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The Effect of between Rows and within Rows Spacing on the Yield and Yield Components of Taro

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Abstract

The experiment was conducted in southern region of Ethiopia to determine the optimum planting density for taro. Three between rows and three within rows spacings were evaluated on Areka agricultural research farm and on farmers' field for three years using taro cultivar '*Bollosso-1*'. The design of the experiment was randomized complete block in complete factorial arrangement. Data were collected on below ground plant growth parameters. The results of statistically analyzed data indicated that stand percent at harvest, tuber weight plant^{-1} and fresh tuber yield were significantly affected by different between rows and within rows spacings. The interaction of these factors did not affect the tuber yield and yield components significantly. On the research farm, 50 cm between rows spacing and within rows spacings of 40 cm and 50 cm gave significantly the highest tuber yield of taro. On the other hand, on farmers' field, 50 cm and 75 cm between rows spacing gave significantly the highest tuber yield of taro. Though, 50 cm between rows spacing gave significantly higher tuber yield, it significantly decreased stand percent at harvest and corm weight plant^{-1}. Taro growers also reported that growing taro with 50 cm row spacing was not convenient for weeding, earth up and also causes mechanical damage during harvest. The result also indicated that between rows spacing wider than 75 cm decreased tuber yield of taro significantly. On the other hand 50 cm within rows spacing gave significantly the highest tuber yield. Tuber yield of Taro was decreased significantly when it was grown under within row spacing wider than 50 cm. So from the result it is concluded that growing taro with spacing of 75 cm between rows and 50 cm within rows produce higher yield of taro.

Keywords: *Bollosso-1*; Farmers; Agriculture; Carbohydrate; Vitamins

Introduction

Taro (*Colcasia esculenta* (L.) Schott) is an ancient and important vegetative propagated root crop species belonging to the monocotyledonous family Araceae. It is an important staple food crop for many people in the world. It is a staple food for many people in developing countries in Africa, Asia and the Pacific Islands. It is a globally important crop, ranked fifth in area and production after cassava, potato, sweet potato and yam [1]. Taro is the second most important root staple crop after sweet potato in terms of consumption The world production of taro is estimated at 11.8 million tons per annum produced from about 2 million hectares with average yield of 6 t/ha. Most of the global production comes from developing countries characterized by small holder production systems relying on minimum external resource input.

Taro is an excellent multipurpose food crop for subsistence agriculture and home gardens. Its ability to tolerate salinity makes it suitable for localities where few other crops grow. As such, it merits more attention in research focusing on yield. While the young leaves and petioles which are occasionally used for food contains about 23% protein on a dry weight basis [2]. It is a tuberous crop that supplies high-energy food to the rural resource poor farmers. The main nutrient supplied by taro is carbohydrate, and it also contains proteins, vitamins and minerals. Taro is also a good source of thiamine, riboflavin, iron, phosphorus, and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese. Taro can also be used for entrapment of flavoring compounds [3]. In Ethiopia, numerous root and tuber crops are grown, mostly in the South and Western parts of the country. Agricultural sample survey report in Ethiopia revealed that a total area of 48,087 hectares of land in 2016/2017 cropping season in Ethiopia was covered by taro. The most common and widely distributed varieties of taro are local variety and '*Boloso-1*' under cultivation. Taro is an important root crop in southern region of Ethiopia. Most districts in the region grow taro for different purposes. It is produced for home consumption, for sale, for planting materials.

Plant spacing in the field is very important and plays a significant role in determining Plant population and their growth and development. Plant population has an effect on yield by imposing competition among plants for nutrients, moisture and sunlight. The adjustments of between rows and within rows in plant population have an important effect on canopy development root and above ground yield components growth. Population density is dependent on the moisture availability and nutrient status of the soil [4]. Hence, optimum planting density should be determined through research works. Determining appropriate crop geometry is one of the most important crop management activities which improves the performance and productivity of plants.

The spacing varies among locations and farmers. In Egypt, in Qalyubia Governorate conditions, intra row spacing of 20 cm was recommended for obtaining early and high production of taro. In

Nigeria the spacing of 30 cm × 100 cm was reported to produce higher taro tuber yield. At Jimma, in Ethiopia, 30 cm × 70 cm spacing was recommended for obtaining high tuber yield of taro [5]. There is limited information on many cultivating aspects of taro in taro growing areas of Ethiopia. This includes agronomic practices like determination of optimum plant population as there are differences in agro-ecological conditions, appropriate spacing for taro production must be generated for taro growing areas of the country. Therefore, the objective of this study was, to determine the optimum plant population for taro that can produce higher taro yield in an effort to develop a package of agronomic practices for improved production of Taro for taro growers of southern region of Ethiopia.

Materials and Methods

A field experiment was conducted at Areka Agricultural Research Center in Southern region of Ethiopia. Areka is located about 300 km south west of Addis Ababa, in Ethiopia found at 7°4'N latitude and 37°41'E longitude and altitude of 1800 meters above sea level. The soils at Areka are deep, highly weathered with a pH of 5.2. The climate is tropical, with mean annual rainfall of about 1500 mm. The daily mean maximum and minimum temperature of the area is 25°C and 13°C, respectively. The main soil type in the area is Nitisols.

The experiment was conducted on the research farm of the center for two years in 2003 and 2004 and recommended to grow taro by 50 cm × 50 cm but the given recommendation was reported by taro growers as inconvenient for weeding, earth up and caused mechanical damage during harvest. So it had to conduct the experiment again on farmers' fields in 2007 for one year. In both locations planting was done manually on flat beds on early march, and harvested on January of the following year. On research farm corms from the variety '*Boloso-1*' was planted using the within rows spacing of 40 cm, 50 cm, 60 cm and between rows of 50 cm, 75 cm, and 100 cm. The plot size was 4 m × 4 m. The design was randomized complete block in complete factorial arrangement with three replications. On the other hand, on farmers' field, the same variety was planted using the within rows spacing of 50 cm, 60 cm, 70 cm and between rows of 50 cm, 75 cm, and 100 cm. The design was randomized complete block in complete factorial arrangement replicated on five farmers' field. The plot size was 5 m wide and 7 m long (35 m^2). Additional water supply or other production inputs were not used in all experiments. All other agronomic and crop protection management activities were carried out equally for all treatments with recommended schedule of field activities for the crop. Data were collected on below ground plant growth parameters, namely; corm length, corm diameter, number of corms/plant, tuber weight $plant^{-1}$ and total tuber yield. Stand percent at harvest and average corm weight were also calculated.

Corm length was recorded the distance from the tip of the corm to a point where the outer leaf petiole attached to the corm. The corm diameter was taken as the diameter of the cross section of the corm at the point where the outer leaf petiole attached to the corm. Stand percent at harvest was calculated by comparing stand number at establishment and at maturity. Average corm weight was calculated by dividing tuber weight $plant^{-1}$ by the number of corms $plant^{-1}$. Tuber yield were taken on plot basis in the case of research center and from 7 m × 3 m subplot area on farmers' field experiment. Data from tuber weight $plant^{-1}$, number of corms $plant^{-1}$, number of cormels $plant^{-1}$, diameter and length of corms were recorded from five randomly selected plants in each plot at harvest in both locations. The collected data were subjected to analysis of variance using Generalized Linear Model (GLM) procedures and the means were separated using Least Significance Difference (LSD) at 5% probability level, using SAS version 9.1 statistical software.

Results and Discussion

Corm length and corm diameter

Neither variation between rows or within rows spacing affected significantly corm length and diameter (Table 1).

Treatment (spacing, cm)	No. of corms $plant^{-1}$	Corm diameter(cm)	Corm length (cm)	Tuber yield (kg/ha)
Between rows				
50	2.6	6.4	10.7	31.3
75	2.3	6.2	10.0	20.1
100	2.2	6.2	11.2	24.5
LSD (5%)	NS	NS	0.9	6.2
Within rows				
40	2.4	6.3	10.8	28.4
50	2.6	6.3	10.7	26
60	2.1	6.1	10.5	21.4
LSD (5%)	NS	NS	NS	NS
CV (%)	46.9	7.7	8.4	24.7

Table 1: Tuber yield and yield components of taro as affected by between rows and within rows spacing.

However corm diameter and length tended to increases with increase between rows spacing. The same result was reported at Jimma. Corm length was found significantly and positively correlated to Stand percent at harvest (r=0.380, P=0.010) and tuber weight $plant^{-1}$(r=0.286, P=0.057). Corm diameter was found significantly and positively correlated to tuber weight $plant^{-1}$(r=0.470, P=0.001), average corm weight(r=0.389, P=001), Number of corms $plant^{-1}$(r=0.317, P=0.034) and tuber yield(r=0.406, P=006).

Number of corms $plant^{-1}$

Tuber number $plant^{-1}$ was not affected significantly by different between rows and within rows spacings on the research farm. However on farmers' fields, the number was significantly increased, as the row width was increased [6]. This was in agreement with the result obtained. Number of corms plant^{-1} was found significantly and positively correlated to corm diameter(r=0.317, P=0.034) and tuber weight plant^{-1} (r=0.382, P=0.010).

Tuber weight plant^{-1}

Tuber weight plant^{-1} increased significantly (p<5%) when taro was grown at wider row spacings of 75 cm and 100 cm. 50 cm row spacing gave significantly the lowest weight plant^{-1}. The highest tuber yield plant^{-1} of 2.5 kg plant^{-1} was recorded from 100 cm between rows spacing. The tuber weight plant^{-1} decreased as plant population increased. Tuber weight plant^{-1} was found significantly and positively correlated to tuber yield per plot(r=0.476, P=001) and average corm weight(r=0.868, P=001).

Stand percent at harvest

Plant Stand percent at harvest was significantly affected by between rows spacing. Plant Stand percent increased with increased between rows and within row spacing's. Significantly lower stand percent at harvest (93.7%) was obtained from 50 cm between rows spacing (Table 2).

Treatment (spacing, cm)	No. of corms plant^{-1}	Corm length (cm)	Corm diameter (cm)	Tuber yield (kg/ha)
Between rows				
50	2.9	11	23.1	29.4a
75	2.6	11.8	24.4	22.7b
100	2.4	11.9	25.5	20.9b
LSD (5%)	NS	NS	NS	4.4
Within rows				
40	2.6	11.6	24.4	26.8a
50	2.7	11.3	24.3	25.2a
60	2.7	11.7	24.3	21.0b
LSD (5%)	NS	NS	NS	4.4
CV (%)	32.8	12	15.7	18.1
Abbreviations: LSD=Least significant differences at 0.05; CV=Coefficient of Variations in percent; NS=Non Significant				

Table 2: Tuber yield and yield components of taro as affected by between rows and within rows spacing.

This may be due to dense population which will cause high between rows competition, which makes the plants weaker and also may be due to the damage occurred during cultivation. Stand percent at harvest was found significantly and positively correlated to corm length (r=0.380, P=010) and tuber weight plant^{-1} (r=0.333, P=0.026).

Tuber yield

Statistically analyzed mean tuber yield data of taro grown on research station farm indicated that, both between rows and within rows spacing showed highly significant effect on taro tuber yield (Table 3).

Treatment (spacing, cm)	No. of corms plant-1	Corm length (cm)	Corm diameter(cm)	Tuber yield (kg/ha)
Between rows				
50	2.7	10.9	14.7	30.3a
75	2.4	10.9	15.3	21.4b
100	2.3	11.5	15.8	22.7b
LSD (5%)	NS	NS	NS	3.7
Within rows				
40	2.5	11.2	15.3	27.6a
50	2.6	11	15.3	25.6a
60	2.4	11.1	15.2	21.2b
LSD (5%)	NS	NS	NS	3.7
CV (%)	39.5	10.5	11.6	21.8
Abbreviations: LSD=Least significant differences at 0.05; CV=Coefficient of Variations in percent; NS=Non Significant				

Table 3: Tuber yield and yield components of taro as affected by rows and between rows and within rows Spacing.

However, the interaction between rows spacing and within rows spacing was not significant. The highest yield of 30.3 t h^{-1} was obtained from the narrowest between rows spacing of 50 cm. similarly, maximum yield was also obtained from the least within rows spacing of 40 cm. Nevertheless, 50 cm between rows and 50 cm within rows spacing was the best combination that gave the highest yield [7]. On farmers' field, taro yields were significantly affected by between rows spacing and within row spacings (P<0.01). The highest tuber yield was recorded when the crop was planted between rows spacing of 50 cm, followed by 75 cm. significantly lower tuber yield was obtained from the plants spaced at 100 cm (Table 4).

Treatment (spacing, cm)	No. of corms plant^{-1}	Corm length (cm)	Tuber weight plant^{-1} (kg)	Average corm weight (g)	Corm diameter (cm)	Plant population at harvest (%)	Tuber yield (kg/ha)
Between rows							
50	5.9b	13	1.8b	207	8.1	93.7b	43.4a
75	7.1a	14	2.2a	205	8.2	97.5a	37.8a
100	7.1a	14	2.5a	226	8.2	97.7a	32.9b
LSD (5%)	1	NS	0.4	NS	NS	1.8	5.7
Within rows							
50	6.9	14	2.2	211	8.1	95	42.8a
60	6.7	14	2.2	213	8.1	96	36.9b
70	6.6	13	2.1	214	8.3	98	34.5b
LSD (5%)	NS	NS	NS	NS	NS	NS	5.7
CV (%)	8.5	9.5	25.4	18.5	8.1	1.3	5.4
Abbreviations: LSD=Least Significant Differences at 0.05; CV=Coefficient of Variations in percent; NS=Non Significant							

Table 4: Tuber yield and yield components of taro as affected by between row and within rows spacing.

Though, 50 cm between rows spacing gave significantly higher tuber yield, it significantly decreased stand percent at harvest and corm weight plant^{-1}. Taro growers also reported that growing taro using 50 cm row spacing was not convenient for weeding, earth up and also causes mechanical damage during harvest. The result also indicated that between rows spacing wider than 75 cm decreased tuber yield of taro significantly [8-12]. Generally, the result of the experiments indicated that growing taro with spacing of 75 cm between rows and 50 cm within rows produce higher yield by using optimum amount of planting material and by easily managing the field throughout the growing period (Table 5).

	Corm diameter	Corm length	Tuber weight plant-1	Average corm weight	Number of corms plant-1	Stand percent
Corm length	0	-	-	-	-	-
P-Value	0.8	-	-	-	-	-
Tuber weight plant-1	0.5	0.3	-	-	-	-
P-value	0	0.1	-	-	-	-
Average corm weight	0.4	0.2	0.87	-	-	-
P-value	0	0.1	0	-	-	-
Number of corms plant-1	0.3	-0	0.38	-0.1	-	-
P-value	0	0.6	0.01	0.43	-	-
Stand percent	-0	0.4	0.33	0.24	0.22	-
P-value	0	0	0.03	0.12	0.14	-
Tuber yield	0.4	0.1	0.48	0.46	0.08	-0
P-value	0	0.7	0	0	0.6	0.9

Table 5: Pearson correlation among stand percent, corm diameter, corm length, tuber weight plant^{-1} and tuber yield ha^{-1}.

Using high plant population may not be recommended because of the enormous amount of planting material that would be needed, whereas availability of planting material is an ever present problem in Taro production.

Besides, there is reduced net return per unit of planting material at high plant populations [13]. Correlations between yield and yield components showed a significant and positive relation between tuber yield and corm diameter (r=0.406, P=0.006), tuber weight plant^{-1} (r=0.476, P=0.001) and average corm weight(r=0. 0.463, P=0.001).

Conclusion

The results indicated that by growing taro with spacing of 75 cm between rows, and 50 cm within rows in southern region of Ethiopia give maximum yield of taro by easily managing the field throughout the growing period and using optimum amount of planting material.

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References

1. Ajijola S (2003) Efficiency of resource use among cocoyam farmers in Owo Local Government area of Ondo State, Nigeria. Moor J Agric Res 4: 281-287.
2. Amany A. Abd- Ellatif, Abo-El-Ezz, E Shehata, Sabry M Youssef (2010) Effect of planting date and intra-row spacing on growth, yield and quality of taro. J agric biol sci 6: 806-814.
3. Eze CC, Okorji EC (2003) Cocoyam production by women farmers under improved and local technologies in Imo State, Nigeria. African J Sci 5: 113-116.
4. Fajardo J (2010) Quality declared planting material protocols and standards for vegetative propagated crops. 41-48.
5. Jirarat T, Sukruedee A, Pasawadee P (2006) Chemical and Physical Properties of flour extracted from Taro (*Colcasia esculenta* (L)) Schott grown in different regions of Thailand. Sci Asia 32: 279-284.
6. Mulugeta Tsedalu, Bizuayehu Tesfaye, Yasin Goa (2014) Effect of type of planting material and population density on corm yield and yield components of taro (*Colcasia esculenta* L). J Biol Agric Healthcare 4: 3208-2014.
7. Ogbonna PE, Orgil KO, Nweze NJ, Opata PL (2015) Effect of planting space on plant population at harvest and tuber yield in taro (*Colcasia esculenta*). Afr J Agric Res 10: 308-316.
8. Onwueme IC, Charles WB (1994) Tropical root and tuber crops: Production, perspectives and future prospects. Food Agric Org 126: 144-146.
9. Quach ML, Melton LD, Harris PJ, Burdon JN, Smith BG, et al. (2003) Cell wall compositions of raw and cooked corms of taro (*Colcasia esculenta*). J Sci Food Agric 81: 311-318.
10. Singh D, J Guaf T, Okpul G Wiles, D Hunter (2006) Taro (*Colcasia esculenta*) variety release recommendations for Papua New Guinea based on multi-location trials. J Crop Hortic Sci 34: 163-171.
11. Singh D, Jackson D, Hunter D, Fullerton R, Lebot V, et al. (2012) Taro leaf blight: A threat to food security. J Open Agric 2: 182-203.
12. Tari AT, Singhal RS (2002) Starch based spherical aggregates: Stability of a model flavoring compound, vanillin entrapped therein. Carbohydr Polym 50: 417-421.
13. Vishnu SN, Muthukrishnan S, Vinaiyaka MH, Muthulekshmi LJ, Raj SM, et al. (2012) Genetic diversity of Phytophthora Colocasia isolates in India based on AFLP analysis. Biotech