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Effect of Removal of Inflorescence on Fresh Vegetable Yield In Waterleaf [*Talinum triangulare* (Jacq.) Willd.]

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Abstract: *A field experiment laid out in randomized complete block design (RCBD) was conducted in the Eastern Farm of the Michael Okpara University of Agriculture, Umudike, to investigate the effect of removal of inflorescence on the yield of waterleaf [Talinum triangulare (Jacq.) Willd.] and to determine the frequency of inflorescence removal that produces the highest fresh vegetable yield. There were five treatments, namely, Treatment 1) - Daily removal of inflorescence, Treatment 2) - weekly removal of inflorescence, Treatment 3) - Bi-weekly removal of inflorescence, Treatment 4) - Monthly removal of inflorescence, and Treatment 5) - No removal of inflorescence. The yield outputs of daily removal of inflorescence and that of weekly removal of inflorescence in respect of both the harvestable as well as edible yield were higher than those of all the other treatments, but did not differ from each other ($p<0.05$). The yields produced by bi-weekly, monthly, and no removal of inflorescence, did not differ from each other in respect of the harvestable yield as well as the edible yield. Weekly removal of inflorescence was recommended over the other treatments because whereas the yield it produced was not different from that produced by daily removal, it demanded one-seventh the man days demanded by daily removal, to produce the same yield, and was therefore more economical in terms of farm labour cost.*

I. Introduction

Waterleaf [*Talinum triangulare* (Jacq.) Willd.], family Portulacaceae, is a herbaceous plant important as a leaf vegetable in Nigeria, especially in the Southeastern part of the country. Some authorities believe it originated in South America, but an African origin is also possible as several *Talinum* species including the closely related *Talinum portulcacifolium* (Forsk.). Schweinf. occur predominantly in Africa (Schippers, 2000). It is distributed throughout the equatorial rain forest belt from South America through Africa and to Asia (Philips, 2002). Waterleaf can often be found growing on its own in the wild, as a result of which it is often regarded as a common weed (van Epenhuijsen, 1974; Nyanayo and Lowokudejo, 1986; Akobundu and Agyakwa, 19887; Emmanuel et al, 2001). As a vegetable, the leaves and tender portions of the shoot are used sole, or in combination with other vegetables in the preparation of sauces with which starchy main dishes like "garri", "fufu", and rice, are eaten. In South-Western Nigeria it is clalled "gbure" by the Yorubas. It is commonly cooked in sauces with Jews' mallow ("ewedu") - *Corchorus olitorius* L. and used in eating "amala", a starchy preparation. In Southeastern Nigeria where it is called "mmong-mmong ikong" by the Efik/Ibibios, it is often cooked with "afang" (*Gnetum africanum* Welw. and *Gnetum bucholzianum* Engl.*)*, and fluted pumpkin (*Telfairia occidentalis* Hook. F.). It is always present in the very popular "edikang ikong" soup of the Efiks / Ibibios. In Cameroun where it is also eaten with some starchy preparations, it is considered a delicacy (Akachukwu and Fawusi, 1995). Waterleaf is important as a herbal remedy in Nigeria where it is used in the treatment of measles. It is used in the treatment of diabetes (Siakia and Sahdeque, 1994). Waterleaf is relished by poultry.

Nutritionally, waterleaf contains, per 100g edible portion, water: 90g; energy: 105 kj, protein: 2.4g, fat: 0.4g, carbohydrate: 4.4g, fiber: 1.0g, Ca: 121 mg, P: 67mg, iron: 5.0mg, thiamin: 0.008 mg, riboflavin: 0.18 mg, niacin: 0.3mg, ascorbic acid: 31mg, (Emmanuel, 2001; Akachukwu and Fawusi, 1995). Sridha and Lakshminarayana (1993) studied lipid classes, fatty acids and tocopherols of waterleaf and reported that the leaves of the plant yielded on extraction with chloroform-methanol, 2.42% lipids (dry weight). They also reported that 36% of the leaf lipids contain medium-chain saturated fatty acids (C10 - C14). Antinutrients in waterleaf includes soluble oxalates which can induce kidney stones, hydrocyanic acid, and nitrates (Emmanuel et al, 2001; Tindal, 1983).

Most of the waterleaf consumed in Southeastern Nigeria up till the 1970's was gathered from the wild, but now, increase in demand for the vegetable, especially in urban centres, has made farmers to go into its cultivation, and it is today a source of income to many families that grow and sell it (van Epenhuijsen, 1974; Emmanuel, 2001). According to Eyo and Ogban (1999), in most urban centres in South – Eastern Nigeria, waterleaf production has become an important component of the farming systems. Unfortunately, investors lack knowledge of some production practices that would bring higher yields. It is taken as an easy - to - grow vegetable that requires little attention. The result of this is the high price paid for it, especially in the dry season (Akachukwu and Fawusi, 1995; Eyo and Ogban, 1999).

Waterleaf starts flowering less than one month after germinating or sprouting, and this continues for so long as the plant is in the field. Flowers are found in inflorescences. An inflorescence is a terminal cyme on a triangular stalk 12-15cm long. Flowers are bisexual and regular. The calyx is made up of five sepals, and the corolla of five petals. The stamens are numerous. The style is slender with 3 -branched stigma. The ovary is superior and develops into an ellipsoid 3-valved capsule containing many seeds. Farmers in Nigeria routinely invest a lot of man hours in removing inflorescences from the growing plant in the belief that the practice boosts yield. This experiment was set up to test this belief by investigating the effect of removal of inflorescences on harvestable and edible vegetable yields in the plant. It was also to determine the frequency of inflorescence removal that would give optimal harvestable and edible vegetable yield in the crop.

II. Materials and Methods

The study was conducted between July and October 2009 in the Eastern Farm of the Michael Okpara University of Agriculture, Umudike. Umudike is located at longitude 07.33^0E and latitude 5.29^0N, at an altitude of 122 m above sea level, has an average rainfall of 2200mm per year, well-distributed over 8 months within the period of March - November, with bimodal peaks in June / July and with a short dry spell, usually in August. The experiment was a field study set up in a randomized complete block design having five treatments and three replications. The five treatments were made up of five frequencies of inflorescence removal, namely, Treatment 1,- daily removal, Treatment 2,- Weekly removal, Treatment 3,-bi-weekly removal, Treatment 4,-monthly removal, and Treatment 5,-no removal. A replication was made up of five plots to which the five treatments were randomly allocated. Each plot measured 2m x 1m. Intra - and inter- row spacing was 25cm, giving a total of 32 plants per plot, and 480 plants in the 15 plots that made up the experiment. Harvestable yield was made up of everything harvested, - the leaves and tender shoots, together with the woody and overgrow stems. Edible yield was made up of only the leaves and tender shoots. The plots were harvested 3 times at an interval of 30 days. Both harvestable as well as edible yields were taken in kg/plot.

III. Results

The means for the harvestable and edible yields for the five treatments studied are presented in Table 1, and the analysis of variance in Table 2. The grand mean for harvestable yield was 51.28 kg/plot. The differences among Treatment means for harvestable yield was highly significant ($p<0.01$). Mean separation was done using Fisher's LSD. Treatment 1 (daily removal of inflorescence) produced the highest harvestable yield of 59.63 kg/plot. This was followed by Treatment 2 (weekly removal of inflorescence),Treatment 4 (monthly removal of inflorescence),Treatment 5 (no removal of inflorescence), and Treatment 3(bi-weekly removal of inflorescence) with 54.67, 47.83, and 47.60, 46.67kg/plt, respectively. Treatment 1 produced significantly more harvestable yield than Treatments 2, 3, 5, and 4 ($p<0.05$). The difference between the harvestable yields produced by Treatments 1 and 2 was significant ($p<0.05$). Treatment 2 produced more harvestable yield than Treatments 3, 5, and 4 ($p<0.05$). Differences among Treatments 3, 4, and 5, in respect of harvestable yield were not significant ($p>0.05$).

Table 1. Table of means for harvestable and edible vegetable yield for the five treatments studied

Treatment	Harv*. Yield (kg/plot)	Edible Yield (kg/plot)
1 (Daily removal of inflorescence)	59.63	22.97
2 (Weekly removal of inflorescence)	54.67	20.87
3 (Bi-weekly removal of inflorescence)	46.67	13.53
4 (Monthly removal of inflorescence)	47.83	13.93
5 (No removal of inflorescence)	47.60	12.15
LSD (5 %)	3.96	5.22

Harv*. = Harvestable

The grand mean for edible yield was 16.69 kg/plot. The differences among Treatment means in respect of edible yield was highly significant ($p<0.01$). Treatment 1 (daily removal of inflorescence) produced the highest edible yield of 22.97 kg/plot. This was followed by Treatments 2, 4, 3, and 5, with 20.87, 13.93, 13.53, and 12.15 kg/plot, respectively. Treatment 1 yielded significantly more edible yield than Treatments 3, 4, and 5 ($p<0.05$). Differences among Treatments 3, 4, and 5 were not significant ($p>0.05$).

Table 2. Analysis of variance for harvestable and edible yield in waterleaf

Source	Df	Harvestable Yield MS	F	Edible Yield MS	F
Replication	2	10.25	2.31	15.88	2.07
Treatment	4	95.96	21.67**	71.29	9.29*
Error	8	4.43		7.67	
Total	14				

Legend: ** = highly significant ($p<0.01$); * = significant ($p<0.05$)

For both harvestable as well as edible yields, Treatments 1 and 2 (daily and weekly removal of inflorescences, respectively), gave the highest yields. Equally, Treatments 4 and 5 (monthly and no removal of inflorescences, respectively), gave the lowest yields in respect of the two parameters. It is clear from above findings that removal of inflorescence had a positive effect on both the harvestable as well as the edible yields in waterleaf.

IV. Discussion

In plants, photosynthetic assimilates are partitioned between the vegetative parts such as roots, stems and leaves on one hand, and the reproductive parts such as flowers, fruits, and seeds, on the other hand. Waterleaf is grown for its vegetative parts, made up of the leaves and tender portions of the shoot. The reproductive parts represented by inflorescences with their flowers, fruits and seeds, are not desired, which is why they are routinely removed by farmers. Regions of plants supplying photosynthetic assimilates to the phloem are traditionally referred to as sources while those that utilize assimilates are referred to as sinks (Noggle and Fritz, 2006). Primary sources are green leaves that have completed their initial phase of expansion and growth. Materials produced in these leaves during photosynthesis are transported to other parts of the plant. Wareing and Patrick (1975) introduced the concept of "sink strength" to refer to the observation that at any given stage of development of a plant, some sinks dominate others, attracting to themselves, the greater proportion of assimilates from all sources.

The relationship between source and sink and the issue of photosynthate partitioning has for a very long time held the interest of crop scientists. Saravitz et al (1994) studied nitrogen uptake and partitioning in response to reproductive sink size in soybean (*Glycine max*) and reported that during reproductive development, seeds become a dominant sink for both carbon as well as nitrogen. They also reported that the nitrogen requirement for fruit growth is derived increasingly from remobilization of nitrogen out of leaves. Pace et al (1999) studied photosynthate and dry matter partitioning in short - and long – season cotton (*Gossypium hirsutum*) cultivars and reported that main stem leaves were an important source of photosynthate to the developing bolls, and also that the total non-structural carbohydrates of the main stem and root contained between 20 and 90% of the 14C photosynthate from the main stem leaves partitioned to the main stem or root at the onset of reproductive growth and early reproductive growth. Mohapatra et al (2004) reported that the partitioning of 13 C – labeled photosynthate varies with growth stage and panicle size in rice. They studied the effect of a reduction of sink size on the partitioning of 13C to different organs of the rice plant, and found that 13C taken up by the three leaves at the post-heading period was translocated mostly to grains and hull of the panicle. Similarly, Binnie and Clifford (1999) studied the sink characteristics of reproductive organs of dwarf bean (*Phaseolus vulgaris* cv Masterpiece) in relation to the likelihood of abscission, and found that pods likely to abscise had reduced sink activity at both the flower and bud stages compared with those likely to be retained.

Removal of inflorescence as was done in the present experiment, means effectively reducing the reproductive sink size in the plant. Reduction in reproductive sink size, by reducing the reproductive demand for assimilates, naturally increases the availability of assimilates for utilization in other (i.e., non - reproductive) areas of the plant, such as in building up the roots, stem, and leaves. The observation in the present study that removal of inflorescence significantly increased both harvestable as well as edible vegetable yield in waterleaf concurs with the report of Saravitz et al (1994) who reported that following the removal of newly formed pods in soybean, allocation of dry matter shifted to vegetative growth, adding that the increased accumulation of dry matter and nitrogen in leaves of completely depodded plants was associated with an increase in both the number as well as total area of leaves following depodding.

Removal of inflorescences resulted in a situation where photosynthetic products were translocated exclusively to the vegetative parts of the plant such as roots, stems, and leaves. This explains why it led to higher vegetable yields in this study. This result is similar to that of Benincasa et al (2006) who studied source - sink relationships in tomato as affected by fruit load and nitrogen availability and allocation towards vegetative organs.

Even though daily removal of inflorescence gave yields higher than weekly removal, the difference between the two treatments was not significant. In terms of farm labour, however, daily removal of inflorescence is seven times as costly as weekly removal. Weekly removal of inflorescence is therefore recommended over all the other frequencies as it gives yield virtually as high as daily removal and also at one-seventh the labour cost

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