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The Effect of Np Fertlizer Rates on the Yield and Yield Components of Taro (*Colocasia esculenta* (L.) Schott.) in Boloso-Sore Woreda Wolaita Zone, Snnpr, Ethiopia

Taye Buke
(M.Sc. In Horticulture) - Principal investigator, (Wolaita Sodo University, College of Agriculture, Department of Horticulture Wolaita Sodo, Ethiopia)
tayebuke@yahoo.com

Gifole Gidago
(M.Sc. In Soil Science) – Co- investigator, (Wolaita Sodo University, College of Agriculture, Department of Plant Science, Wolaita Sodo, Ethiopia)
gifoleg@yahoo.com

***Abstract* – A field experiment 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 NP 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 N (0, 23, 46 and 69 kg/ha) and four levels of P (0, 10, 20 and 30 kg/ha). A total of 16 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 increase in N level had significant effect on number of suckers, plant height, plant diameter ,tuber length and tuber diameter in both year one (2006 E.C.) and year two (2007E.C.) but leaf number and tuber weight for year one and only tuber weight for year two showed non-significant difference in both N and P different levels. NP interaction significantly (p<0.05) affected the average number of suckers, plant height, plant diameter, tuber length and tuber diameter. But the interaction had no effect on leaf number and tuber weight at year one (2006) whereas NP significantly (0.05) affected sucker number, plant height, leaf number, plant diameter, tuber length and tuber diameter but the interaction had no effect on tuber weight at year two (2007).The study showed that there was no significant differences on yield/tuber weight of taro at various level of N and P fertilizer and also on their interaction in two years 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 NP levels.**

***Keywords* – Taro (Colocasia esculenta (L.) Schott.), DAP, Urea, TSP, 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 is referred to botanically as colocasia esculenta (L) Schott. It is perennial tropical crop with a large pelt ate ("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).

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 considered to have originated in the Indo-Malayan region from where it was dispersed to east and Southeast Asia, the Pacific Islands, Madagascar and Africa, and then introduced to the Caribbean and other parts of tropical America (Ivancic and Lebot 2000). Taro is considered to be a less adaptive crop because of its predominant vegetative propagation and its requirement for high fertility soil. 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.

Taro is a crop of prime economic and cultural importance to the people of Pacific Island Countries (PICs) In PNG; taro is consumed by a majority of the population whose livelihood relies predominantly on subsistence farming. In addition to its economic importance, taro has a long history of social and cultural attachment in PNG societies. This sentimental attachment to taro is evident also in other cultures within the Oceania and the Southeast Asian regions (Onwueme 1999). In PNG, taro is a prized commodity for traditional social activities such as compensation payments, bride price ceremonies and feasts. Its importance stems from the crop's unique taste, its early association with the people's culture and its high labour input requirements.

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).

Taro is the second most important root staple crop after sweet potato in terms of consumption (Singh et al. 2006) and is ranked fourth root crop after sweet potato, yam and cassava in terms of its production by weight (Bourke and Vlassak 2004) with an estimated annual production of over 229,088 tones. Major constraints to taro production include diseases like TLB, pests as taro eetle, poor soil management practices and declining fertility, lack of value addition to production and lack of efficient marketing systems. However, of the various constraints, TLB and taro beetle are of prime importance since the former can reduce yield by up to 50 percent and can also lead to poor quality of the corms (Paiki 1996; Sar et al. 1998) while the later can cause up to 95% crop loss due to damaged corms.

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.

Farmyard is a major fertilizer used for taro production in SNNPRS. However, it cannot support large scale production since the availability of farmyard manure is limited and the preparation of it is laborious. There is increased use for Nitrogen (UREA) fertilizer which reaches up to 150kg/ha and the P (DAP) fertilizer use is mostly 100kg/ha in Wolaita area since the year 2009 (WZARDD, 2011). However, the taro producers at the region, use undetermined or no rate of DAP and UREA fertilizers (EndriasGeta, 2011). The people in area do not have any recommended dose of fertilizers though. Despite all the potentials and opportunities of having such a long history with a diversified conducive agro-ecology base, this spice sub-sector potential remained unexploited. The sub-sector is still not organized or packaged, low in productivity and inefficient. This is attributed to several factors; poor soil fertility, shortage of improved varieties, and poor agronomic practices are the most important ones (Hailemichael et al., 2008; MoARD, 2007). Mostly farmers grow taro and get the produce with very low yield due to lack of research and technology.

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 (EndriasGeta, 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 /NP/ fertilizer rate for growth and productivity of taro;
- To determine the effect of NP 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 is native to South India and Southeast Asia. It is a perennial, tropical plant primarily grown as a root vegetable for its edible starchy corm, and as a leaf vegetable. It is a food staple in African, Oceanic and South Indian cultures and is believed to have been one of the earliest cultivated plants. *Colocasia* is thought to have originated in the Indo-Malayan region, perhaps in eastern India and Bangladesh, and spread eastward into Southeast Asia, eastern Asia, and the Pacific islands; westward to Egypt and the eastern Mediterranean; and then southward and westward from there into East Africa and West Africa, whence it spread to the Caribbean and Americas. It is known by many local names and often referred to as "elephant ears" when grown as an ornamental plant.

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.

Root and tuber crops are widely cultivated in southern Ethiopia, and support a considerable portion of the country's population as source of food. Prominent among these are: potato (*Solanum tuberosum* L.), sweet potato (*Ipomoea batatas* L.), enset (*Ensete ventricosum* (Welw), Cheesman), godere (*Colacasia esculanta* L.), yams (*Dioscorea spp.*), Ethiopian dinch (*Coleus parviflorus*), koteharrie (*Diaspora bulbiferous*), and anchote (*Coccinia abyssinica*). Among these, enset, anchote, and some yams are endemic to Ethiopia

3.2. Botanical Description

The term taro is used to refer to *Colocasia esculenta* (L.) 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 pelt ate ("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. It's 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. It's delicious flesh feature crispy in texture, and water chestnut like nutty flavor.

Yautia (*Xanthosoma* species), also known as *tannia*, *malanga* etc., is similar to taro but smaller and has somewhat elongated, bumpy corms grown widely in East Asia, Caribbean and South American regions. **Eddoe** (*Colocasia esculenta antiquorum*) is also smaller corm with irregular surface (like root ginger) grown widely in India, China, and Japan as well as in some Caribbean countries. It is known as *arbi* in the Indian subcontinent (http://one-vibration.com/profiles/blogs/taro-root-a-super-food-for-the-world#.Ui7IEH-_7IU)

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 trowels or "pineapple planters," to a depth of at least 6 inches in the ground (http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top)

The proper plant spacing for a particular farm operation would not only depend on the final yield per acre but on other decision factors. These could be the type of tractor equipment a farmer chooses to use, the uniformity of individual corm size to meet the demand of the type of market (retail, restaurant, supermarket, chipping, etc.), the weed maintenance program, the amount of hulisa farmer needs to prepare for an acre, and the time of year that a field is planted. Considering that most farmers use a hand drawn tiller to cultivate rows, a spacing of 1 x 3 to 1 x 4 feet would be appropriate. The approximate yield of no.1 corms per acre would be about 28,000 lb with an individual conn size of about 3 lb. The percentage of no.1 corms would probably range in the 80 percent range which is considered good. Weeding would be required 2 or 3 times during the early growth stages.

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).

In many parts of Sub-Saharan Africa (SSA), root and tuber are a major source of sustenance. They account for 20 percent of calories consumed in the region (Gregory J. Scott, *et al.*, 2000**)**. In developing countries, root and tubers are very important, especially in the food system of remote, generally marginalized areas, with particular low-income levels (Yared, 2007). Under traditional farming system, root and tuber crops have some advantage over other sources of carbohydrates. They produce highest yield of calories per unit of land area, the yield are stable under conditions where other crops may not succeed, and they are cheap to produce. Besides being a source of carbohydrates, root and tuber crops contains proteins and vitamins and serve as security crop, alleviating seasonal shortage of foods caused by natural or man-caused disasters. Yared, (2007), pointed out that, root and tuber crops play multi-purpose roles in the global food system as a starch supplier, food security crop, source of cash income, raw material for feed and processed products, and as key components in small-scale agro-enterprise development.

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 (Collocasia 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 starch is one of the most nutritious, easily digested foods. Similar to many other root crops taro corms are high in carbohydrate in the form of starch and low in fat and protein. The starch is 98.8 percent digestible, a quality attributed to its granule size, which is a tenth that of potato, making it ideal for people with digestive difficulties. The corm is an excellent source of potassium (higher than banana), carbohydrate for energy, and fiber. When eaten regularly, taro corm provides a good source of calcium and iron. Taro leaves eaten as a vegetable are excellent sources of provitamin A carotenoids, calcium, fiber, and vitamins C and B2 (riboflavin), and they also contain vitamin B1 (thiamin) (John J, 2007).

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).

The taro leaf, like other higher plant leaves, is rich in protein. It contains about 23% protein on a dry weight basis. It is also a rich source of calcium, phosphorus, iron, Vitamin C, thiamine, riboflavin and niacin, which are important constituents of human diet (FAO, 1999). Taro is rich in energy or carbohydrate, low in fiber and a faire source of fat and oils. When it is compared to Tannia and other root crops it has highest content of Phosphorus, Magnesium, and Zinc. Like most plant origin foods taro also contains a variety of anti-nutritional and toxic components. Taro contains oxalates, phytates trypsin and amylase inhibitors, phytates, tannins and cyanide in some cultivars. Therefore is very important to processes taro before consumption. Taro is an important food crop in world, taro leaves are used as a vegetable in laulau, and taro corms are made into poi. Corms are also boiled, steamed, and baked, and may be fried to make chips (http://www.ctahr.hawaii.edu/fb/taro/taro.htm#top).

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.

Taro has many benefits over potatoes but does actually contain more calories, gram for gram, with 142 calories per 100 grams to the 93 calories per 100 grams of a potato. However, with the additional benefits of fiber and a low Glycemic Index, taro is still a good choice as a starch vegetable (http://www.nutrition-and-you.com/taro.html).

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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).

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).

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 11/4 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

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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>. 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.

The soil analyses for K, Ca, and Mg must be done with ammonium acetate extractant; 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 laulau 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 Ethiopia, 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 18^0C (Simon, 1992).

4.2. Treatments, Design and Experimental materials

4.2.1. Treatments of the experiment

Table 1: Treatment combinations used in the experiment

Treatments	0 (P1)	10 (P2)	20 (P3)	30 (P4)
O (N1)	N1P1 (T1)	N1P2 (T2)	N1P3 (T3)	N1P4 (T4)
23 (N2)	N2P1 (T5)	N2P2 (T6)	N2P3 (T7)	N2P4 (T8)
46(N3)	N3P1 (T9)	N3P2 (T10)	N3P3(T11)	N3P4 (T12)
69(N4)	N4P1 (T13)	N4P2(T14)	N4P3(T15)	N4P4 (T16)

The experiment consisted of four levels of N (0, 23 kg N ha-1, 46 kg N ha-1 and 69 kg N ha-1), and four levels of P (0 Kg ha-1, 10 kg P ha-1, 20 kg P ha-1, 30 kg P ha-1) with 16 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 N source was urea and DAP, whereas the sources of P was DAP and TSP. The fixed P fertilizer was applied at final land preparation/planting time and then nitrogen was applied as a top dressing in two equal doses at 45 and 90 days after planting. All other crop management practices were done as per the recommended practices for taro in similar way.

4.2.2. Design of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in factorial arrangement. Planting was done on February14 and 15 at 2006 E.C. and 2007 E.C. 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 N and 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) (Table 2). But the level of N on sucker number (SN) and tuber weight (TW) and the level of P for all parameters showed no effect (Table 2). 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 2:c).

Table 2: Mean values of the analyzed parameters as affected by N and P levels, year one experiment

a. Mean values of parameters for Nitrogen level:

TRT	NS	PH	LN	PD	TL	TD	TW
1(N=0)	3.969a	46.33ab	16a	32.112ab	11.667ab	26.666ab	33000a
2(N=0.023)	4.695a	59.22a	21.39a	46.334a	12.999a	27.472a	50000a
3(N=0.046)	4.584a	51.97a	18.832a	43.064a	12.665a	27.444a	54333a
4(N=0.069)	5.052a	62.28a	27.989a	46.667a	13.468a	28.349a	61000a

b. Mean values of parameters for phosphorous level:

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

c. Mean values of parameters for Nitrogen phosphorous interaction:

TRT	NS	PH	LN	PD	TL	TD	TW
1	4.890abc	52.32ab	20.110a	39.553abcd	11.777bc	26.663bcd	26667a
2	3.210c	41.78b	14.333a	28.003d	11.780bc	24.890d	30667a
3	3.443abc	42.00b	14.667a	30.890bcd	11.557bc	27.000abcd	32000a
4	4.333abc	49.22ab	17.777a	30.000cd	11.553bc	28.110abcd	42667a
5	5.443abc	62.89ab	22.443a	51.557a	12.997abc	31.333a	54667a
6	4.553abc	69.67a	21.553a	44.000abcd	14.223ab	27.777abcd	46667a
7	4.447abc	49.00ab	24.223a	41.777abcd	13.333abc	27.220abcd	64000a
8	4.337abc	55.33ab	17.333a	48.000abc	11.443c	23.557d	34667a
9	4.553abc	54.44ab	21.220a	42.670abcd	15.113a	26.447bcd	56000a
10	3.337bc	40.11b	14.553a	30.667bcd	11.323c	27.000abcd	33333a
11	5.890a	54.89ab	25.000a	48.667abc	12.780abc	26.110bc	65333a
12	4.557abc	58.45ab	14.553a	50.220ab	11.443c	30.220abc	62667a
13	4.657abc	61.67ab	22.443a	54.223a	13.423abc	26.887abcd	65333a
14	4.670abc	62.45ab	21.113a	46.890abcd	13.333abc	30.733ab	64000a
15	5.780ab	61.34ab	24.667a	47.553abcd	13.447abc	27.890abcd	58667a
16	5.100abc	63.67ab	15.743a	38.000abcd	13.667abc	27.887abcd	56000a
CV	**2.04227**	**2.04227**	**2.04227**	**2.04227**	**2.04227**	**2.04227**	**2.04227**
LSD	**2.481**	**24.715**	**NS**	**19.995**	**2.7209**	**4.6227**	**NS**

Ns = non-significant, NS= Number of suckers per plant, PH= average plant height, LN= average leaf number, PD = Plant diameter, TL= Tuber length, TD= Tuber diameter and TW= Tuber weight/h.

5.2.2. Year two

The effect of N and 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, both level of N and P had significant ($p<0.05$) effect on average number sucker (NS), and only level of N had significant effect on plant diameter (PD) but all other parameters had no significant effect (Table 3).

NP interaction significantly ($p<0.05$) affected the average leaf number, plant height (PH) cm, sucker number, plant diameter and tuber diameter but tuber length and tuber weight had no effect (Table 3).

Table 3: Mean values of the analyzed parameters as affected by N and P levels at year two experiment)

a. Mean values of parameters for Nitrogen level:

TRT	NS	PH	LN	PD	TL	TD	TW
1(N=0)	4.025ab	48.973abc	37.445ab	59.152a	14.038a	26.631ab	90033a
2(N=0.023)	4.500ab	58.973abc	28.055ab	52.777ab	14.556a	26.807ab	80866a
3(N=0.046)	4.500ab	67.030abc	27.417ab	56.362a	15.750a	26.861ab	83500a
4(N=0.069)	5.245a	67.310abc	28.890ab	58.810a	13.917a	26.418ab	80866a

b. Mean values of parameters for phosphorous level:

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

c. Mean values of parameters for Nitrogen phosphorous interaction

TRT	NS	PH	LN	PD	TL	TD	TW
1	4.3333bcd	43.22bc	60.11ab	54.457abc	13.547b	28.767ab	73600a
2	3.3233cd	50.67abc	28.447ab	62.443a	15.223b	35.557a	96800a
3	4.3333bcd	48.00abc	33.557ab	60.943ab	13.947b	27.310ab	98267a
4	4.1100bcd	54.78abc	27.667ab	58.890ab	13.443b	24.890b	91467a
5	4.4433bcd	75.22a	30.110ab	61.333ab	15.220b	28.223ab	90400a
6	3.8867bcd	63.89abc	21.333b	50.667bc	15.000b	27.447ab	72667a
7	4.8900abcd	40.11c	36.110a	44.220	30.447a	23.780b	98133a
8	4.7800abcd	56.67abc	24.667ab	54.887abc	12.557b	27.777ab	62267a
9	2.8900d	59.45abc	24.443ab	56.003ab	16.667b	27.777ab	86667a
10	4.4467bcd	70.22ab	30.447ab	60.333ab	15.223b	28.557ab	97333a
11	5.6633ab	69.67ab	32.443ab	55.663ab	14.887b	29.557ab	78933a
12	5.0000abc	68.78abc	22.333ab	53.447abc	16.223b	21.553b	71067a
13	4.7667abcd	68.00abc	28.333ab	55.330ab	13.003b	24.557b	71867a
14	4.4467bcd	73.45a	29.223ab	60.220ab	15.333b	27.780ab	79067a
15	6.6667a	67.67abc	32.223ab	62.670a	14.223b	26.667ab	96000a
16	5.1000abc	60.11	25.780ab	57.000ab	13.110b	26.667ab	76533a
CV	2.04227	2.04227	2.04227	2.04227	2.04227	2.04227	2.04227
LSD	2.0193	28.686	13.8	10.677	11.788	10.106	NS

Ns = non-significant, NS= Number of suckers per plant, PH= average plant height, LN= average leaf number, PD = Plant diameter, TL= Tuber length, TD= Tuber diameter and TW= Tuber weight/h.

5.3. Yield component characters

5.3.1. Year One Experiment, 2016.

The effects of different levels of N on the yam growth parameters i.e., average plant height per plant, showed a significant effect and the highest mean plant height (62.28.5) was recorded at 69kg/ha level and the lowest (46.33) were obtained at 0 kg/ha N levels. Similarly, the N level showed significant effect on mean plant diameter, mean tuber diameter and mean tuber length per plot with the highest 46.667, 13.468 and 2.66 respectively and with the lowest mean 32.112, 26.666 and 11.667 respectively (Table 2a). The effects of different levels of P showed none significant effect on all yam growth parameters per plot (Table 2b).

The effects of different levels of NP interaction on the yam growth parameters i.e., average number of suckers, plant height t, plant diameter, tuber length and tuber diameter showed a significant effect and the highest mean plant height per plant (5.89, 69.67, 54.22,15.11and 31.33) was recorded at NP= (0.046, 0.044), (0.023, 0.022), (0.069,0), (0.046,0) and (0.023,0) and the lowest (3.21,40.11,28.00,11.32, and 23.56) were obtained at NP= (0,0.022), (0.046,0.022), (0,0.022), (0.046,0.022) and (0.023,0.065) kg/plot, respectively. But none significant on numbers leaves (Table 2c).

From the above data, for the year one or first year experiment, the highest plant height (PH), plant diameter (PD), tuber length (TL), and tuber diameter were recorded at biggest N level (N= 0.069 g per plot) but the levels of N showed brought no differences on number of suckers, leaves number and also yield of taro per plot, whereas the level of P totally showed no effect on all growth parameters and on the yield per plot.

5.3.2. Year Two Experiment, 2015

The effects of different levels of N on the yam growth parameters i.e., average number of suckers and plant diameter per plant, showed a significant effect and the highest mean (5.245 and 59.125) were recorded at N = 0.069g and 0g/plot and the lowest mean(4.025 and 52.77) were obtained at N level = 0 kg and 0.025g/plot respectively. But other growth parameters (plant height, leaves number, tuber length and tuber diameter), were affected none significant by N level per plot (Table 3a). 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 (Table 3b).

The effects of different levels of NP interaction on the all yam growth parameters collected i.e., average number of suckers, plant height, leaf number, plant diameter, tuber length and tuber diameter showed a significant effect and the highest mean per plant (6.6667, 75.22, 36.11,62.443, 30.447 and 35.557) were recorded at NP= (0.069, 0.044), (0, 0.022), (0.023, 0.044), (0, 0.022), (0.023, 0.044) and (0, 022) and the lowest (2.89, 40.11, 21.333, 44.22, 12.557 and 21.553) were obtained at NP (0.044,0.022), (0.023,0.044), (0.023,0.022), (0.023,0.044), (0.023,0.065) and (0.046,0.065) per plot, respectively (Table 3c).

From the above data, for the second year at 2007E.C. experiment the highest number of suckers and plant diameter were produced from the maximum N level (0.069 g per plot) whereas the highest number of sucker and highest tuber length produced at P level of 0.044 g per plot. But the level of showed no differences for all the remaining growth parameters and the yield of taro (Table 3a). This means number of suckers and plant diameter per plot increased with the increasing N and number of suckers and tuber length per plot increased with the increasing of P up to third treatment only (Table 3b).

The interaction of NP had significant effect on all yield attributes of taro but not on tuber yield of taro. It is revealed that both N and P had positive impact on some growth parameters of taro production but the effect of N was found to be more distinct than the effect of P. However, with the increase of N levels, other field parameters of taro linearly increased (M.M. Haque et al; 2007).

The study in the Bangladesh showed that yield contributing parameters progressively increased with the increase rates of N up to 180 kg/ha which was significantly different over 0 Nitrogen This result agree with only year one and some of the yield contributing parameters like plant height, plant diameters, tuber length and tuber diameter and year two for only number of sucker parameters, but 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 both N and P levels and both by two years studies, no yield of taro. This is may be due to the N and P fertility requirement of taro for our study area or site is not the primary issue for taro production, as both N and P level was not affected yield of taro at our study site for both two years.

5.4. Yield of taro

The different levels of N, P and their interaction both at year one and year two experiments were affected yam tuber yield none significant. This may be due to the presence of required NP 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 N and 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 N (0, 23, 46 and 69 kg ha-1) and four levels of P (0, 22, 44, and 65kg ha -1). A total of 16 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 analysis revealed that increase in N level had highly significant ($p<0.05$) effect on plant height (PH), plant diameter (PD), tuber length (TL) and tuber diameter (TD) for year one experiment and significant effect only on number of sucker and plant diameter for year two experiment (Table 2 & 3). 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 (Table 2).

NP interaction significantly ($p<0.05$) affected the average plant height (PH), number of suckers (NS), plant

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diameter (PD), tuber length (TL), tuber diameter (TD). But the interaction had no effect on leaves number and yield at year one (Table 2). NP interaction significantly ($p<0.05$) affected the average leaves number (LN), plant height (PH), number of suckers (NS), plant diameter (PD), tuber length (TL), tuber diameter (TD) and yield per plot were considered and no significant effect on tuber weight (TW) or yield (Table 3) for year two experiment.

Even though the experiment was conducted at one location two years finally to measure the data of taro yield, the NP fertilizer level study showed none significant effect on final yield at both years. Particularly, the nitrogen level increase reveals progressive increment for some taro yield components (growth parameters).

In summary, taro production should be supported by fertilizer application through repeated and different location studies or experiments on application of NP 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 N and 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 N and 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 N 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.Currrent 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 HumanNutrition, 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 Bullefin 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. *ITAG Publishing*, 103-105 Southampton Row, London WCIB 4HL, UK

[17] Wolaita Zone Agricultural and Rural Development Department, 2011 year, annual report.

[18] 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.

[19] http://www.ctahr.hawaii.edu/oc/freepubs/pdf/RES-114-14.pdf

[20] http://www.fao.org/docrep/005/ac450e/ac450e08.htm

AUTHOR'S PROFILE

Taye Buke Ashango was born in Sorei Hombba kebele, Boloso sorie woreda of Wolayta 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 for Office of Agriculture in Kacha Bira woreda of 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).