



# The Effect of P Fertilizer Rates on The Yield and Yield Components of Taro (*Colocasia Esculenta* (L.) Schott.) in Boloso-Sore Woreda Wolaita Zone, SNNPR, Ethiopia

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**Abstract** – Research was conducted at Boloso-Sore Woreda (Sore Homba Kebele), Wolaita Zone ,for two years, during the 2013/2014 and 2014/2015 cropping season to evaluate the influences of different rates of P fertilizer on yield components and yield of introduced Taro or Boloso-1 (*Colocasia esculenta* (L.) Schott.). The experiment was laid out in randomized complete block design (RCBD) with three replications. The treatments consisted of four levels of P (0, 10, 20 and 30 kg/ha). A total of 4 fertilizer rates (treatments) were used in a factorial arrangement. Duncan's multiple range tests were employed to compare means at 5% probability levels. Parameters number of suckers per plant, plant height, number of leaves per plant, tuber size (length and diameter in centimeters), and weight of tubers per plant were considered. The analysis revealed that leaf number and tuber weight for year one and only tuber weight for year two showed non-significant difference at different levels of P fertilizer. The study showed that there was no significant differences on yield/tuber weight of taro at various level of P fertilizer in both year experiments at the same location. As result, it needs further studies at different location and years after conducting soil analysis in order to recommend the affordable and profitable P levels.

**Keywords** – Taro (*Colocasia Esculenta* (L.) Schott.), DAP, Boloso-1 (Taro), Yield, Yield Components.

## I. INTRODUCTION

Taro is a common name for the corms and tubers of several plants in the Araceae family. Of these, *Colocasia esculenta* is the most widely cultivated crop (FAO, 1990). Taro (*Colocasia esculenta* (L.) Schott) is an ancient and important vegetatively propagated root crop species belonging to the monocotyledonous family Araceae. It is the fourteenth most consumed vegetable worldwide (Lebot and Aradhya 1991) and is grown primarily in humid tropical regions of the world.

Taro originated in South Central Asia, probably in India or the Malay Peninsula. Wild forms occur in various parts of South Eastern Asia. From its centre of origin, it spread eastward to the rest of South East Asia, and to China, Japan and the Pacific Islands. From Asia, taro spread westward to Arabia and the Mediterranean region. By 100 B.C., it was being grown in China and in Egypt. It arrived on the east coast of Africa over 2,000 years ago; it was taken by voyagers, first across the continent to West

Africa, and later on slave ships to the Caribbean. Today, taro is pan-tropical in its distribution and cultivation. The greatest intensity of its cultivation, and its highest percentage contribution to the diet, occurs in the Pacific Islands. However, the largest area of cultivation is in West Africa, which therefore accounts for the greatest quantity of production. Significant quantities of taro are also grown in the Caribbean, and virtually all humid or sub-humid parts of Asia (FAO, 1999).

Taro is cultivated for its edible corms and a staple food throughout the subtropical and tropical regions of the world. And can be consumed as both a staple food and vegetable, and processed as a food ingredient, animal feed, etc (FAO, 1999). Taro has much importance in ensuring food security, in earning foreign currency as being a cash crop and also as a means for rural development. Moreover, it has been reported to have a wide range of uses in religious festivals, as mild laxative, in treatment of wounds and snake bites, reducing body temperature in a feverish patient and others (FAO, 1999). Nutritionally, Taro contains more than twice the carbohydrate content of potatoes

Taro is a good source of magnesium. It is a low fat food incorporating vitamin C, iron and potassium. The starch grains of taro are small, thus it improves digestibility which is an important factor when selecting a starchy food that will not be bulky on the digestive system. Thus taro can be used as a combination in the manufacture of infant meals, recovering patients with such problems that require carbohydrate as a source of energy which will not stress their metabolic process. Taro starch is also good for peptic ulcer patients, patients with pancreatic disease, chronic liver problems and inflammatory bowel disease and gall bladder disease (Emmanuel-Ikpeme, *et al.*, 2007).

Plants utilize N and P nutrients in large amounts and the deficiency of these elements has a detrimental effect on growth and development (Tisdale *et al.*, 1995). Moreover, high mobility of N and increased possibilities of P for chemical reactions and fixation in soils, place them in the priority list of soil fertility management components. It has been reported that most tropical soils are deficient in N and P (Chien and Menon, 1995). Taro is a heavy feeder. Nutrient management is always an important consideration for Taro because it requires large quantities of nutrients.

Crop research in Ethiopia has largely concentrated on

the more important cereal, oil and industrial crops. The rather localized importance of indigenous vegetables seems to be part of the reason for the lack of national research focus. Most of the traditional vegetable and root crops of Ethiopia are produced by small farmers following traditional practices. There is no direct attention paid to package production and non-cultivated species. They are not fully documented and no programmes are currently aimed at their development and production.

It is necessary to determine the correct rate and time of application of the chemical fertilizers for the optimum yield/quality as well as to analyze the economic aspect of fertilizer application (Endrias Geta, 2011). Addressing these constraints perfectly fit into the Agriculture sector policy direction of GTP which focuses on enabling small holding farmers to access and use appropriate improved modern technology, thereby enhancing production and productivity of the sector in Agricultural development.

It is now becoming increasingly clear that the major constraints to increased production of the crop that has not been clearly addressed is the fertilizer application of system of the crop and the yielding potentials of taro is not well studied and documented. Therefore, it seems important to identify the fertilizer rate for the production systems (potentials and constraints) of taro for yield, so that it will improve the farmers' production system and increase productivity and well-being in a way that can be sustained. Thus, the objective of research project is to fill these gaps.

## II. OBJECTIVES

- To determine the optimum P fertilizer rate for growth and productivity of taro;
- To determine the effect of P fertilizer rates on growth and productivity of taro;
- To provide the basis for a sound fertilizer recommendation for current and potential taro growers.

## III. LITERATURE REVIEW

### 3.1. Origin and Distribution

Taro originated in South Central Asia, probably in India or the Malay Peninsula. Wild forms occur in various parts of South Eastern Asia. From its centre of origin, it spread eastward to the rest of South East Asia, and to China, Japan and the Pacific Islands. From Asia, taro spread westward to Arabia and the Mediterranean region. By 100 B.C., it was being grown in China and

in Egypt. It arrived on the east coast of Africa over 2,000 years ago; it was taken by voyagers, first across the continent to West Africa, and later on slave ships to the Caribbean. Today, taro is pan-tropical in its distribution and cultivation. The greatest intensity of its cultivation, and its highest percentage contribution to the diet, occurs in the Pacific Islands. However, the largest area of cultivation is in West Africa, which therefore accounts for the greatest quantity of production. Significant quantities of taro are also grown in the Caribbean, and virtually all

humid or sub-humid parts of Asia (FAO, 1999).

Root and tuber crops are found in a wide variety of production systems and do well under various levels of management from low to high input systems. This is a distinctive feature, which makes them important for improving the productivity and richness of agro-systems. Even though their agronomic properties have been well documented, their food and industrial quality characteristics have not been studied extensively. The full potential of these staples is being realized in developing countries and they would continue to contribute to energy and nutrient requirements for the increasing population.

### 3.2. Botanical Description

It is a family of Aracea cultivated for its edible corms. Taro is referred to botanically as *Colocasia esculenta* (L) Schott. It is vegetatively propagated, perennial tropical crop with a large peltate ("shield-shaped") or heart-shaped leaves, in contrast to *Xanthosoma* whose leaves are hastate ("spear shaped") or arrow shaped. *Colocasia* and *Xanthosoma* are together called cocoyams in many parts of the world, especially in Africa, old cocoyam for *Colocasia* and new cocoyam for *Xanthosoma*. In the Pacific regions, both genera are known as "taro". However both genera appear to be cultivated in Ethiopia where they are known without differentiating between them as "Godere" (Amharic) and "Boina" (Wolaitigna) (Simon, 1992).

Farmers give many reasons why they cultivate taro. Taro is cultivated because of produce reasonable amounts of yield when other crops hardly grow, resistant to disease and pests, ease of ecological adaptation and utilization of different purposes. In South and Southwestern Ethiopia, for instance, farmers cultivated different taro cultivars were distinguished one from the other on the bases of morphological and phonologic characters. However, the existence of different vernacular names for the same cultivar of the species, or vice versa has created problems to classify accessions while avoiding duplicates. Genetic diversity refers to the variation of genes within species. Diversity of Taro here defined as the presence of different accessions found in south and Southwest Ethiopia.

### 3.3. Characteristics of Taro

Taro is a large perennial herbaceous plant growing up to 5-6 feet. Its rather large heart-shaped leaves with frilly edges at the end of long stout petioles appear like elephant's ear. It grows best in marshy, wet soil and warm humid climates. The corm grows to the size of turnip, has a globular or oblong shape with brown fibrous skin. The surface is marked with circular rings indicating the points of attachment of scaly leaves. Inside its flesh has been white to cream yellow color, but may have different colors depending on cultivar types. An average-size corm weighs about 2-4 pounds. Its delicious flesh feature crispy in texture, and water chestnut like nutty flavor.

### 3.4. Ecology

Taro can be grown under two distinctly different cultural management systems: upland (dryland) taro planted in non-flooded, rain-fed areas, and lowland (wetland) taro grown in waterlogged or flooded fields. Much of the taro grown in Hawaii is wetland taro, but upland taro production is rapidly increasing. "Upland taro"



includes all varieties or cultivars of *Colocasia esculenta*, commonly called taro, and *Colocasia esculenta* var. *globulifera*, locally called dasheen or araimo, that are planted under non-flooded conditions.

Upland taro can be grown throughout the year in Hawaii. It is best adapted to a warm, moist environment. Evenly distributed rainfall is ideal. Supplemental irrigation is necessary in dry, low-rainfall areas. Upland taro can be grown on a wide range of soil types, but best results are obtained on deep, well drained, friable loams with pH 5.5-6.5. Rocky or stony soils should be avoided to prevent deformed corms and difficult harvesting.

### 3.5. Cultivation and development

The bulk of world production of taro is in Africa, followed by Asia and then Oceania. The major producers in Asia are China, Japan, Philippines and Thailand; while in Oceania, production is dominated by Papua New Guinea, Samoa, Solomon Islands, Tonga and Fiji (FAO, 1999). In Africa, Zaire (Congo) and Cameroon are the dominant producers. In Ethiopia, root crops are grown widely in the south region. Among these crops, taro is one of the important food sources as well as income source to the farmer. It has a great potential to supply high quality food and one of the cheapest source of energy (Patrick *et al.*, 1999).

#### 3.5.1. Soil Preparation

Soil preparation for upland taro is similar to that for most upland crops, such as corn. Existing vegetation is turned under with a moldboard or disc plow, or by spading. Incorporate phosphate fertilizer, if required, during cultivation; also, most soils benefit from adding compost. After a few days to allow for decomposition, break soil clods by harrowing or motivating or, in small gardens, with a hoe or rake. After the soil has been pulverized, the surface may be smoothed in preparation for planting. Upland taro can be planted on ridges, in furrows, or on flat ground. Prepare rows, and use a guide string to plant 18-24 inches apart within rows 18-24 inches apart.

#### 3.5.2. Varieties

Several varieties of taro can be used for upland planting. The most common and easily accessible varieties in Hawaii are 'Lehua Maoli' and 'Bun Long'. 'Lehua Maoli' is an excellent "poi" taro, while 'Bun Long' is an excellent table taro that is also grown for making taro chips. Dasheen varieties are 'Tsurunoko', 'Miyako', and 'Akado'. A few unnamed dasheen varieties are also grown in Hawaii (<http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top>)

#### 3.5.3. Propagation

Planting materials called "huli" (sets) are prepared from suckers or main plants. These consist of the upper 1/8-1/4-inch section of the corms or cormels and the first 10-12 inches of the petioles. Dasheen also can be planted using hulis, but the small, unmarketable cormels are more commonly used. These are planted after the dormancy period, when shoots (sprouts) come out of the growing tips. Huli and cormels can be planted by hand, using hand towels or "pineapple planters," to a depth of at least 6 inches in the ground

(<http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top>)

Approximately 12,000 hulis would be required for an acre

and this is considered a reasonable proportion. The wider spacing treatments yielded very high averages of percent no.1 corms, while the closer spacing treatments yielded very low averages of percent no.1 corms. Taro is commonly known to be a poor competitor in culture and a low amount of sunlight interception per plant observed in the early growth stage of taro is suspected as a limiting factor for attaining the best level of percent no.1 corms. We suggest that farmers consider planting with a wider spacing during the winter months and a narrower spacing during the summer months to optimize quality and production

(<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/RES-114-14.pdf>).

### 3.6. Importance

#### 3.6.1. Economic Importance of taro

Root and tuber crops are used as staple food in most countries in the world but their contribution to the energy supply of the population varies within a large range depending on the country (0 to 56% with a world mean of 5). Many species and varieties are consumed but three species (namely; cassava, Irish potato and sweet potato) provide 93% of the root and tuber (R&T) crops used for direct human consumption in the world. Some species are restricted in limited areas but the greatest; numbers of them are widespread by the mere fact that they have been diffused by men outside their origin area during the two last millenaries. The dispersion was mainly performed during the last five centuries by the Portuguese as they travel in search of slaves, by both the Portuguese and Spanish during their missionary journeys and by Arab traders (FAO, 1990).

Root crops are cheap, readily available and essential energy source for many poor people who face problem of food availability. Although they contain little protein, or fat some particularly sweet potato and yam, are source of vital vitamins (A and C) (UNIFEM, 2002). The main advantages of root crops as a staple food compared with cereals are that they are cheaper source of energy, can be cultivated easily and provide more dietary energy per hectare at a lower cost (principally because of reduced labor inputs). They generally require a comparatively low level of husbandry (UNIFEM, 2002).

Many of the developing world's poorest producers and most undernourished households depend on root and tuber as a contributing, if not principal, source of food and nutrition. In part, these farm households value root and tuber because root and tuber produce large quantities of dietary energy and have stable yields under conditions in which other crops may fail root and tubers produce remarkable quantities of energy per day, even in comparison to cereals. Potatoes lead the way in energy production, followed by yam. In addition, some root and tuber are an important source of vitamins, minerals, and essential amino acids such as lysine (Scott, *et al.*, 2000).

The relative importance of individual root crops varies both by region and country. For example yams are a major food crop in West Africa, the Caribbean, the south Pacific Islands, South-East Asia, India and some parts of Brazil. Cassava is particularly important in South America, west



East, Central and South Africa and Oceania. Taro plays an important cultural role in the diet of the people of the Pacific Islands, West Africa, Oceania and the West Indies (UNIFEM, 2002).

Taro (*Colocasia esculenta*) is an important food crop in tropical areas of Africa, Asia and Latin America. It is particularly important for food security since many tropical areas often experience unfavorable environmental conditions. In Ethiopia, Taro has been cultivated mainly and extensively in dense populated and high rainfall areas of South, Southwest and Western parts of the country. Its use as a potential crop in Ethiopians has been appreciated since 1984 famine. In some areas, it used as fill seasonal food gaps when other crops are not in the field.

Taro contains about 7% protein on a dry weight basis. This is more than yam, cassava or sweet potato. The protein fraction is low in histidine, lysine, isoleucine, tryptophan, and methionine, but otherwise rich in all the other essential amino acids (FAO, 1999).

Taro is a staple food throughout the subtropical and tropical regions of the world. And can be consumed as both a staple food and vegetable, and processed as a food ingredient, animal feed, etc (FAO, 1999). Taro has much importance in ensuring food security, in earning foreign currency as being a cash crop and also as a means for rural development. Moreover, it has been reported to have a wide range of uses in religious festivals, as mild laxative, in treatment of wounds and snake bites, reducing body temperature in a feverish patient and others (FAO, 1999). Nutritionally, Taro contains more than twice the carbohydrate content of potatoes and yield 135 kcals per 100 g. Taro contains about 7% protein on a dry weight basis.

This is more than yam, cassava or sweet potato (FAO, 1999). Patrick *et al.*, (1999) also stated that the protein content of taro is higher than the other root crops, 3.3 g and 2.2 g in leaves and tuber respectively. The protein fraction is low in histidine, lysine, isoleucine, tryptophan, and methionine, but otherwise rich in all the other essential amino acids. The protein content of the corm is higher towards the corm's periphery than towards its centre. This implies that care should be taken when peeling the corm; otherwise a disproportionate amount of the protein is lost in the peel (FAO, 1999).

Taro is a good source of magnesium. It is a low fat food incorporating vitamin C, iron and potassium. The starch grains of taro are small, thus it improves digestibility which is an important factor when selecting a starchy food that will not be bulky on the digestive system. Thus taro can be used as a combination in the manufacture of infant meals, recovering patients with such problems that require carbohydrate as a source of energy which will not stress their metabolic process. Taro starch is also good for peptic ulcer patients, patients with pancreatic disease, 2 chronic liver problems and inflammatory bowel disease and gall bladder disease (Emmanuel-Ikpeme, *et al.*, 2007).

### 3.6.2. The Health Benefits of Taro

Taro root is often used in a similar fashion to a potato, but in fact has better nutritional qualities than a potato. It has almost three times the dietary fiber, which is important

for proper digestive health and regularity. Fiber can also fill you up and make you feel less hungry with fewer calories. Taro root has a low Glycemic Index, as opposed to potato which has a high Glycemic Index. A low GI means that taro effects blood sugar levels slowly, without the peaks and crashes of a high GI, which lead to increased hunger later on. Eating a diet of low GI foods can also help prevent diabetes.

Taro is nutritious, and is an excellent source of potassium, which is an essential mineral for many bodily functions. Taro also contains some calcium, vitamin C, vitamin E and B vitamins, as well as magnesium, manganese and copper. Taro leaves contain good amounts of vitamins A and C, fiber and a relatively high amount of protein. Eating taro can lead to kidney stones and gout as well as other health complications if it is not prepared properly by boiling for the recommended amount of time. It can also be steeped in water overnight before cooking to further reduce the amount of oxalates. To absolutely minimize risk, milk or other calcium rich foods should be eaten with taro in order to block oxalate absorption. However, taro is a staple food for many people around the world and should not be considered a high risk food after it is cooked.

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Further, the corms provide healthy amounts of some important minerals like zinc, magnesium, **copper**, iron, and manganese. In addition, the root has very good amounts of potassium. Potassium is an important component of cell and body fluids that help ([http://one-vibration.com/profiles/blogs/taro-root-a-super-food-for-the-world#.Ui7IEH\\_7IU](http://one-vibration.com/profiles/blogs/taro-root-a-super-food-for-the-world#.Ui7IEH_7IU)).

**Nutritious Food** - Taro Root contains lots of vitamins A, C, B, and E vitamins as well as lots of trace minerals such as copper, magnesium, calcium, iron, selenium, manganese, zinc, potassium, and beta-carotene and cryptoxanthin which are great antioxidants helping to protect you from disease and slow the aging process... and a good amount of protein too! In fact Taro Root is more nutritious than potatoes and it's a gluten free. Taro root is a cholesterol free and low in sodium too, contains B vitamins important for boosting up your immune system... and it's a good low fat food.

**High in Vitamin A** - Taro leaves can be cooked and eaten too, and they contain more than 160% of your daily requirement of Vitamin A. And the leaves and the roots



contain polyphenols that are powerful antioxidants that protect from heart disease, strokes, and cancer.

**High in Vitamin E and Magnesium** - Taro Root is very high in Vitamin E thus helping to protect you from cancer and heart disease. And Taro Root has a good amount of potassium helping to lower blood pressure and help with fluid regulation. Plus Taro Root is a good source of magnesium that's important for muscle, bone, and nerve health... and works to lower blood pressure and blood sugar too.

**Amino Acids and Omega 3 oils** - Taro Root contains over 17 different amino acids that are important for maintaining good health, and it also contains life giving Omega 3 and 6 oils which are important for cardiovascular health, cancer prevention, and for preventing disease in general.

**Reduces Fatigue** - Taro Root because of its low glycemic index is a great food for athletes... with long lasting energy without spikes in glucose.

**Other Benefits** - Taro Root also helps with irritability, lowers blood pressure, prevents cell damage, helps to protect from colds and flues, helps with skin rashes, nausea, and also helps to regulate cholesterol, builds strong bones, and supports thyroid function.

**Great Flavor and Beautiful Plants-** Taro Roots and leaves must be cooked, and the roots have a nutty flavor that's wonderful, and the leaves can also be cooked... and some say they tastes like cabbage. The large leaves are called elephant ears and make wonderful ornamental plants... they are very beautiful. Taro Roots can be used in all kinds of dishes from curries, to eating them boiled and mashed just like potatoes, and in just about any recipe that you use potatoes. Taro can also be roasted, boiled, steamed, fried for chips, made into cakes, purred, and just about any other way you want to use them... and you can find Taro Chips at your local super market. You can buy Taro Roots at your local super market, at Asian markets, Latin American markets, and other ethnic stores. ([http://www.spc.int/lrd/index.php?option=com\\_content&view=article&id=613&Itemid=370](http://www.spc.int/lrd/index.php?option=com_content&view=article&id=613&Itemid=370)).

### 3.7. Fertilizer

Taro requires good soil fertility. At two, four, and six months after planting, apply 1 lb per 100 square ft area of 16-16-16 or similar fertilizer as side dressing. Alternatively, side-dress with 1 1/4 lb per 100 square ft three and six months after planting. These levels of fertilizer are based on results obtained on relatively poor (infertile) soils.

The recommendations given here are intended to assist commercial taro growers to improve fertilizer programs for wet (flooded) taro and help increase yields, avoid excessive fertilizer applications and costs, limit disease severity resulting from over fertilizing with nitrogen, and reduce environmental pollution. These are "interim" recommendations because they are subject to refinement as more information becomes available. This information is intended to be used in conjunction with the best-management practices given in *Taro, Mauka to Makai; A Taro Production and Business Guide for Hawai'i Growers*, available from CTAHR. Updates to this

information will be announced and made available on the Internet website

<[www.ctahr.hawaii.edu/taronexus/taronexus.htm](http://www.ctahr.hawaii.edu/taronexus/taronexus.htm)>.

Computers to access the Internet are available at many public library branches. To use these recommendations, a laboratory analysis for soil pH and soil levels of the nutrients P, K, Ca, and Mg must be done on soil samples from the *lo'i* early enough so that the results can be available and fertilizers can be mixed into the soil before planting. Send the samples for analysis to a commercial laboratory or the CTAHR Agricultural Diagnostic Service Center.

P analysis must be done with the modified Truog method. Fertilizer recommendations given here are not appropriate for soil data obtained with other extraction methods. After planting, leaf tissues must be periodically sampled and analyzed to monitor the crop's nutrient status. Based on these analyses, apply supplemental fertilizer if needed. Fertilizer recommendations are given as simple fertilizers rather than as complete fertilizers (blends). Use of simple fertilizers allows flexibility in providing the nutrients needed without over applying other nutrients.

Fertilizer levels are given in pounds or tons per acre. Pre-plant fertilizer applications based on soil analysis compare your soil analysis results to the ranges given in left column of the following sections, and read across to the fertilizer recommendation. These fertilizers should be applied and tilled into the soil before planting. Recommendations for fertilizer rates for 'Bun Long' taro vary widely depending on location and management. Local taro growers are producing good crops with the recommended fertilizer inputs but these rates are speculative and possibly excessive to requirements for optimum marketable yield. This recommendation is tested along with experimental rates to more accurately quantify the nutrient requirement for taro in the Top End dry season environment.

### Conclusion

This trial showed that the 'farmer's rate' is excessive and that a 40% reduction in fertilizer inputs would result in only a 3-4% reduction in marketable yield. Although the limitations of this trial required that the fertilizer be applied in a solid form, the injection of fertilizers through irrigation would be the method used by growers. The trial will be repeated in 2005 with a demonstration planting using injected fertilizer on the same grower's property. This will lead to a sound fertilizer recommendation for taro growers in the Top End.

### 3.8. Pest and weed Control

#### 3.8.1. Weed control

Taro is very susceptible to weed competition, especially during the first 3- 4 months after planting, when the leaf canopy is being formed. During this time, control weeds by hand pulling or cultivating with a hoe or other implement.

After the crop has attained the maximum vegetative stage, the lush foliage will shade out weed growth, and cultivation for weed control should be minimized to avoid injuring the roots and the developing corms.

### 3.8.2. Pest and Disease Control

Several insects attack upland taro in Hawaii. The most common and important are the leafhoppers (*Tarophagus proserpina*) and aphids (*Aphis* spp.). These insects usually do not cause serious damage unless they are present in large numbers. They damage the taro plants by sucking sap from the petioles and leaf blades. Leafhopper damage can be distinguished by the presence of numerous brown to black spots on the petioles, caused by stains from sap that has oozed from puncture holes on the petioles. Aphids are easily observed on the young leaves. The taro root aphid, however, is not easily observed because it may be confined to the below-ground parts of the plant. Most taro insect pests can be controlled by spraying with insecticides\*, but the taro root aphid is difficult to control in this way.

Among the diseases that affect upland taro in Hawaii, leaf blight caused by *Phytophthora colocasiae* is the most prevalent. Its incidence is influenced greatly by climatic conditions and is most serious during wet seasons. Its presence usually diminishes during the dry months of the year. To control leaf blight, apply fungicides\*. A wetting agent (surfactant, or "sticker") is recommended for better leaf coverage of the fungicide\*. Leaf blight can be recognized by the formation of purplish to brownish circular water-soaked spots on the surfaces of the leaves. A clear yellow liquid is exuded from the spot. Other diseases of upland taro are dry rot caused by *Sclerotium rolfsii* and phyllosticta leaf spot caused by *Phyllosticta colocasiophyla*. These can be serious in upland taro but seldom occur in well managed upland taro plantings (<http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top>)

### 3.8.3. Harvesting

Upland taro is ready for harvest 8-10 months after planting. As harvest time approaches, the leaves turn yellowish and the petioles are short, usually less than 2 ft long. The corms protrude from the ground. Dasheen is ready for harvest when all or most of the cormels have become dormant; that is, when the leaves have dried. Time of maturity varies with location, varieties used, soil fertility, and water availability (<http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top>).

For home use, taro may be harvested as required over a period of several weeks. Dasheen can be harvested and stored for a considerable length of time. However, the corms should be thoroughly cleaned, washed, and drained before storage. Storage under refrigerated conditions will prolong the life of the corms. Poi taro cannot be stored for any considerable length of time without seriously impairing its quality, whether for poi or table use. Leaves used for luau or lalau can be harvested at any time during the growth of the crop. Only the young leaves are harvested, and the taro is allowed to continue to grow (<http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top>).

## IV. MATERIALS AND METHODS

### 4.1. Description of the study area

The study was conducted at Boloso Sore, one of major taro producing Woreda of Wolaita Zone, Southern as

described below. It is located at 37°36'35"E longitude and 7°08'05"N latitude with the distance of 300km from Addis Ababa to South direction and 30km from Wolaita Sodo town to North- West direction. The altitude is about 1602 masl with an average annual rainfall of about 1375 mm. and the mean minimum and maximum temperature of the area is about 18°C (Simon, 1992).

### 4.2. Treatments, Design and Experimental materials

#### 4.2.1. Treatments and design of the experiment

Table 1: Treatment combinations used in the experiment  
Treatments: O (P1) 10 (P2) 20(P3) 30(P4)

The experiment consisted of four levels of P (0 Kg ha-1, 10 kg P ha-1, 20 kg P ha-1, 30 kg P ha-1) with 4 treatments and one best performing cultivars which was released from Areka Agricultural Research Center that is known by the name 'Boloso one' from the model farmer was used. Mother taro corms 7/8 cm long having with at most the same number of active buds and with similar diameters was used as planting materials.

The sources of P was DAP and TSP. The fixed P fertilizer was applied at final land preparation/planting time. All other crop management practices were done as per the recommended practices for taro in similar way. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in factorial arrangement. Planting was done on February 14 and 15 at 2014. and 2015. respectively, according to the local farmers' practice of the area and planting was done at Boloso Sore woreda. The gross plot size was 3 m x 6 m length and width. The net plot size was 2 m x 5 m with 4 rows/plot and 10 plants/row. The spacing was 50 cm between rows and plants. The spacing between two consecutive plots and between replications was 1 m. The inner 2 rows were used for data collection leaving 2 boarder plants from each row and leaving 2 outside rows. Weeding frequencies, harvesting and threshing will be according to the farmer's practices. Similar to farmers' condition, every practice was applied.

#### 4.3. Data collected

Data collected for field experiment, both pre-harvest and postharvest data's in all of the treatment plots was recorded from net harvestable rows on randomly selected eight plants from each plot for number of suckers per plant, plant height, number of leaves per plant, plant diameter, tuber size (length and diameter in centimeters), weight of tubers or yield per plant were recorded.

**Stand count:** Plant population per plot after 4 weeks of first planting was counted and recorded. In the same manner stand count of the crop just immediately before harvesting will be counted and recorded.

**Plant height:** Eight plants from harvestable plot of each treatment were randomly selected. On eight randomly selected plants, the height of the plant was recorded in cm from the ground level to the tip of the leaf at the time of final harvesting and the mean per plant was worked out.

**Number of leaves:** The total number of leaves was counted from eight randomly selected plants and leaves per plant were worked out.



**Number of suckers:** The total number of suckers was counted from eight randomly selected plants and suckers per plant were worked out.

**Plant diameter:** The plant diameter of eight selected plant was measured and worked out.

**Tuber length and tuber diameter:** For eight selected plants tuber length and tuber diameter was measured and worked out.

**Weight of tuber (kg):** The randomly selected eight plants were unplanted carefully at harvest and the portion of below the ground was separated. Then the fresh weight of below the ground part or yield of the crop was weighted and the mean weight per plant base was worked out.

**Total corm yield/ha:** The total yield per plot in kg in to yield per hectare in Kg by multiplying the yield per net plot with a multiplication factor in which case the total plant stand and yield per plot were recorded so as to confirm the date on an individual plant basis. Yield per hectare in Kg was calculated.

4.4. Statistical analysis

The mean values of each of the above parameters was computed and subjected to analysis of variance /ANOVA/ following the SAS statistical package (Version 9.0). The statistical significance was determined using F- test. LSD was employed to compare means at 5% probability levels.

4.5. Soil analysis

Regarding the soil analysis, it was followed the procedures proposed by Sahelmedehin and Taye (2000). Soil samples was randomly collected from the depth (0-30 cm) of the experimental sites and composited and analyzed before planting. Soils was collected using Havilin’s (1999) formula and analyzed for the total N and available P, soil texture, PH, CEC, and organic matter content using standard laboratory procedure in Wolaita Soddo Regional Soil Laboratory. N was analyzed according to Kjeldhal method and P according to Olson et

al., method; using procedures in laboratory manual prepared by Sahlemedhin and Taye (2000).

V. RESULTS AND DISCUSSION

5.1. Physico-chemical Properties of Soils of two Experimental Sites

The pH of the soil was slightly acidic i.e., 5.7 and 5.9 at year one and year two respectively which is acidic at first year and optimum at year second year. As to composite soil sample analysis, the total N content of the soil before planting was 0.14% and 0.12, the P content was 1.98ppm and 2.00ppm, Organic Carbon content was 1.87 and 1.72, and CEC was 16.4 and 15.4 at year one and year two respectively. At the planting time and after planting for one month there was no rain fall and more mulching was used to conserve soil moisture. But during the vegetative growing the intensity as well as the distribution of the rain fall was heavy.

5.2. Analysis of variance

5.2.1. Year one

The effect of P on the Taro yield was evaluated by considering the performance of the Boloso one taro parameters: leaf number (LN), plant height (PH), sucker number (SN), plant diameter (PD), tuber diameter (TD), tuber length (TL) and tuber weight or yield (TW). The analysis revealed that the level of N had significant (p<0.05) effect on average plant height (PH), plant diameter (PD), tuber diameter (TD) and tuber length (TL). But the level of N on sucker number (SN) and tuber weight (TW) and the level of P for all parameters showed no effect. The NP interaction significantly (p<0.05) affected plant height (PH), plant diameter (PD), sucker number (SN), tuber diameter (TD) and tuber length (TL). But the interaction had no effect on leaf number per and tuber weight (TW).

Table 1: Mean values of the analyzed parameters as affected by P levels, year one experiment

TRT	NS	PH	LN	PD	TL	TD	TW
1(P=0)	4.886a	57.83a	21.554a	47.001a	13.328a	27.833a	50666a
2(P=0.022)	3.943a	53.50a	17.888a	37.39a	12.665a	27.60a	43667a
3(P=0.044)	4.890a	51.81a	22.139a	42.222a	12.780a	27.055a	55000a
4(P=00065)	4.721a	56.67a	16.352a	41.555a	12.027a	27.444a	49000a

5.2.2. Year two

The effect of P on the taro yield was evaluated by considering the performance of the Boloso-1 taro parameters: leaf number (LN), plant height (PH), sucker

number, plant diameter, tuber diameter, tuber length and tuber weight or yield. The analysis showed that, P had significant (p<0.05) effect on average number sucker (NS), but all other parameters had no significant effect.

Table 2: Mean values of the analyzed parameters as affected by P levels at year two experiment

TRT	NS	PH	LN	PD	TL	TD	TW
1(P=0)	3.9692abcd	61.4725a	35.7490a	56.7808ab	14.6085b	27.331a	80633a
2(P=0.022)	4.0259abc	64.5575a	27.3625a	58.4158ab	14.9448b	29.835a	86466a
3(P=0.044)	5.3883a	56.3625a	33.5833a	55.8740ab	18.3760a	26.8285a	92833a
4(P=00065)	4.7475ab	60.0085a	25.1118a	56.0560ab	13.8333b	25.2218a	75333a

5.4. Yield component characters

5.4.1. Year One Experiment, 2014

The effects of different levels of P showed none significant

effect on all yam growth parameters per plot. For the year one or first year experiment, the level of P totally showed no effect on all growth parameters and on the yield per plot.

#### 5.4.2. Year Two Experiment, 2015

The effects of different levels of P showed significant effect on number of suckers and tuber length per plant and the highest mean (5.388 and 18.378) were recorded at P level 0.044g per plant for both parameters and also lowest mean (3.969 and 13.833) were obtained at P level (0 and 0.065g per plot respectively). But other growth parameters (plant height, leaf number, plant diameter and tuber length) were affected none significantly by P level per plot. Number of suckers and tuber length per plot increased with the increasing of P up to third treatment only.

The study of level of P fertilizer effect for both two years study does not agree with the study in the Bangladesh. This is may be due to P fertilizer level of our study area as the P level may be available enough for the taro requirement. Also the other study in Property of Mr. Sok Lee – Darwin River by M. Traynor for taro fertilizer rate trial 2004 showed that 40% reduction in fertilizer inputs would result in only a 3-4% reduction in yield of taro. Also this study disagrees with our study result of taro yield on which P levels and both by two years studies, no significant effect on yield of taro. This is may be due to the P fertility requirement of taro for our study area or site is not the primary issue for taro production, as P level was not affected yield of taro at our study site for both two years.

#### 5.5. Yield of taro

The different levels of P fertilizer both at year one and year two experiments were affected yam tuber yield none significantly. This may be due to the presence of required P fertilizer levels at the experiment location.

## VI. CONCLUSION AND RECOMMENDATION

Information on fertility status of soils and crop responses under different fertility management strategies are very crucial for profitable and sustainable agricultural production. In view of this, a study was conducted to investigate the influence of P fertilizer application on yield and yield traits of Boloso-1 taro (*Colocasia esculenta* (L.) variety at Boloso-Sore during 2013/2014 and 2014/2015 cropping season. The experiment was laid out in randomized complete block design (RCBD) with three replications. The treatments consisted of four levels of P (0, 22, 44, and 65kg ha<sup>-1</sup>). A total of 4 fertilizer treatments were used in a factorial arrangement. Duncan's multiple range tests were employed to compare means at 5% probability levels. Parameters leaves number (LN), plant height (PH), number of suckers (NS), plant diameter (PD), tuber length (TL), tuber diameter (TD) and tuber weight (TW) or yield per plot were considered. The level of P at year one study had no significant ( $p < 0.05$ ) effect on all yield contributing parameters and also yield but significant effect only on number of suckers and tuber length at second year study.

Even though the experiment was conducted at one location two years, finally to measure the data of taro yield, the P fertilizer level study showed none significant effect on final yield at both years. In summary, taro

production should be supported by fertilizer application through repeated and different location studies or experiments on application of P fertilizer. The strategy for maximizing crop yield by supplying fertilizers to soils requires knowledge of the inherent nutrient status and nature of nutrient release of the soils, and the nutrient uptake potential of the crop.

Therefore, results of this study pointed out to the possibility of promoting higher yields by manipulation of growth aspects and yield performance which is none significant, of two year experiments at one or the same location through use of P applications.

#### Recommendation:

Even though N and NP interaction showed significant effect on almost all growth parameters or yield attributes, had none significant effect on tuber yield at two year experiments were observed in response to the increased rates of P it is very difficult to arrive at definite recommendations based on this study as it was conducted in only one location over two season and soil fertility varies from location to location and seasonally by adopting one variety. In view of this, the future studies should articulate towards:

- ❖ Studies involving more cultivars, multi-location, multi-season and additional rates of and P application, under diverse management practices such as farmers, irrigated or rained conditions etc., which may facilitate fine-tuning of fertilizer recommendations.

## REFERENCES

- [1] Chien, H. S. and G. Menon. 1995. Agronomic evaluation of modified phosphate rock products. *Fertilizer Research*, 41: 197-205.
- [2] Emmanuel-Ikpeme, C.A., Eneji, C.A., Essiet, U., (2007). Storage Stability and Sensory Evaluation of Taro Chips Fried in Palm Oil, Palm Olein Oil, Groundnut Oil, Soybean Oil and Their Blends. *Pakistan Journal of Nutrition* 6 (6), 570-575
- [3] Endrias G. & Asfaw K., 2011. Production, Processing and Marketing of ginger in Southern Ethiopia. Haramaya University, Ethiopia.
- [4] FAO (1999). Taro Cultivation in Asia and the Pacific. Regional Office for Asia and the Pacific, Bangkok, Thailand.
- [5] Hailemichael, G, and D. Tilahun, 2004. Current status of spice research. Ethiopian Agricultural research organization, Jimma Agricultural Research center, Tepi Agricultural Research Sub-Center.
- [6] Ivancic, A. and V. Lebot. 2000. The Genetics and Breeding of Taro. CIRAD, Montpellier Cedex, France.
- [7] John J. Cho, Roy A. Yamakawa, and James Hollyer, (2007). Hawaiian, Kalo, Past and future, Corporative Extension service, college of Tropical Agriculture and Human Nutrition, University of Hawaii at Manoa.
- [8] M. Traynor, 2004. Taro Fertiliser Rate Trial 2004. P5
- [9] MOARD, 2007. Annual yield assessment report 2007. Results on area, production and yield a coffee, tea and spices. *Statistical Bulletin* 150. Addis Ababa. Ethiopia.
- [10] Onwueme, I. 1999. Taro Cultivation in Asia and the Pacific. FAO, Bangkok.
- [11] Patrick, M. M., Grace, W. N., and Christine, H.S. K., (1999). Traditional Food Plants of Kenya: National Museum of Kenya. P. 288, Nairobi, Kenya.
- [12] Scott, G.T. Rosengrant, M.W and Ringler, C., (2000). Root and tubers for the 21st century.
- [13] Simone Adebo, (1992). Taro root in North Omo. FPR Technical Pamphlet No.2. FARM Africa. Addis Ababa, Ethiopia.





- [14] Tisdale, S.L., W.L. Nilson and J.D. Beaton. 1998. Soil fertility and fertilizers. Fifth (ed.) MacMillan Pub. Co., New York.
- [15] Trends, projections, and policy options. Food, agriculture, and environment discussion. Paper 31. IFPRI.
- [16] UNIFEM, (2002). Root Crops Processing, The united Nations Development Fund for Women.
- [17] ITAG Publishing, 103-105 Southampton Row, London WC1B 4HL, UK
- [18] Wolaita Zone Agricultural and Rural Development Department, 2011 year, annual report.
- [19] Yared Dagne, (2007). Studies on indigenous production and evaluation for tuber yield of taro cultivars (*Colocasia esculenta* L. (Schott)); at Dalbo watershed, Wollaita Zone, Southern Ethiopia, M.Sc. Thesis, Hawassa University, Awassa, Ethiopia.
- [20] <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/RES-114-14.pdf>
- [21] <http://www.fao.org/docrep/005/ac450e/ac450e08.htm>

## AUTHOR'S PROFILE



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was born in Sorei Hombba kebele, Boloso sorie woreda, Wolaita Zone on February 23, 1975. He attended his primary, secondary, and high school in Dubbo Catholic mission, Areka and Bodditi schools respectively until 1994. He joined Awassa College of Agriculture in 1995 and graduated with B.Sc. Degree in Plant Production and Dry Land Farming in 1999. He then served as senior expert in different positions in Office of Agriculture in Kacha Bira woreda, Kambata Tambaro zone for three years. And then he was appointed as head of Humbo Woreda/District Agriculture and Rural Development Coordination office and worked there until he joined Hawassa University for his M.Sc study. He joined Hawassa University, Awassa College of Agriculture in 2005 for Graduate Studies to specialize Horticulture and graduated in 2008. He finally after graduating his MSc. he has been working in Wolaita Sodo University in South Ethiopia as lecturer, researcher and coordinating Continuous Education Program in University (CEP).