica* L.) seedling varieties to inorganic N Source (UREA) fertilizer rates, time of application and N uptake for two years. The experiment consist of two coffee varieties 74110 and 75227 as main plots and seven treatments as a sub plots: Negative control (without input), positive control (recommended N from UREA), recommended N from UREA once at planting, recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf, half recommended N from UREA once at planting, recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf, recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf and Recommended N +1/2 recommended N from UREA once at planting. Soil and leaf samples before planting and soil sample after harvesting collected from each of the experimental plots and subjected to soil and plant tissue analysis standard laboratory. The result revealed that application of recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf *75227 coffee variety, recommended N +1/2 recommended N from UREA once at planting *75227 coffee variety and Positive control (recommended N from UREA) *75227 coffee variety gave the maximum plant height, stem girth, leaf area, root volume, total dry mater and leaf N Uptake. The least coffee seedlings growth parameters and N uptake were recorded from negative control*74110 coffee variety. In general UREA ^{stable} was improves coffee seedling growth and increase total dry matter production for coffee seedling similar as the existing UREA. The experiment was conducted for tow yeas on two coffee varieties. For sound full recommendation it is better to conduct on different coffee varieties and at the main field.

Article Info

Received: 06 December 2021
Accepted: 15 January 2022
Available Online: 20 January 2022

Keywords

Coffee seedling, Fertilizer, N uptake, Time of application, Urea.

Introduction

Urea is used extensively as a high Nitrogen fertilizers but agronomic test have shown that 15-70 % of the applied urea may be lost due to leaching and could therefore be unavailable to crops. Nitrogen is an important component of the coffee plant. It exists as a basic unit in proteins, nucleic acids, chlorophyll, and other living things. It is an important part of the enzyme systems and plays an important role in all metabolic processes in the plant. Nitrogen greatly determines the production of plants and as a result of that of vegetates that produces. A balanced nitrogen supply increases photosynthetic activity, plant growth and gives a dark green color to the leaves. It also plays an important role in accelerating the vegetative growth of coffee seedlings (Parecido *et al.*, 2021).

Nitrogen is an important component of many of the nutrients needed for coffee seedlings growth and development is necessary for carbohydrate consumption, growth and development (Agbede, 2009). The importance of nitrogen in a coffee nutrient depends largely on its presence found mainly in the dry matter of the protoplasm, or living constitute, of plant cells. Icon, therefore, what is needed in the multiplicity of several growth processes occurring in coffee plant. With the exception of adequate supply available, all other conditions are permissible, right plant growth is impossible and will happen. It follows that nitrogen is a highly depleted nutrient in coffee production. Nitrogen gives green color to plants because it is part of chlorophyll and regulates plant growth. When nitrogen is deficient or transient deficiency, leaves will contain less chlorophyll, gray or yellow leaves color instead of healthy dark green and may have abnormal growth. As a result the leaves it will not work well in preparing food. Symptoms begin to appear on older leaves as nitrogen is transferred to smaller tissues that grow farther away from the old one (Carelli *et al.*, 2006)

The vital aspect of coffee cultivation begins from production of coffee seedling with desirable characteristics under the recommended nursery management operations. However any improper handling made at the early stage would remain to cause poor field establishment and hence reduced yield performance and life span of coffee trees in the field. In coffee seedlings growing soil media, nitrogen is also one of the most susceptible macronutrients to environmental loss, such as ammonia volatilization (NH_3), nitrous oxide (N_2O) emissions, nitrate leaching (NO3), etc. Any form of N losses from the soil systems can be major limitations for crop production, soil sustainability, and environmental (Mahmud *et al.*, 2021).

UREA is a new modern concentrated fertilizer based on amide nitrogen containing a urease inhibitor (NBPT) (Mesfin *et al.*, 2021). The fertilizer granules are sized, which guarantees a higher uniformed application and almost eliminates the presence of dustable powders. The urease inhibitor, which is used for coating the granule surface, delays the conversion of $CO(NH_2)^2$ to NH_4+ after dissolution, therefore increasing the direct efficiency of the applied nitrogen However, the effect of urease inhibitor (nBTPT) depends on the climate, soil, crop and management (Abalos *et al.*, 2014). However, in Ethiopia the rate and time of application of UREA fertilizer on coffee seedlings have not been conducted. The aim of this research work was to evaluate the response of UREA Fertilizer, Time of application and N uptake on coffee growth at seedling stage.

Materials and Methods

Site descriptions

A nursery research experiment was conducted at Jimma Agricultural Research Centre which located to Southwestern part of Ethiopia. It was situated between 7040' N latitude and 36047'E longitudes with an altitude of 1753 m above sea level. The average annual precipitation of the area received is 1639 mm. The annual mean maximum temperature was 26.6^{o}C and minimum 13.9 ^{o}C. Eutiric Nitisol was the dominant soil types in the study area.

Experimental design and treatment management

This experiment was carried out from 2018-2019 for two consecutive years at Jimma Agricultural Research Center nursery site. The treatments were laid down with split plot design with three replications which contains tow coffee released varies 74110 and 75227 as a main plot and one inorganic N fertilizers from UREA (780mg) and five UREA as a sub plot (Table 1). All experimental plot except negative control received recommended P rates of (800mg)/pot from TSP once at planting time. Different N fertilizer from UREA and UREA applied at time of planting and the second split applications when the seedlings attain two pair of leaves according to the treatments. The experimental soil was Eutiric Nitisol which is known by naturally acidic chemical properties. For this reason all treatments received agricultural lime

$CaCO_3$ equal rates based on exchangeable acidity of the soil before three weeks of sowing time. Different nursery activates like watering, mulching and weeding were conducted regularly for all treatments.

Data collected

After nine month when the seedlings attain six pair of leaves the representative sample were selected randomly from the experimental plot and the growth parameters were taken. Plant height was measured from the base to the tip the seedlings by using hand meter. Stem girth was measured at the base near a medium surface using caliper. Leaf area was measured from petiole to the tip and leaf width at broadest part was measured. Then, detached leaf area was calculated the methods conducted by Yakob *et al.,* (1998). Shoot and Root dry matter were measured after the shoot and root samples properly dried in to an oven (at the temperature of 70 ^{o}C to constant weight for 24 hrs.) and then the dry weights was recorded by using a sensitive balance. Root volume was recorded by water displacement method using graduated cylinder half filed with water. The volume of water displaced due to the immersion of each sample was calculated and the average was taken as root volume. Finally the data was analyzed by using SAS 9.3 and the mean was separations were done by LSD at 5 % significance level for all treatments.

Soil analysis

Soil samples before planting and after harvesting collected from each of the sampling. The collected samples were air dried and ground to pass through a 2 mm sieve to be measured for selected soil parameters. Soil pH was recorded by potentiometrically (1:2.5 soil: H_2O) suspension using a combined glass electrode pH meter (Sahilemedhinm and Taye, 2000). Exchangeable acidity was determined by saturating the soil samples with potassium chloride solution and titrated with sodium hydroxide (Mclean, 1965). The Organic carbon (OC) content of the soil was determined by the wet combustion procedure of (Walkley and Black, 1934). The total soil nitrogen (N) content of the soil was determined by wet-oxidation Kjeldahl methods (Jakson, 1967). Available P was extracted and determined by the Bray-II method (Bray and Kurtz, 1945).

Plant Tissue Analysis

Sample leaves from the same central seedlings were dried and prepared for laboratory analysis on leaf nutrient contents nitrogen. The sampled plant tissue was oven-dried at 70 0C for 24 hours to a constant weight. There after total nitrogen analyzed by modified Kjeldhal methods as described by Jackson (1975).

Nitrogen uptake

The nutrient uptake was calculated as the product of the nutrient concentration multiplies with dry matter yield (Osonubi, 2011) Uptake of N = % N* Dry matter

Results and Discussion

The initial result of soil indicated that soil pH 5.18 which is characterized by acidic (Murupy, 1968). Total N and available P were ranged from 0.12 % and 14.63 ppm respectively. The total N concentrations were found in medium range (Debele, 1980), the extractable phosphorus concentration was found in low (Brayand Kurtz, 1945) respectively.

The organic carbon and organic matter concentrations was 1.4 %, which is found low (Debele, 1980). After harvesting the analyzed soil result revealed that soil pH ranges from 5.48-5.65 which is near to slightly acidic (Table 2). This is due to the agricultural lime CaCO3 improves the soil pH by displacing the acidic cations Al^{3+} and H^{+} from the soil. Total nitrogen also improved from 0.12 % to 1.8 % as compared with initial soil results (Table 2).

The analysis results of 2018 seedlings growth data revealed that there is statically significance difference among time of application, rates of UREA and UREA fertilizers and coffee variety. The maximum seedlings height (38.35 cm), stem girth (2.69 mm), leaf area (29.87 cm^2) were recorded from Recommended N +1/2 Recommended N from UREA once at planting coffee variety 75227 (Table 2) similarly leaf dry Matter (6.09 g), stem dry matter (6.09 g)) and root dry mater (0.88 g) were recoded from Recommended N +1/2 Recommended N from UREA once at planting coffee variety 75227 (Table 3).

Table.1 Treatments combinations

T.N	Main plot	Subplots
1	Coffee variety 74110	Negative control (without input)
2	Coffee variety 74110	Positive control (Recommended N from UREA)=780 mg
3	Coffee variety 74110	Recommended N from UREA once at planting =780 mg
4	Coffee variety 74110	Recommended N from UREA in two splits (1/2 at planting and 1/2 at two pair of true leaf)= 780 mg
5	Coffee variety 74110	Half Recommended N from UREA once at planting=390 mg
6	Coffee variety 74110	Recommended N + 1/2 Recommended N from UREA in two splits (1/2 at planting and 1/2 at two pair of true leaf) = 1170mg
7	Coffee variety 74110	Recommended N +1/2 Recommended N from UREA once at planting=1170 mg
8	Coffee variety 75227	Negative control (without input)
9	Coffee variety 75227	Positive control (Recommended N from UREA)=780mg
10	Coffee variety 75227	Recommended N from UREA once at planting =780mg
11	Coffee variety 75227	Recommended N from UREA in two splits (1/2 at planting and 1/2 at two pair of true leaf)=780mg
12	Coffee variety 75227	Half Recommended N from UREA once at planting=390mg
13	Coffee variety 75227	Recommended N + 1/2 Recommended N from UREA in two splits (1/2 at planting and 1/2 at two pair of true leaf)=1170mg
14	Coffee variety 75227	Recommended N + 1/2 Recommended N from UREA once at planting=1170mg

Table.2 Soil results after coffee seedlings harvested

Treatments	pH(1:2.5)		Available P (mg-kg)		Total N (%)		Organic carbon (%)	
	V1	V2	V1	V2	V1	V2	V1	V2
1.Negative control (without input)	5.48	5.38	12.15	13.54	0.13	0.13	1.13	1.43
2.Positive control (Recommended N from UREA)=780 mg	5.77	5.58	13.33	15.0	0.13	0.14	1.46	1.87
3.Recommended N from UREA once at planting =780 mg	5.20	5.75	16.87	16.41	0.12	0.12	1.67	1.77
4.Recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf = 780 mg	5.58	5.82	15.23	14.37	0.11	0.16	1.64	1.69
5.Half Recommended N from UREA once at planting=390 mg	5.55	5.92	16.49	16.25	0.14	0.14	1.79	1.53
6.Recommended N + 1/2 Recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf = 1170mg	5.82	5.35	17.34	18.07	0.15	0.16	1.16	1.72
7.Recommended N +1/2 Recommended N from UREA once at planting=1170 mg	5.65	5.96	18.77	19.34	0.16	0.18	1.88	1.95

V1= Coffee seedlings variety 74110, V2= Coffee seedlings variety 75227

Table.3 The response of coffee seedlings growth parameters to UREA, UREA at 2018 planting season

Treatments	PH(cm)	SG(mm)	LA(Cm2)	LDM(g)	SDM(g)	RDM(g)
T1	18.63g	1.26d	12.62e	1.03d	1.90fe	0.37bc
T2	27.81edc	2.36bac	14.48edc	1.37dc	1.40f	0.48bc
T3	23.61feg	1.74bdc	15.41edc	1.68bdc	2.47fed	0.52bc
T4	22.46feg	1.57dc	18.73bedc	1.55dc	3.51bedc	0.61bac
T5	25.58fed	1.70bdc	17.21bedc	1.49dc	2.47fed	0.50bc
T6	23.82feg	1.73bdc	15.56edc	2.28bac	2.28fed	0.44bc
T7	33.25bac	1.94bdac	15.23edc	2.62ba	5.19bac	0.77ba
T8	20.39fg	2.54ba	13.18ed	1.36dc	1.90fe	0.46bc
T9	25.43fed	1.72bdc	15.43edc	1.50dc	2.64fed	0.50bc
T10	28.96bedc	2.11bdac	22.20bac	2.06bdc	3.62bedc	0.72ba
T11	31.67bdc	2.33bac	22.15bac	2.37bac	3.94bdc	0.71bac
T12	27.08edc	2.09bdac	20.97bdc	1.92bdc	3.37fedc	0.50bc
T13	35.32ba	2.50ba	24.69ba	2.61ba	5.35ba	0.78ba
T14	38.35a	2.69a	29.87a	3.25a	6.09a	0.88a
LSD (5%)	6.56	0.86	8.01	1.04	1.97	0.34
CV%	8.75	7.54	6.88	7.27	6.55	7.92

Table.4 The response of coffee seedlings growth parameters to UREA, UREA at 2019 planting season

Treatments	PH(cm)	SG(mm)	LA(Cm2)	LDM(g)	SDM(g)	RDM(g)
T1	17.13d	2.52c	16.39e	0.89c	0.44c	0.34b
T2	21.57bdac	3.87ba	19.51dec	1.29bac	0.67bc	0.44ba
T3	24.52bac	3.58ba	18.96dec	1.08bc	0.53c	0.41ba
T4	19.74bdc	3.36bac	27.63bac	1.55ba	0.71bc	0.35b
T5	20.37bdac	3.5ba	21.92bdec	1.10bac	1.22ba	0.38ba
T6	20.40bdac	3.5bac	18.81de	1.09bac	0.55c	0.38ba
T7	20.63bdac	3.64ba	18.59de	1.11bac	0.58c	0.38ba
T8	18.34dc	2.86bc	18.09de	0.90c	0.46c	0.35b
T9	26.67a	3.77ba	30.21ba	1.73a	0.80bc	0.51ba
T10	25.19ba	3.86ba	29.32ba	1.67ba	0.71bc	0.53ba
T11	25.29ba	3.98a	30.65a	1.57ba	0.80bc	0.59ba
T12	25.55ba	4.04a	28.68ba	1.54ba	0.63c	0.48ba
T13	24.27bac	3.64ba	26.58bdac	1.65ba	1.56a	0.54ba
T14	25.98ba	3.90a	25.30bdac	1.69ba	0.80bc	0.59a
LSD (5%)	6.36	1.02	8.75	0.63	0.56	0.23
CV%	10.83	9.62	8.25	8.84	9.53	7.26

Fig.1 Total dry matter production of coffee seedlings (2018-2019)

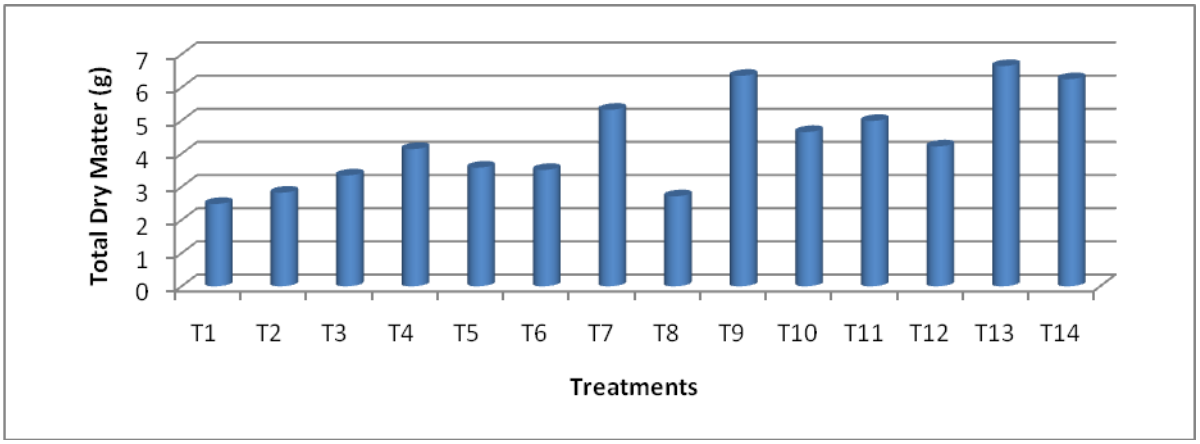


Fig.2 The root volume of coffee seedlings (2018-2019)

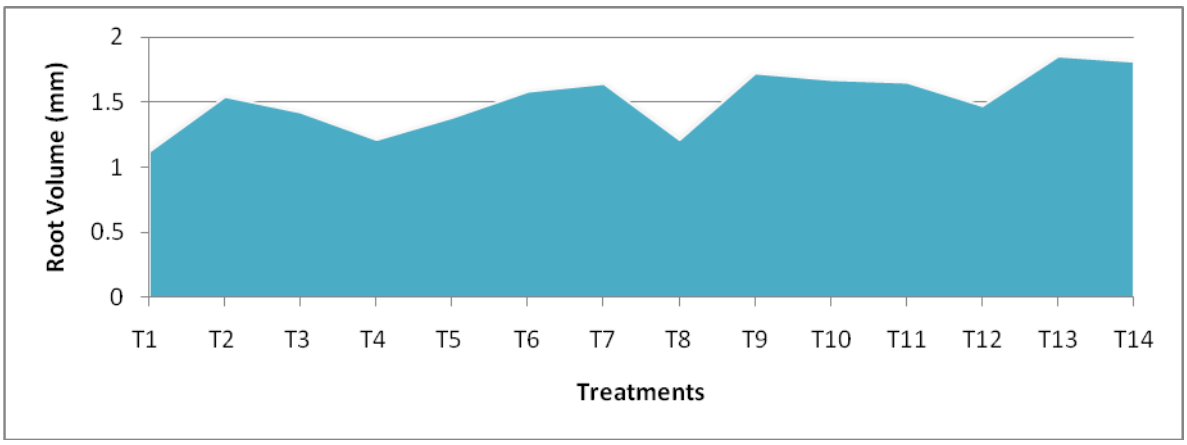
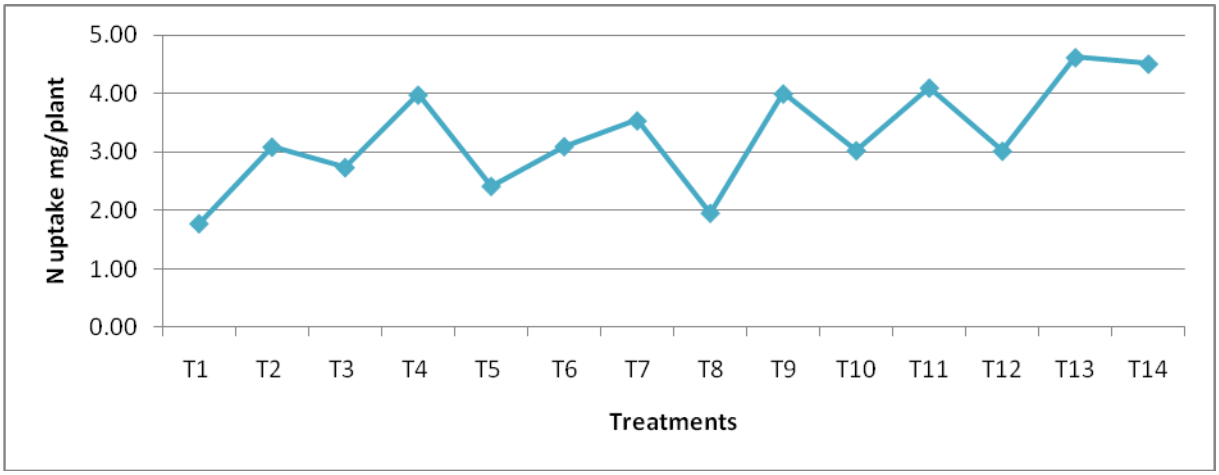


Fig.3 Leaf N uptake of coffee seedlings (2018-2019)



The treatment recommended N + 1/2 recommended N from UREA in two splits (1/2 at planting and 1/2 at two pair of true leaf) coffee variety 75227 gave the maximum plant height (35.32 cm), stem girth (2.50 cm), leaf area (24.69 m^2), leaf dry matter (2.61 g), stem dry matter (5.35 g) and root dry matter (0.78 g). From the tow

coffee varieties 75227 gave a good response to rate and time of applications UREA and UREA fertilizer and better seedling performance as compared with 74110 coffee varieties. On the other hand the lowest plant height (18.63 cm), stem girth (1.26 g), leaf area (12.62 g), leaf dry matter (1.03 g), stem dry matter (1.90 g) and root dry matter (0.37 g) were recorded from the negative control plots coffee variety 74110 (Table 3).

The second year 2019 coffee seedlings growth analysis data indicated that there was statically significance difference among the treatments. The maximum plant height plant height (26.67 cm) was recorded from positive control (Recommended N from UREA)*coffee variety 75227. The maximum Stem girth (4.04 mm), (3.90 mm) and (3.98mm) were recorded from recommended N + 1/2 Recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf * 75227 coffee variety, Recommended N +1/2 Recommended N from UREA once at planting * 75227 coffee variety and Half Recommended N from UREA once at planting * 75227 coffee variety respectively. Leaf, stem and root dry matter also significantly affected by time and rate of UREA and UREA fertilizer and coffee varieties (Table 4). The maximum leaf dry matter (1.73 g), stem dry matter (1.56 g) and root dry matter (0.59 g) were recorded from positive control (Recommended N from UREA)*coffee variety 75227, recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf and Recommended N +1/2 Recommended N from UREA once at planting. The lowest plant height (17.13 cm), stem girth (2.52 mm), leaf area (16.39 m^2) c' leaf dry matter (0.89 g), stem dry matter (0.44g) and root dry mater (0.34g) was recorded from negative control***** 74110 coffee variety (Table 4).

Coffee seedlings dry matter influenced by rate and time applications of UREA and UREA The maximum (6.64g), (6.25 g) and (6.35 g) were recorded from Recommended N + 1/2 Recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf * 75227 coffee variety, Positive control (recommended N from UREA) * 75227 coffee variety and recommended N +1/2 recommended N from UREA once at planting * 75227 coffee variety respectively. The least (2.48 g) total dry matter was recorded from negative control*74110 coffee variety (Figure 1).

Time and rate of UREA and UREA was affected by 74110 and 75227 coffee varieties. The maximum mean root volume (1.85 mm), (1.81mm) and (1.72mm) were recorded from recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf, recommended N +1/2 Recommended N from UREA once at planting and positive control (recommended N from UREA) respectively. The least mean root volume (1.12 mm) was recorded from negative control*74110 coffee variety (Figure 2).

Coffee seedlings N uptake was highly affected by UREA, UREA rates, time of applications and coffee varieties. The two year mean data indicated that the maximum N uptake/ plant (4.62 %), (4.51 %), (4.10 N%) and (4.0%) were recorded from recommended N + 1/2 Recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf * 75227 coffee variety, recommended N +1/2 Recommended N from UREA once at planting * 75227 coffee variety and recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf 75227 coffee variety and positive control (recommended N from UREA) respectively. The minimum leaf N uptake was recorded from negative control* 74110 coffee variety (Figure 3).

Recommendation

The nursery experiment was conducted to evaluate the response of coffee seedling varieties to inorganic N source (UREA) fertilizer, time of application and N uptake for two consecutive years. The result revealed that application of recommended N + 1/2 recommended N from UREA in two splits 1/2 at planting and 1/2 at two pair of true leaf *75227 coffee variety, recommended N +1/2 recommended N from UREA once at planting *75227 coffee variety and Positive control (recommended N from UREA) *75227 coffee variety gave the maximum plant height, stem girth, leaf area, root volume, total dry mater and Uptake. The least coffee seedlings growth parameters and N uptake were recorded from negative control*74110 coffee variety. The experiment was conducted for tow yeas on two coffee varieties. For sound full recommendation it is better to conduct on different coffee varieties and at the main field.

References

Abalos, D., Jeffery, S., Sanz-Cobena, A., Guardia, G. and Vallejo, A., 2014. Meta-analysis of the effect of urease and nitrification inhibitors on crop productivity and nitrogen use efficiency. *Agriculture, Ecosystems & Environment*, *189*, pp.136-144.

Berhanu D 1980. The physical criteria and their rating proposed for land evaluation in the highland region of Ethiopia. Land Use Planning and Regulatory Department, Ministry of Agriculture, Addis Ababa, Ethiopia.

Bray, R. H. and Kurtz, L. T., 1945. Determination of total, organic, and available forms of phosphorus in soils. *Soil science*, *59*(1), pp.39-46.

Carelli, M. L. C., Fahl, J. I. and Ramalho, J. D. C., 2006. Aspectos do metabolismo de nitrogênio em plantas de café. *Brazilian Journal of Plant Physiology*, *18*, pp.9-21.

Jakson, M. L., 1967. Soil Chemical Analysis Prentice Hall of India Private Ltd. *New Delhi*.

Mahmud, K., Panday, D., Mergoum, A. and Missaoui, A., 2021. Nitrogen losses and potential mitigation strategies for a sustainable agroecosystem. *Sustainability*, *13*(4), p.2400.

McLean, E. O., 1965. Aluminum. *Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties*, *9*, pp.978-998. Murphy, G.I., 1968. Pattern in life history and the environment. *The American Naturalist*, *102*(927), pp.391-403.

Mesfin, T., Tamru, S., Aklilu, Y. and Bekele, D., 2021. Impact of UREA Stable on Soil Property, Nitrogen Use Efficiency and Yield of Durum Wheat under Balanced Fertilizer Application.

Parecido, R. J., Soratto, R. P., Guidorizzi, F. V., Perdoná, M. J. and Gitari, H. I., 2021. Soil application of silicon enhances initial growth and nitrogen use efficiency of Arabica coffee plants. *Journal of Plant Nutrition*, pp.1-11.

Sahilemedhin, S., and Taye, B. 2000. *Procedures for Soil and Plant Analysis Technical Paper*. National Soil Research Center, Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

Walkley, A. and Black, I. A., 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil science*, *37*(1), pp.29-38.

How to cite this article:

Ewnetu Teshale, Gebreslassie Hailu, Obsa Atnafu, Adugna Bayeta and Bikila Takele. 2022. Response of Coffee (*Coffea arabica* L.) Seedling Varieties to Inorganic N Source (UREA) Fertilizer, Time of application and N uptake. *Int.J.Curr.Res.Aca.Rev.* 10(01), 73-80. doi: https://doi.org/10.20546/ijcrar.2022.1001.008