

Determining Optimum NPS and Urea Fertilizer Rates for Taro [*Colocasia esculenta* (L.) Schott] Production in Cheha District, Ethiopia

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Abstract: Taro is a tropical and subtropical perennial herbaceous root crop. There are various compelling reasons to encourage Ethiopians to cultivate root and tuber crops. Taro corms have a higher nutritional content than most other root/tuber crops. In the south, west, and southwestern regions of Ethiopia, taro is widely farmed and used as a food and source of revenue. Both chemical and organic fertilizers work well on taro. However, the vast majority of taro growers, particularly those who make a living from it, do not use fertilizer. During the 2017 and 2018 cropping seasons, a field experiment was undertaken in the Cheha district of the Gurage zone to identify the proper rate of NPS and urea for taro yield. Due to inadequate agronomic practices, taro yields in the research region are much lower than the crop's potential yield. Plant population, planting pattern, weeding, fertilizer management, and better variety are the main factors causing low production. As a result, a randomized complete block design with three replications was used to layout the combination of three levels of urea and three levels of NPS fertilizer. Because it is a new release with a high yield, the Boloso-I taro cultivar was chosen. In both the 2017 and 2018 cropping seasons, the application of urea and NPS enhanced taro yield. The best cost-effective yield was obtained by applying 242 kg/ha NPS and 187.5 kg/ha urea. As a result, for taro production in the Cheha district, a combination of 242 kg/ha NPS and 187.5 kg/ha urea is suggested.

Keywords: Corm, Boloso-I, NPS, Taro, Urea, Yield

1. Introduction

Taro is a tropical and subtropical perennial herbaceous root crop belonging to the *Colocasia* genus in the *Araceae* plant family [1]. It is primarily grown by resource-poor farmers in a variety of ecological settings around the world, ranging in altitude from 1,300 to 2,300 meters. It requires a lot of water to grow, mainly because of its large transpiring surface. Rainfall or irrigation of 1,500-2,000mm is normally required for optimal productivity. Farmers prefer it because it works with a variety of low-input farming techniques and is dependable in adverse weather, drought, and low soil fertility [2]. When planted in fertile soil with a high water holding capacity and high organic matter content, taro produces well. It is best to have slightly acidic soil with a pH of 5.5 to 6.5 and a modest clay concentration. Consistently, moist soils

appear to be the best for maximizing the growth and yield of this crop [3].

There are numerous compelling reasons to promote root and tuber cultivation in Ethiopia. First and foremost, they are one of the most flexible mainstays for addressing food security for millions of people while also producing more food per unit of land area [4]. The fact that taro has the potential to succeed under conditions that are adverse for most crops makes it an ideal subsistence crop for areas where advanced agricultural technology is lacking [5]. In comparison to most other root/tuber crops, taro corms have a higher nutritional content. Both the leaf and the corm have been demonstrated to be high in protein and nutrients such as calcium, potassium, and phosphorus [6]. The corm of the taro plant is edible and contains protein, carbohydrates, fat, crude fiber, vitamin C, thiamin, riboflavin, and niacin [6]. Taro corms contain the most

starch of any plant [7]. With an energy level of 135 kcal/100 g, taro corms have nearly double the carbohydrate content of potatoes. It also has a higher protein level than yam, cassava, and sweet potato [7].

Taro is widely grown and used as a food and a source of income in the south, west, and southwestern regions of Ethiopia. According to data from the Central Statistical agency's (CSA) agricultural sample survey, taro area coverage, production, and productivity are growing over time. According to the CSA data, between the 2009 and 2018 growing seasons, taro area coverage, production, and productivity increased from 30,251.07ha to 45,995.28 ha; 228,242.78 tons to 11,797, 769.33 tons; and 7.54 tons/ha to 25.65 ton/ha respectively. It was placed third in terms of area coverage behind potatoes and sweet potatoes, and second in terms of production and productivity behind sweet potatoes, among the primary root crops grown in key growing regions of Ethiopia [8]. However, under extensive care, the yield could reach 73 t/ha [9].

2. Materials and Procedures

2.1. Experimentation Site

A field experiment was conducted in the Cheha district in the Gurage zone during the 2017 and 2018 cropping seasons. The experimental location is at an elevation of 1945 meters above sea level and is located at 08°10'18" N, 037°50'15" E. The amount of rainfall varies depending on the season, but the average annual rainfall is predicted to be 1700 mm, with a high temperature of 26°C and a minimum temperature of 15°C. Clay loam is the predominant soil type in the area. Agriculture is the most important economic activity in rural areas, with rain-fed agricultural production dominating.

2.2. Treatments

In this experiment, twelve different fertilizer managements (rate and type) were involved. The details of the involved treatments are shown in table 1 below.

Table 1. Treatment combination.

Treatment No	Treatment	Treatment No	Treatment
1	Control (without fertilizer)	7	302.5 kg/ha NPS +187.5 kg/ha urea
2	20 t/ha FYM	8	302.5 kg/ha NPS +150 kg/ha urea
3	181.5 kg/ha NPS + 112.5 kg/ha urea +20t/ha FYM	9	302.5 kg/ha NPS +112.5 kg/ha urea
4	242 kg/ha NPS +150 kg/ha urea	10	181.5 kg/ha NPS +150kg/ha urea
5	242 kg/ha NPS +187.5 kg/ha urea	11	181.5 kg/ha NPS +187.5kg/ha urea
6	242 kg/ha NPS +112.5 kg/ha urea	12	181.5 kg/ha NPS +112.5 kg/ha urea

2.3. Experimental Design and Procedures

During the dry season, the experimental field was plowed by a tractor, and at planting time, it was harrowed and leveled by hand. The *Boloso-I* taro cultivar was planted with an inter-and intra-row spacing of 80 cm and 60 cm, respectively. Southern Agricultural Research Institute (SARI), Areka Agricultural Research Center, has officially released this cultivar. The crop was planted before the wet season started. At the initial cultivation, NPS was applied 15 days following emergence on a treatment basis. 30 days before planting, farmyard manure was applied and incorporated into the soil. After 30 days of emergence, urea was top-dressed on a treatment basis during the second cultivation. Two months after emerging, it was finally earthen up. When the leaves of 50% of the plants in the plot became yellowish, harvesting was done plot-wise.

2.4. Data Collection

Plant height: The average height of five randomly selected plants on each plot was measured from ground to top of the leaf blade.

Number of suckers per plant: Total number of suckers per plant was counted from five randomly selected plants from the middle rows of each plot and the mean number was taken.

Corm girth: At harvest, the girth of five randomly selected corms was measured and the average was taken.

Single Corm weight: The weight of five randomly selected corms was measured by sensitive balance and the average

was taken at harvest.

Total corm fresh yield: Total corm fresh yield was recorded by measuring the weight of corms and suckers from the net plot area of each plot.

2.5. Statistical Analysis

The collected data were subjected to analysis of variance (ANOVA). After fitting the ANOVA model, multiple mean separations were carried out using the LSD method) at a 5 percent level of significance. The SAS-9.2 statistical software was used for all statistical analyses [10].

3. Results and Discussion

Plant height: The combined analysis of variance data indicated that the application of NPS and urea had a significant ($p < 0.05$) effect on plant height. As the rate of these fertilizers increases, the plant height increases. For instance, the shortest plant height (58.80cm) was recorded due to growing taro without fertilizer while the tallest (97.30cm) was recorded due to the combination of the highest rates of NPS and urea (302.5 kg/ha NPS and 187.5 kg/ha urea) (Table 2).

Number of suckers per plant: Also, the application of urea and NPS increased the number of suckers per plant compared to growing taro without fertilizer and only farmyard manure.

Corm weight: Single corm weight was significantly ($p < 0.05$) affected by the application of urea and NPS fertilizers. Application of both urea and NPS fertilizers improved corm weight. Accordingly, the largest single corm

weight (495.2 g) was obtained by application of 242 kg/ha NPS and 187.5 kg/ha urea (Table 2).

Corm girth: The combined analysis of variance data indicated that the application of NPS and urea had a significant ($p < 0.05$) effect on plant height. The highest corm girth was recorded due to the application of 242 kg/ha NPS and 187.5 kg/ha urea. Further increment in both urea and NPS did not show a significant advantage on these yield components (Table 2).

Total tuber yield: The combined data analysis revealed that total tuber yield was significantly affected by treatments.

Application of both urea and NPS increased the tuber yield of taro until the optimum rates of these fertilizers were attained. Application of both urea and NPS above from the optimum rate of these fertilizers showed a decrease in tuber yield. Accordingly, the highest yield (45.97 t/ha) was recorded due to the application of 242 kg/ha NPS and 187.5 kg/ha urea while the lowest yield (27.05 t/ha) is obtained from plots assigned with no fertilizer. The highest yield was due to the application of 242 kg/ha NPS and 187.5 kg/ha urea the result of a larger corm size (Table 2). The highest and the lowest tuber yield of taro are likely due to the larger corm weight.

Table 2. Response of taro to fertilizer application in Cheha district.

Treatments	Ph (cm)	Spp	Cg (cm)	Cw (g)	Tuber (t/ha)
Control (without fertilizer application)	58.8f	3.8cd	24.0d	325.5e	27.05f
20 t/ha FYM	73.5c-f	4.0cd	24.1cd	439.8abc	27.50ef
181.5 kg/ha NPS + 112.5 kg/ha urea +20t/ha FYM	86.3abc	4.8ab	26.0bcd	412.2cd	34.37b-f
242 kg/ha NPS +150 kg/ha urea	79.8bcd	4.4abc	27.7b	403.1cd	34.34b-f
242 kg/ha NPS +187.5 kg/ha urea	87.6ab	3.9cd	30.7a	495.2a	45.97a
242 kg/ha NPS +112.5 kg/ha urea	89.5ab	4.2a-d	26.6b	430.6bcd	42.62ab
302.5 kg/ha NPS +187.5 kg/ha urea	97.3a	4.5abc	27.2b	445.7abc	40.55abc
302.5 kg/ha NPS +150 kg/ha urea	83.3a-d	4.5abc	25.8bcd	371.7de	32.52c-f
302.5 kg/ha NPS +112.5 kg/ha urea	64.1ef	4.1bcd	28.0b	477.2ab	35.93b-e
181.5 kg/ha NPS +150kg/ha urea	76.5b-e	5.0a	26.3b	420.5bcd	31.39def
181.5 kg/ha NPS +187.5kg/ha urea	69.1def	3.8cd	26.5b	437.5abc	31.73def
181.5 kg/ha NPS +112.5 kg/ha urea	71.3def	3.5d	26.2bc	398.2cd	37.43bcd
LSD (5%)	14.6	0.8	2.2	61.4	8.47
CV (%)	11.11	11.31	4.98	8.62	14.24

Ph=plant height, Spp=Suckers per plant, Cg=corm girth, Cw=corm girth.

4. Conclusion

The results showed that the application of 242 kg/ha NPS and 187.5 kg/ha urea resulted in the highest tuber production. As a result, for taro production in the Cheha district, 242 kg/ha NPS and 187.5 kg/ha urea are advised.

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