EFFECT OF NITROGEN FERTILIZER RATES AND WEED CONTROL TREATMENTS ON WEEDS GROWTH AND PRODUCTIVITY, QUALITY AND ECONOMIC FEASIBILITY OF TARO CROP

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Abstract

Two field experiments for taro vegetable crop were carried out in El-Kanater El-Khiria, Horticulture Research Station, Kalubia Governorate, Egypt, in a split plot design during the two successive 2015 and 2016 seasons. This study aimed to investigate the effects of two nitrogen fertilizer rates at 90 or 120 kg/ fed. in main plots and nine weed control treatments in sub plots *i.e.* Harness at one liter/ fed., Sencor at 300 g/ fed. and Stomp extra at 1.7 liter/ fed. each individual and/ or plus Roundup at one liter/ fed., Roundup individual, hand hoeing twice after 25 and 40 days from sowing and untreated check (control) on weeds growth and vegetative growth, yield, quality and economic feasibility of taro. The main findings of this research revealed that nitrogen fertilizer rate at 90 kg/ fed. gave the highest decrease in dry weight of weed categories *i.e.*, broadleaf weeds, grassy weeds and total weeds in both seasons and increased diameter and weight of taro corm in the second season. Whereas, taro plant height, taro number of leaves/ plant and uptake of nitrogen by weeds were increased by application of nitrogen rate at 120 than 90 kg/ fed. during the two seasons without any significant differences in the yield of taro, its components, chlorophyll content and chemical analysis characterized. The use of Stomp extra at 1.7 liter/ fed. applied as post-sowing plus Roundup at one liter/ fed. after 25 days from sowing applied as taro pre-emergence above soil surface exhibited significantly decreased in dry weight of total weeds by 96.9 and 95.1 % in first and second seasons, respectively. Application of Seconr at 300g /fed. plus Roundup at rate of one liter/ fed. reduced the previous total weeds by 93.3 and 94.5% and increased taro yield (43.6 and 43.5%) in the first and second seasons, respectively. Thus, these herbicides can broaden weed control weed spectrum with long weed control season, which minimize taro yield by weed competition, consequently eliminated N uptake from soil and improved protein and starch accumulation in favor taro crop yield. Also, it can be advised as alternative hand hoeing to weed control in this crop with economic feasibility and delectable herbicides residues and under permissible levels which accompanied with high quality for taro growth characteristics i.e. plant height, number of leaves/ plant and chlorophyll reading in leaves, corm length, corm diameter, corm weight, corm fresh yield, dry matter % and chemical of taro corms (protein percentage, starch percentage and total nitrogen of corm yield).

Key words: Taro - nitrogen fertilizer rates - herbicides – residues-economic feasibility

INTRODUCTION

Taro (*Colocasia esculenta* L. Schott) is a stem tuber crop belongs to the family Araceae (Henry, 2001). This crop is widely cultivated in most tropical and sub-tropical areas of the world and is considered one of the most important vegetables grown in Egypts. The total area cultivated with taro is 8400 fed. which produce 122808 tons with an average of 14.62 tons of corms/ fed. in 2014 season. Taro occupies considerable acreage especially in Menoufia, Kalubia and Assuit Governorates (El-Sharkawy *et al.,* 2003). Taro requires sufficient amounts of nitrogen fertilization for high and economic yields. Nitrogen fertilizers provide plants with amino acids and consequently protein which is important for plant growth and maturation. Application of mineral nitrogen is essential to sustain and improve crop yield (Mondrati, 2014). Furthermore, taro vegetable crop sprouting and grow above ground surface approximately after by 25 days from sowing, meanwhile weeds grow faster than taro and there is an urgent need to control pre or post emergence weeds early by using herbicides or mechanically by hoeing to overcome this problem. For this reason, both nitrogen fertilization and weed control are considered major players in taro corm productivity. Some researchers as El-Sharkawy (2007) found that taro plant height, chlorophyll content, fresh weight/ plant, total yield/ plot, corm length and diameter increased with increasing nitrogen application up to 80 kg N/ fed. compared with 40 or 160 kg N/ fed. Tadesse and Tesfaye (2010) found that tuber yield of taro increased up to 150 kg N/ ha and decreased when nitrogen rate increased to 200 kg N/ ha. Also, Walter and Falaniko (2016) conducted an experiment with three nitrogen rates (0, 100, 200 kg/ ha) on taro and concluded that the application of 100 kg/ ha of nitrogen gave the highest values of plant height and number of leaves. Whereas, Mondrati (2014) worked on taro and stated that different nitrogen levels (30-60-90-120 kg/ ha) had significant influence on the plant growth parameters (plant height and number of leaves), yield contributing parameters (corm length, corm girth, corm yield as ton/ ha) and nitrogen uptake in all the plant parts and gave the highest values with application of 120 kg N/ ha. On other hand, weeds can cause severe taro yield reduction (80 - 90 %) due to weed competition. Also, corm shape and dry matter accumulation were affected by level of weed infestation. Oluwafemi (2013) mentioned that there was effective weed control by the use of pre or post emergence herbicides and their combinations with hand weeding, where the highest taro corm number and corm yield (kg/ plant) were recorded when used Diuron + hand weeded treatment as compared with hand weeded treatment twice at 3 and 8 weeks after planting and can eliminate yield losses of taro. The weeds and weed management practices appreciably affected root development in taro and therefore weed free

period up to 60 days was essential for proper root development (Nedunchezhiyan and Satapathy 2003). Also, weeds can be controlled well with metribuzin at 1.6 and 3.2 kg as pre-emergence in taro plants (Lanbert *et al.,* 1979).

Up till now there are no official herbicides were registered weed control in taro field which can be used beside nitrogen fertilization in Egypt. Therefore, the aim of this study was to evaluate the effect of nitrogen fertilization rates and the application of some pre and post emergence herbicides on weed growth, taro yield, its quality and economic feasibility.

MATERIALS AND METHODS

Two field experiments were conducted at El-Kanater El-khiria, Horticulture Research Station, Kalubia Governorate, Egypt, during 2015 and 2016 seasons, to evaluate the effect of two rates of nitrogen fertilizer, nine weed control treatments and their interaction on controlling weeds growth as well as vegetative growth, yield and quality of taro plants (*Colocasia esculenata* L.). Seed pieces were cut longitudinally by knives to pieces contain about 3-4 buds from taro mother corms (local cv. Balady) and planted on 31/3/2015 and 17/2/2016 then harvested by plowing in December and November in both seasons, respectively. The plot area was 10.5 m^2 (3.5 m length x 3 m width) and the space between the plants was about 50 cm in the middle of the ridges. Irrigation used in the experiment was flood irrigation and the fertilizers were put manually in the furrows. The nitrogen was applied in the form of ammonium sulphate (20.5% N) application at 25 and 40 days from sowing.

Each experiment included eighteen treatments which were arranged in randomized split plot design with four replications. The two rates of nitrogen were arranged in the main plots as follows:

1. 90 kg N/ fed.
2. 120 kg N/ fed.

Whereas, the nine weed control treatments were randomly distributed in the sub plots as follows:

1. Acetachlor (2-chloro-N-ethoxymethyl- 6- ethylaceto-o- toluidide), which are known commercially as Harness 84% EC was applied post sowing at rate of one liter/ fed.
2. Acetachlor at rate of one liter/ fed. was applied post sowing plus Glyphosate at the rate of one liter/fed. was applied as post emergence after 25 days from sowing and before taro emergence.
3. Pendimethalin (N-(1-ethylpropyl)–3,4 dimethyl- 2,6 dinitrobenzenamin) which are known commercially as Stomp extra 45.5 % CS was applied post sowing at rate of 1.7 liter/ fed.

4. Pendimethalin at 1.7 liter/ fed. was applied post sowing plus Glyphosate at the rate of one liter/ fed. was applied as post emergence after 25 days from sowing and before taro emergence.
5. Metribuzin [4-amino-6-(1,1-dimethylethyl)-3-(methylthio)1,2,4-triazip-5 (4H) one], which are known commercially as Sencor 70 % WP was applied as post-emergence after 15 days from sowing at rate of 300 g/ fed.
6. Metribuzin at the rate of 300 g/fed. was applied after 15 days from sowing plus Glyphosate at the rate of one liter/fed. was applied as post emergence after 25 days from sowing and before taro emergence.
7. Glyphosate (N-(phosphonomethyl) glycine), which are known commercially as Roundup 48 % WSC was applied as post emergence after 25 days from sowing at rate of one liter/fed. and before taro emergence.
8. Hand hoeing twice after 25 and 40 days from sowing.
9. Untreated check (control).

The main physical and chemical analysis of the tested soil (Table 1) was determined according to Jackson (1967).

Table 1. Physical and chemical analysis of the soil of taro at experimental field (0-30 cm) depth in 2015 season

Particle size distribution						
Sand %	Silt %	Clay %	Soil texture		Organic matter %	
30.67	22.74	46.59	Clay		2.1	
Chemical of soil						
N mg/100g	P mg/100g	K mg/100g	SO_4^{--}	Cl^-	HCO^{---}	CO_3^{--}
52.50	22.04	45.20	0.51	0.50	0.89	0.0
K^+	Na^+	Mg^{++}	Ca^{++}	EC dS/ m	pH	
0.6	0.7	0.34	0.26	0.19	8.30	

All herbicidal treatments were sprayed with knapsack sprayer CP3 with 200-liter water/ fed. Other agriculture practices e.g. irrigation, fertilization, pest and diseases controls were managed in accordance with the recommendations of Ministry of Agriculture for taro planting in clay soil.

The following data were recorded:

A- Weeds growth

Weeds were hand pulled randomly from one square meter of each plot after 15 days from the last treatment in the experiment. Then, weeds were classified into two categories (annual broad leaf and grassy weeds). The dry weight g/ m^2 of weeds was recorded after drying in oven at 70 °C for 72 hours.

B- Taro vegetative growth

Five plants were taken off randomly from each treatment after 210 days from sowing to record the growth parameters:

1- Plant height (cm).

2- Number of leaves/ plant.

C- Corm yield parameters of taro

At harvesting time (270 days from sowing) plants of the whole plots were taken to estimate the following data:

1- Corm fresh weight (kg).

2- Corm diameter (cm).

3- Corm length (cm).

4- Fresh weight of yield (t/ fed.).

5- Dry matter percentage.

D - Herbicide residues in taro

In the first season, the herbicides residues for Stomp Extra (Pendimethalin), Harness (Acetachlor) and Sencor (Metribuzin) in taro corm were analyzed by using the Gas Liquid Chromatography method according to Nguyen *et al*. (2008) in Herbicides Research, Central Laboratory.

E – Chemical analysis

1. Nitrogen uptake (kg/ fed.) in total weeds was calculated in dry weeds after 180 days from sowing according the following equation:

$$\frac{\text{Dry weight of weeds (ton/ fed.)} \times \text{nitrogen percent in weeds}}{100}$$

2. Chlorophyll reading of taro leaves (SPAD), were measured after 210 days from sowing in the fresh fifth top fully leaf (a digital Chlorophyll meter, model Minolta Chlorophyll meter SPAD-502, manufactured by Minolta Company was used). SPAD unit = 10 mg/ 100g fresh weight of leaves (Netto *et al*., 2005).
3. Samples of corms were dried at 70 ^{o}C till constant weight then were used for the chemical determinations and were calculated according dry weight basis.

a) Starch % was determined according to Nelson (1974).

b) Protein % was determined as nitrogen present by micro-Kjeldahl method, according to A.O.A.C. (1975), then N was multiplied by 6.25 (Tripathi *et al.,* 1971) as described by Pregl (1945).

c) Nitrogen uptake (kg/ fed.) in taro corms was calculated according the following equation:

$$\frac{\text{Total dry yield (ton/ fed.)} \times \text{nitrogen percent in corms}}{100}$$

F- Economic feasibility of nitrogen fertilizer rates and weed control methods

Economic evaluation as a result of due to nitrogen fertilizer rates and weed control treatments was calculated according to Heady and Dillon (1961) as follows:

Gross income = yield/ ton x price of tons.

Gross margin = gross income – total cost.

Benefit/ cost ratio = gross income/ total cost.

G-Statistical analysis

Mean values of each trait were subjected to the analysis of variance to test the significance as described by Gomez and Gomez (1984), using MSTAT-Computer V4. The comparisons of treatment means were done with Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

It was noticed that the experimental soil of the two sites was moderately infested by both grassy and broadleaf weeds species. The weed species included *Portulaca oleracea* L.; *Sonchus oleraceus* L.; *Chenopodum album* L.; *Bidens bipinnata* L.; *Amaranthus ascendenss* lois; *Xanthium strumarium* L. and *Malva parviflora* L. as annual broad-leaved weeds with infestation rates 0.69 ton and 1.17 ton dry weight/ fed. in first and second seasons, respectively. Meanwhile, annual grassy weeds were *Echinochloa colonum* L.; *Brachiaria reptans* L.; *Phalaris minor* L. and *Setaria viridis* L. with infestation rates 0.25 ton and 0.29 ton dry weight/ fed. in the both seasons, respectively.

1. Effect of nitrogen fertilizer rates on

1.1. Weeds growth

Data presented in Table (2) revealed that there were significant differences between the two rates of nitrogen fertilizer on dry weight of weeds in both seasons. N fertilization rate at 120 kg N/ fed. increased percentage of the dry weight of broadleaf weeds, grassy weeds and their total by 43.3, 19.8 and 35.5% in the 1st season, respectively, and 5.8, 1.5 and 4.8% in the 2nd season respectively, as compared with 90 kg N/ fed. These results may be increasing photosynthesis by nitrogen application.

1.2. Vegetative growth, yield and its components of taro

The obtained data for growth characters, yield and its components of taro are given in Table (2). Rates of the applied N significantly affected plant height and leaves number per plant in both seasons. In these respective, high values of plant height and average number of leaves/plant were achieved by application of N at 120 kg/ fed. (165.6 cm and 9.0 in the first season, respectively, corresponding to 157.1 cm and 7.9 in the second season, respectively). Meanwhile, N fertilizer at 90 kg/ fed. gave the lowest values for these characters (159.1 cm and 7.7 in the first season and 141.1 cm

and 6.6 in the second season, respectively). These results are in agreement with results report by Mondrati (2014) on taro and stated that the plant growth parameters (plant height and number of leaves per plant) increased with increasing N level. In contrast, El-Sharkawy (2007) and Walter and Falaniko (2016) found that the growth rate of taro increasing with increased the rate of nitrogen fertilizer to a certain extent and then decreases.

Concerning the effect of nitrogen fertilizer rates on taro yield, its components and dry matter % there were no significant differences effect in both seasons. On the contrast, corm diameter and corm weight (kg) increased significantly with 90 kg N/ fed. and were 2.4 and 9.9 %, respectively, compared with 120 kg N/ fed. in the second season only. The results agreed with Hartemink *et al.* (2000) who mentioned that the yield of marketable taro corms was not affected by N fertilizer (0, 100, 200, 300 and 400 kg/ ha). While, El-Sharkawy (2007), Mondrati (2014) and Walter and Falaniko (2016) stated that the yield and quality of taro were affected significantly by different N fertilizer levels. From the obtained results, we can state that low nitrogen fertilization rate was the best utilization

1.3. Leaves chlorophyll reading of taro

From the obtained data in Table (2) it was noticed that there are no significant differences between 120 or 90 kg N /fed. treatments on leaves of chlorophyll reading in taro plant (mg/ g) in both seasons. The results agree with El-Sharkawy (2007) who stated that the chlorophyll content of taro leaves showed non-significant differences between N fertilizer rates.

Table 2. Effect of two nitrogen rates on dry weight of mixture annual weeds growth and vegetative growth, yield components and leaves chlorophyll reading of taro in 2015 and 2016 seasons

Nitrogen rates kg/ fed.	Dry weight of annual weeds g/ m^2			Vegetative growth, yield components and leaves chlorophyll reading of taro							
	Broad weeds	Narrow weeds	Total weeds	Plant height (cm)	Leaves number/ plant	Corm diameter (cm)	Corm length (cm)	Corm weight (kg)	Fresh yield (t/ fed.)	Dry matter (%)	Leaves chlorophyll reading (mg/ g)
2015 season											
90	24.5b	12.1b	36.6b	1591b	7.7b	8.8a	9.0a	1.23a	12.2a	33.4a	41.9a
120	35.1a	14.5a	49.6a	165.6a	9.0a	8.7a	9.2a	1.22a	12.37a	33.5a	39.4a
2016 season											
90	44.7b	13.4a	58.1b	141.1b	6.6b	8.3a	8.6a	1.01a	11.2a	31.5a	39.3a
120	47.3a	13.6a	60.9a	157.1a	7.9a	8.1b	8.5a	0.91b	11.29a	31.4a	37.5a

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test

1.4. Nitrogen uptake in weeds, nitrogen uptake in taro corm, taro protein percent and taro starch percent.

Data in Table (3) indicated that the increasing N fertilization to 120 kg/ fed. significant increases in nitrogen uptake as kg/ fed. in weeds by 39.7 and 27.6%, in both seasons, respectively as compared with N fertilization with 90 kg/ fed. Meanwhile, no significant differences were observed between 90 or 120 N kg/ fed. for nitrogen uptake (kg/ fed.), protein % and starch % in taro corm in both seasons.

Table 3. Effect of two nitrogen rates on nitrogen uptake in weeds and taro corm, taro protein percent and taro starch percent in 2015 and 2016 seasons

Nitrogen rates kg/ fed.	Nitrogen uptake in weeds (kg/ fed.)	Nitrogen uptake in taro corm (kg/ fed.)	Taro protein %	Taro starch %
2015 season				
90	6.96b	35.2a	5.1a	48.5a
120	9.72a	35.1a	4.6a	44.7a
2016 season				
90	9.84b	25.5a	5.2a	50.1a
120	12.56a	25.3a	4.7a	46.2a

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test

2. Effect of weed control treatments on

2.1. Weeds growth

All herbicidal treatments and hand hoeing exerted significant reduction percentage on the dry weight of presented weeds as compared with untreated check in both seasons (Table 4). Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. decreased in the dry weight of broad leaf, grassy and their total weight by 97.7, 94.9 and 96.9 % in the first season, respectively and by 95.9, 91.9 and 95.1 % in the second season, respectively compared to control. Sencor at 300 g/ fed. plus Roundup at one liter/ fed. reduced the previous respective weeds by 94.3, 90.8 and 93.3% in the first season, and by 95.3, 91.3 and 94.5 5 in the second season. Harness at one liter/ fed. plus Roundup at one liter/ fed. reduced the previous respective weeds by 94.2, 90.8 and 93.3 % in the first season, respectively and by 95.2, 91.3 and 94.5 % in the second season respectively. While, the efficacies of the rest weed control methods were in descending order as follows: Roundup at one liter/ fed., hand hoeing twice, Stomp extra at 1.7 liter/ fed., Sencor at 300 g/ fed. and Harness at one liter/ fed. compared to untreated check (control) in both seasons.

Table 4. Effect of weed control treatments on dry weight of mixture annual weeds, taro vegetative growth and taro yield components in 2015 and 2016 seasons

Weed control treatments rate/ fed.	Time of application*	Dry weight of annual weeds g/ m2			Vegetative growth and yield components of taro							
		Broad weeds	Narrow weeds	Total weeds	Plant height (cm)	No of leaves/ plant	Leaves chlorophyll reading (mg/g)	Corm diameter (cm)	Corm length (cm)	Corm weight (kg)	Yield (t/ fed.)	Dry matter %
2015 season												
Harness 84% at 1 L	Post-sow.	27.9b	10.0c	37.9b	153.2e	6.6e	34.9f	7.6f	8.5e	1.17e	11.5e	32.2c
Harness plus Roundup	Post-sow. + pre em.	9.4f	5.6de	15.0f	173.0b	9.0bc	40.4c	9.5bc	9.4bc	1.31e	13.4b	33.1a
Stomp extra 45.5 % at 1.7 L	Post-sowing	15.9d	7.6cd	23.4d	157.5de	7.1b	36.4de	9.2cd	8.4e	1.29dc	12.5cd	32.8b
Stomp extra plus Roundup	Post-sow. + pre em.	3.8g	3.1e	6.9g	181.2a	9.8a	46.0a	10.0a	10.6a	1.49a	14.9a	33.3a
Sencor 70% at 300 g	pre em.	19.4c	13.7b	33.1c	160.2cd	7.8d	36.4de	8.5e	8.7de	1.07f	11.9de	32.2b
Sencor70 % plus Roundup	pre em.	9.3ef	5.6de	14.9f	174.0b	9.5ab	42.7b	9.8ab	9.8b	1.37b	13.5b	33.2a
Roundup 48% at 1.0 L	pre em.	11.2e	6.0e	17.2f	163.5c	8.5c	38.4cd	8.9de	9.0cd	1.25d	12.6c	32.7b
Hand hoeing twice	After 25-40days	10.0ef	9.5c	19.5e	162.5cd	8.5c	37.2e	8.8e	9.3bc	1.12ef	11.8de	33.3c
Untreated check	-	163.3a	60.6a	223.9a	136.5f	5.5f	33.0f	6.7g	7.7f	0.95g	9.4f	30.8d
2016 season												
Harness 84% at 1 L	Post-sow.	29. 0b	9.8b	38.8b	132.7d	6.0e	36.6e	6.9f	8.5c-e	0.90d	10.4e	28.1f
Harness plus Roundup	Post-sow. + pre em.	13.2e	5.9c	19.1e	164.2a	8.5b	43.2c	8.6c	9.0bc	0.98bc	12.0b	31.6b
Stomp extra 45.5 % at 1.7 L	Post-sowing	20.3d	6.7c	27.0d	145.5c	6.6d	37.4c	8.3cd	8.0e	0.98bc	11.2cd	30.8c
Stomp extra plus Roundup	Post-sow. + pre em.	11. 3e	5.5c	16.8e	171.0a	9.1a	48.5a	9.9a	10.0a	1.14a	12.9a	32.0a
Sencor 70% at 300 g	pre em.	26.3c	7.8bc	34.1c	155.3b	7.3c	39.0de	7.6e	8.8bc	0.95cd	11.4c	28.3e
Sencor70 % plus Roundup	pre em.	13.0e	5.9c	18.9e	166.7a	8.6b	45.0b	9.3b	9.4b	1.01b	12.2b	31.5b
Roundup 48% at 1.0 L	pre em.	14.2e	6.2c	20.4e	154.5b	7.5c	41.7cd	8.5cd	8.5c-e	0.94cd	11.4c	30.9c
Hand hoeing twice	After 25-40days	15.0e	6.2c	21.2e	151.5bc	7.1c	40.8cd	8.1de	8.3de	0.94cd	11.0d	29.3d
Untreated check	-	277.8a	67.9a	345.6a	100.7e	4.5e	33.8f	6.3g	6.9f	0.77e	8.5f	27.2g

*Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence, hand hoeing after 25 and 40 days from sowing.

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test.

2.2. Vegetative growth, yield and its components of taro

Data presented in Table (4) revealed that all herbicidal treatments and hand hoeing twice favorably affected the vegetative growth and yield of taro plants in both seasons. The significant increasing percentages of plant height (cm), leaves number/ plant, corm fresh weight (kg), corm length (cm), corm diameter (cm) and fresh and dry weight yield (ton/ fed.) were 32.7, 78.2, 49.3, 37.7, 56.8, 58.5 and 8.11 % in the first season, respectively, by Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. than untreated check and were 69.8, 102.2, 57.1, 44.9, 48.1, 51.8 and 17.6 % in the second season, respectively. Sencor at 300 g/ fed. plus Roundup at one liter/ fed. was the following treatment on increasing the previous respective characteristics by 27.5, 72.7, 46.3, 27.3, 44.2, 43.6 and 7.79 % than untreated check in the first season, respectively, and were 65.5, 91.1, 47.6, 30.4, 31.2, 43.5 and 15.8 % in the second season, respectively. Harness at one liter/ fed. plus Roundup at one liter/ fed. than untreated check gave the third following treatment in increasing percentage the previous respective characteristics by 26.7, 63.6, 41.8, 22.1, 37.9, 42.5 and 7.46 % in the first season, respectively, and 63.1, 88.9, 36.5, 30.4, 27.3, 41.2 and 16.2 % in the second season, respectively. Similar results were obtained by Oluwafemi (2013) who indicated that the use of herbicides and hand weeding had a significant positive relationship with vegetative growth and yield of taro. This result may be contributed to lower weed number followed by reduction of dry matter of weeds and lower weeds yield. Moreover, weeds which emerge earlier during the first three months after sowing lead to endanger reduction in the crop yield more than those appeared later. It has been shown that the most damaging effect of weed competition on yield was weed competition with taro plants during canopy formation and early tuberization (third month after sowing) and less than from the fourth months until harvest.

2.3. Leaves chlorophyll reading of taro

All weed control treatments increased significantly leaves chlorophyll reading of taro leaves in both seasons (Table 4). Stomp extra at 1.7 liter/ fed., Sencor at 300 g/ fed. and Harness at one liter/ fed. each plus Roundup at one liter/ fed. gave the highest significant increases by 39.4, 29.4 and 22.4 % in the first season, respectively, and by 43.5, 33.1 and 27.8 % in the second season, respectively, as compared with untreated check. Meanwhile, the other treatments *i.e.* Roundup at one liter/ fed., hand hoeing twice, Sencor at 300 g/ fed., Stomp extra at one liter/ fed. and Harness at one liter/ fed. showed increasing percentage in chlorophyll reading in taro leaves by 16.4, 12.7, 10.3, 10.3 and 5.8 % in the first season, respectively, and by 23.3, 20.7, 15.4, 10.7 and 8.3 % in the second season, respectively compared with untreated check. The improvements of chlorophyll content may be directly to the elimination of weed competition on nitrogen uptake and other nutrients which improve taro growth and synthetic chlorophyll pigment apparatus or direct stimulation of herbicide.

2.4. Nitrogen uptake in weeds, nitrogen uptake in taro corm, taro protein percent and taro starch percent.

Data in Table (5) and Figs (1 and 2) showed that all weed control treatments decreased significantly nitrogen withdrawal in weeds from soil as compared with untreated check. These results were true in both 2015 and 2016 seasons. The percentage of reduction of nitrogen withdrawal were estimated by 98.9, 96.5, 95.8, 95.0, 92.3, 89.4, 85.9 and 85.3% in 2015 season and the respective values for these treatments were 96.8, 96.2, 96.1, 96.1, 96.1, 93.4, 92.3 and 90.1% in 2016 season than untreated check and vice versa with nitrogen uptake in taro corm as kg/ fed. which trended to be increased significantly under various weed control treatments than untreated check in both seasons. These increases percentage were 96.4, 94.2, 68.3, 64.7, 58.5, 58.0, 55.8 and 17.0 in 2015 season and 252.2, 178.3, 133.9, 121.7, 117.4, 114.8, 93.9 and 74.8 in 2016 season of the mentioned herbicides or hand hoeing than untreated check treatment, respectively. These above results suggested clearly that weeds can compete about N uptake from soil and controlling these weeds by herbicides or hand hoeing can minimize nitrogen elimination by weeds in favor of improving taro crop. Similar results were obtained by herbicides and hand hoeing for protein % and starch % in both seasons. All herbicidal treatments and hand hoeing gave high significant increase protein and starch percentage in both seasons. Stomp extra at rate of 1.7 liter/ fed. plus Roundup at one liter/ fed. increased protein and starch percentage by 62.2 and 49.4 % in the first season, respectively, and by 48.7 and 44.8 % in the second season, respectively compared to untreated treatment.

Table 5. Effect of weed control treatments on chemical analysis of taro in 2015 and 2016 seasons

Weed control treatments rate/ fed.	Time of application*	Nitrogen uptake in weeds (kg/ fed.)	Nitrogen uptake in corm taro yield (kg/fed.)	Taro protein %	Taro starch %
2015 season					
Harness 84% at 1.0 L	Post-sow.	7.2b	26.2c	4.5d	43.9c
Harness plus Roundup	Post-sow. + pre em.	1.72c	35.4b	5.2bc	50.1ab
Stomp extra 45.5 % at 1.7 L	Post-sowing	3.6bc	36.9b	5.0b-d	48.1bc
Stomp extra plus Roundup	Post-sow. + pre em.	0.92c	44.0a	6.0a	53.2a
Sencor 70% at 300 g	pre em.	5.24bc	34.9b	4.5cd	44.2c
Sencor plus Roundup	pre em.	2.08c	43.5a	5.3b	49.7ab
Roundup 48% at 1.0 L	pre em.	2.44c	35.5b	4.9b-d	47.9bc
Hand hoeing twice	After 25-40days	6.92bc	37.7ab	4.7b-d	46.3bc
Untreated check	-	49.0a	22.4c	3.7e	35.6d
2016 season					
Harness 84% at 1.0 L	Post-sow.	7.0b	20.1e	4.7c	46.0c
Harness plus Roundup	Post-sow. + pre em.	2.72b	24.7cd	5.2b	51.1b
Stomp extra 45.5 % at 1.7 L	Post-sowing	4.4b	25.0cd	4.8c	46.9c
Stomp extra plus Roundup	Post-sow. + pre em.	2.24b	40.5a	5.8a	55.6a
Sencor 70% at 300 g	pre em.	5.48b	22.3de	4.7c	46.3c
Sencor plus Roundup	pre em.	2.72b	32.0b	5.5ab	53.0ab
Roundup 48% at 1.0 L	pre em.	2.68b	25.5c	4.7c	46.1c
Hand hoeing twice	After 25-40days	2.76b	26.9c	5.1bc	49.9bc
Untreated check	-	70.76a	11.5f	3.9d	38.4d

*Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence, hand hoeing after 25 and 40 days from sowing.

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test.

Sencor at 300 g/ fed. plus Roundup at one liter/ fed. increased the previous characteristics by 43.2 and 39.6 % in the first season, respectively, and by 41.0 and 38.0% in the second season, respectively. Whilst, Harness at one liter/ fed. plus Roundup at one liter/ fed. gave the following increasing by 21.6 and 23.2% in the first season, respectively, and by 20.5 and 19.0% in the second season, respectively compared to untreated treatment.

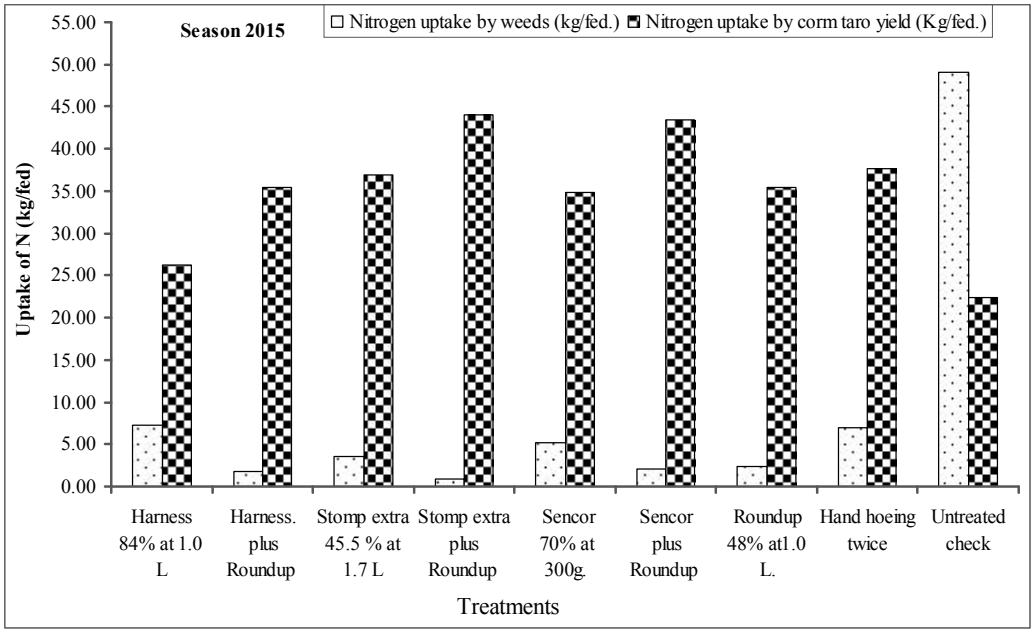

Fig. 1. Nitrogen uptake in weeds and taro corm in the first season

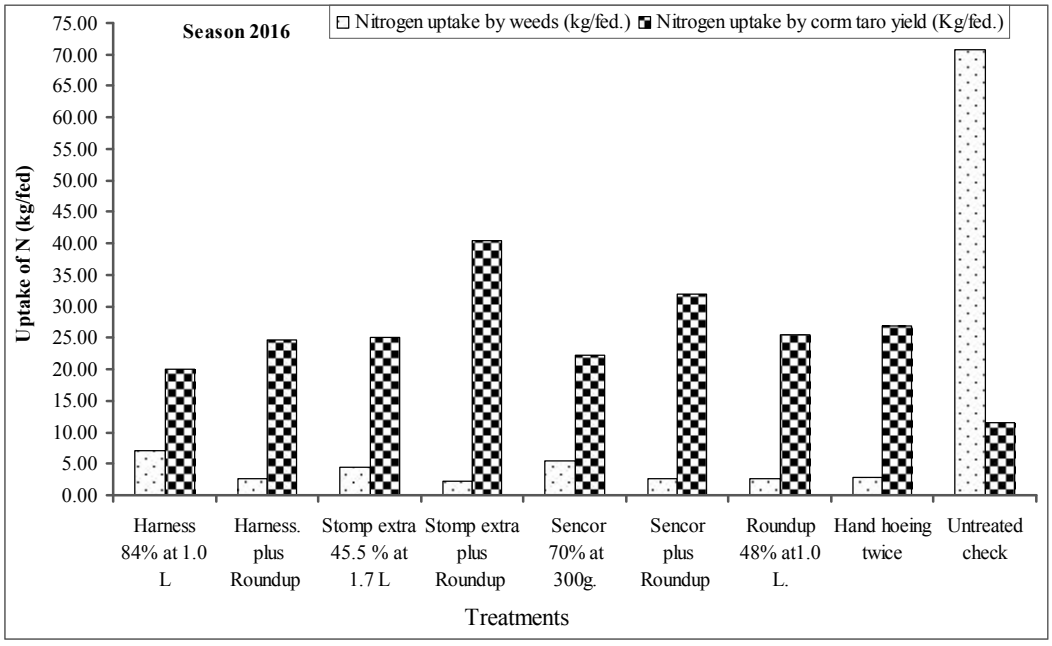

Fig. 2. Nitrogen uptake in weeds and taro corm in the second season

3. Effect of interaction between the two nitrogen fertilizer rates and weed control treatments on

3.1. Weeds growth

The effect of interaction between nitrogen fertilizer rates and weed control treatments caused significant reduction in the dry weight of weeds in both seasons (Table 6). The application of Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. with 90 kg nitrogen/ fed. gave the highest reduction percentage in dry weight of broadleaf, grassy weeds and their total compared to the interaction between untreated control under 120 kg nitrogen/ fed. The same weed control treatment with 120 kg N/ fed. gave the second highest reduction in the dry weight of the two weed categories and their total then the application of Harness at one liter/ fed. or Sencor at 300 g/ fed. each plus Round up at one liter/ fed. with 90 kg N/ fed. gave the following reduction in the two weed categories and their total in both seasons. Furthermore, the interactions between Roundup at one liter/ fed. with 90 kg N/ fed. or 120 kg N/ fed. reduced the dry weight of the two weed categories and their total and were approximately equal to the interaction between hand hoeing twice with 90 or 120 kg N/ fed. While, the lowest significant reduction was obtained by the rest interactions between the three soils applied treatments individually with 90 or 120 kg N/ fed. It can be concluded that using two herbicides together at different time and mode of action improved controlling weeds and gave taro plants chance to grow well without weed competition with 90 kg N /fed.

3.2. Vegetative growth, yield and its components of taro

Results in Table (7) showed significant increase in growth characteristics of taro plants (plant height (cm) and number of leaves/ plant) as well as yield and its components (yield t/ fed., corm diameter (cm), corm length, corm weight (kg) and dry matter %) in the both seasons by all interactions between weed control treatments and N fertilizer rates. The highest values of plant height (cm) and number of leaves/ plant were by application of Stomp extra at rate 1.7 liter/ fed. plus Roundup at one liter/ fed. under 120 kg N/ fed. following by Sencor at 300 g/ fed. plus Roundup at one liter/ fed. under 120 kg N/ fed. compared with the interaction between control treatment under 90 kg N /fed. in both seasons. Concerning, the corm diameter, corm length, corm weight, dry matter and yield of taro increased by application of Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. with 90 or 120 kg N/ fed. compared to the interaction between control treatment under 90 or 120 kg N /fed. in both seasons.

Table 6. Effect of the interaction between nitrogen rates and weed control treatments on dry weight of annual weeds during 2015 and 2016 seasons

Nitrogen rate kg/ fed.	Weed control treatments rate/ fed.	Time of application*	Dry weight of annual weeds g/ m^2		
			Broad weeds	Narrow weeds	Total weeds
2015 season					
90	**Harness 84% at 1.0 L**	Post-sow.	24.4d	8.0ef	32.4e
	Harness plus Roundup	Post-sow. + pre em.	7.0hi	5.0f-h	12.0k
	Stomp extra 45.5 % at 1.7 L	Post-sowing	14.5ef	7.1e-g	21.5h
	Stomp extra plus Roundup	Post-sow. + pre em.	3.8i	2.7h	6.6l
	Sencor 70% at 300 g	pre em.	16.6e	12.4cd	29.0f
	Sencor plus Roundup	pre em.	8.9h	3.7gh	12.5k
	Roundup 48% at 1.0 L	pre em.	8.7h	5.3gh	13.9k
	Hand hoeing twice	After 25-40days	8.8h	8.5d-f	17.4ij
	Untreated check	-	128.2b	57.7b	185.9b
120	**Harness 84% at 1.0 L**	Post-sow.	31.3c	12.0cd	43.3c
	Harness plus Roundup	Post-sow. + pre em.	8.3hi	6.3f-h	14.6jk
	Stomp extra 45.5 % at 1.7 L	Post-sowing	17.3e	8.1ef	25.3g
	Stomp extra plus Roundup	Post-sow. + pre em.	3.8i	3.5gh	7.3l
	Sencor 70% at 300 g	pre em.	22.2d	15.0c	37.1d
	Sencor plus Roundup	pre em.	9.8gh	7.5e-g	17.2ij
	Roundup 48% at 1.0 L	pre em.	13.7e-g	6.7f-h	20.4i
	Hand hoeing twice	After 25-40days	11.1f-h	10.4de	21.5h
	Untreated check	-	198.4a	63.4a	261.8a
2016 season					
90	**Harness 84% at 1.0 L**	Post-sow.	28.3c	9.5cd	37.8cd
	Harness plus Roundup	Post-sow. + pre em.	12.4e	5.5e	17.8g
	Stomp extra 45.5 % at 1.7 L	Post-sowing	20.0d	6.6de	26.5f
	Stomp extra plus Roundup	Post-sow. + pre em.	10.7e	5. 0e	15.7g
	Sencor 70% at 300 g	pre em.	26.1c	7.7c-e	33.9e
	Sencor plus Roundup	pre em.	12.8e	5.5e	18. 3g
	Roundup 48% at 1.0 L	pre em.	14.1e	6.0e	20.1g
	Hand hoeing twice	After 25-40days	14.7e	5.1e	19.8g
	Untreated check	-	269.0b	66.2a	335.2b
120	**Harness 84% at 1.0 L**	Post-sow.	29.7c	10.1c	39.8c
	Harness plus Roundup	Post-sow. + pre em.	14. 0e	5.7e	19.7g
	Stomp extra 45.5 % at 1.7 L	Post-sowing	20.7d	6.8c-e	27.5f
	Stomp extra plus Roundup	Post-sow. + pre em.	11.9e	5.9e	17.8g
	Sencor 70% at 300 g	pre em.	26.4c	7.9c-e	34.3de
	Sencor plus Roundup	pre em.	13.2e	6.3de	19.5g
	Roundup 48% at 1.0 L	pre em.	14.2e	6.4de	20.6g
	Hand hoeing twice	After 25-40days	15.4e	7.2c-e	22.6g
	Untreated check	-	286.5a	69.6b	356.1a

*Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence , hand hoeing after 25 and 40 days from sowing.

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test.

Table 7. Effect of the interaction between nitrogen fertilizer rates and weed control treatments on vegetative growth, leaves chlorophyll reading and yield components of taro during 2015 and 2016 seasons

Nitrogen rate kg/ fed.	Weed control treatments rate/ fed.	Time of application*	Plant height (cm)	N. of leaves /plant	leaves chlorophyll reading (mg/g)	Corm diameter (cm)	corm length (cm)	Corm weight (kg)	Fresh yield (t/fed.)	Dry mater %
2015 season										
90	**Harness 84% at 1.0 L**	Post-sow.	151.5h	5.6lm	35.5eh	7.7fg	8.3g	1.16f	11.6ef	33.1d
	Harness plus Roundup	Post-sow. + pre em.	168.0de	8.0gi	40.7cd	9.5ab	9.4b-d	1.31b-d	13.4b	33.8a
	Stomp extra 45.5 % at 1.7 L	Post-sowing	156.5gh	6.0kl	37.1dg	9.4bc	8.4g	1.30b-d	12.4c-e	32.0c
	Stomp extra plus Roundup	Post-sow. + pre em.	176.0bc	9.0df	48.8a	10.0a	10.5a	1.50a	15.1a	34.2a
	Sencor 70% at 300 g	pre em.	158.0fg	6.6jk	37.1dg	8.8de	8.6fg	1.07g	11.9ef	32.1c
	Sencor plus Roundup	pre em.	169.0cd	8.6eg	44.7b	9.8ab	9.9b	1.38b	13.4b	33.9a
	Roundup 48% at 1.0 L	pre em.	162.0dg	7.3ij	38.7de	8.8de	9.0d-f	1.27d	13.06b-d	32.9bc
	Hand hoeing twice	After 25-40days	160.5eg	7.6hi	37.4dg	8.7de	9.3c-e	1.12fg	12.0ef	31.9c
	Untreated check	-	131.0j	5.0m	33.9gh	6.6h	7.7i	0.94h	9.3g	30.8e
120	**Harness 84% at 1.0 L**	Post-sow.	155.0gh	7.6hi	34.4fh	7.6h	8.7f-h	1.18ef	11.47ef	33.2d
	Harness plus Roundup	Post-sow. + pre em.	178.0b	10.0ac	40.1cd	9.4bc	9.4cd	1.30bc	13.34bc	34.1a
	Stomp extra 45.5 % at 1.7 L	Post-sowing	158.5fh	8.3fh	35.7eh	8.9de	8.4gh	1.28cd	12.51d	33.8a-c
	Stomp extra plus Roundup	Post-sow. + pre em.	186.5a	10.6a	43.2bc	10.0a	10.7a	1.48a	14.89a	33.9a-c
	Sencor 70% at 300 g	pre em.	162.5dg	9.0df	35.8eh	8.3g	8.8e-g	1.08gh	11.84e	33.7a-c
	Sencor plus Roundup	pre em.	179.0ab	10.3ab	40.7cd	9.7ab	10.1b	1.37b	13.50b	34.1a
	Roundup 48% at 1.0 L	pre em.	165.0df	9.6bd	38.1df	8.9de	9. 0ef	1.24c-e	12.77cd	33.7a-c
	Hand hoeing twice	After 25-40days	164.5df	9.3ce	37.1dg	8.8d-f	9.4cd	1.12f-h	11.57ef	33.5c
	Untreated check	-	142.0i	6.0kl	32.2h	6.8i	7.8i	0.95i	9.47g	31.5e
2016 season										
90	**Harness 84% at 1.0 L**	Post-sow.	125.0e	5.3g	37.8fh	7.0ig	8.5d-f	0.95e-h	10.4g	30.8g
	Harness plus Roundup	Post-sow. + pre em.	153.0bc	8.0c	44.7bd	8.7c-e	9.0bc	1.03b-d	11.9bc	33.0bc
	Stomp extra 45.5 % at 1.7 L	Post-sowing	138.5d	6.0f	39.1eh	8.4e-g	7.9fg	1.02b-e	11.3d-f	3.2c-f
	Stomp extra plus Roundup	Post-sow. + pre em.	162.0b	8.3c	49.4a	10.0a	10.1a	1.19a	12.9a	33.2a
	Sencor 70% at 300 g	pre em.	153.0bc	6.6e	41.4df	7.7gh	8.9b-f	0.99d-f	11.5cd	31.0fg
	Sencor plus Roundup	pre em.	155.0bc	8.0c	45.4bc	9.4b	9.5a-c	1.06b	12.1b	32.9b
	Roundup 48% at 1.0 L	pre em.	148.5cd	6.6e	42.2ce	8.6d-f	8.6c-f	1.00c-f	11.4d	3.2.4c-f
	Hand hoeing twice	After 25-40days	146.0cd	6.3ef	41.8ce	8.1e-h	8.2ef	0.99c-f	10.9f	31.5d
	Untreated check	-	89.0g	4.0h	36.0h	6.4jk	6.9h	0.83j	8.4h	27.6h
120	**Harness 84% at 1.0 L**	Post-sow.	140.5d	6.6e	35.5hi	6.8hi	8.4e	0.85d-f	10.47g-i	31.0f
	Harness plus Roundup	Post-sow. + pre em.	175.5a	9.0b	41.7cf	8.5c	9.0bc	0.93bc	12.17bc	33.2bc
	Stomp extra 45.5 % at 1.7 L	Post-sowing	152.5bc	7.3d	35.7h	8.2c-e	8.0f	0.94bc	11.23d-f	3.26cd
	Stomp extra plus Roundup	Post-sow. + pre em.	180.0a	10.0a	47.7ab	9.8a	9.9a	1.10a	12.99a	33.6a
	Sencor 70% at 300 g	pre em.	157.7bc	8.0c	36.7gh	7.5g	8.6de	0.91b-d	11.42de	31.5ef
	Sencor plus Roundup	pre em.	178.5a	9.3b	44.7bd	9.2b	9.3b	0.97b-c	12.30b	33.1b
	Roundup 48% at 1.0 L	pre em.	160.5b	8.3c	41.1df	8.4cd	8.4e	0.89b-e	11.97de	32.6cd
	Hand hoeing twice	After 25-40days	157.0bc	8.0c	39.9eg	8.0d-f	8.3c-f	089c-f	11.04ef	31.6de
	Untreated check	-	112.5f	5.0g	31.7i	6.2k	6.97h	0.73h	8.56j	27.9g

*Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence , hand hoeing after 25 and 40 days from sowing.

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test.

3.3. Leaves chlorophyll reading of taro

The interactions between Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. under 90 kg N /fed. gave the highest increasing percentage in leaves chlorophyll reading of taro compared to the interaction between control treatment under 120 kg N /fed. in both seasons.

3.4. Nitrogen uptake in weeds, nitrogen uptake in taro corm, taro protein percent and taro starch percent

Data in Table (8) indicated that the interaction between Stomp extra at 1.7 liter/ fed. plus Roundup at one liter/ fed. with 90 kg N/ fed. gave the highest reduction percentage in nitrogen uptake in weeds (kg/fed.) by 98.5 and 97.5% in the first and second seasons, respectively, as compared to control treatment with 120 kg N/ fed. On the contrast, the interactions between Stomp extra plus Roundup with 90 kg N /fed. gave the highest increasing percentage in nitrogen uptake in corms, protein percentage and starch percentage of taro corms in both seasons.

Table 8. Effect of the interaction between nitrogen fertilization rates and weed control treatments on chemical analysis of taro during 2015 and 2016 seasons.

Nitrogen rates (kg/ fed.)	Weed control treatments rate/ fed.	Time of application*	Nitrogen uptake in weeds (kg/ fed.)	Nitrogen uptake in taro (kg/ fed.)	Taro protein %	Taro starch %	Nitrogen uptake in weeds (kg/ fed.)	Nitrogen uptake corm taro (kg/ fed.)	Taro protein %	Taro starch %
			2015season				2016 season			
90	Harness 84% at 1.0 L	Post-sow.	5.84d	26.4c-e	4.5c-e	44.3de	6.32c	20.2f	5.0d-g	48.5c-f
	Harness plus Roundup	Post-sow. + pre em.	1.52d	35.5a-c	5.4a-c	51.7ab	2.48c	24.6c-e	5.4b-d	52.7a-d
	Stomp extra 45.5 % at 1.7 L	Post-sowing	3.12cd	37.2ab	5.4a-c	51.9ab	4.2c	24.9c-e	5.0c-f	49.3b-e
	Stomp extra plus Roundup	Post-sow. + pre em.	0.84d	44.3a	6.1a	54.7a	2.0c	40.7a	6.1a	56.4a
	Sencor 70% at 300 g	pre em.	4.56cd	35.0b-d	4.7c-e	45.5cd	5.36c	22.1ef	4.9d-g	47.6d-f
	Sencor plus Roundup	pre em.	1.64d	43.3ab	5.9ab	52.3ab	2.6c	32.0b	5.7ab	54.0a-c
	Roundup 48% at 1.0 L	pre em.	1.88d	35.5a-c	5.2b-d	50.5a-c	2.56c	25.5c-e	4.9d-g	47.8d-f
	Hand hoeing twice	After 25-40days	2.68cd	37.6ab	4.7c-e	46.4b-d	2.52c	26.3cd	5.2b-d	51.4a-d
	Untreated check	-	40.52B	22.6e	4.0ef	39.0e	60.46b	11.5g	4.4g	43.2f
120	Harness 84% at 1.0 L	Post-sow.	8.6c	26.0de	4.5fg	43.6de	7.72c	20.1f	4.5fg	43.6f
	Harness plus Roundup	Post-sow. + pre em.	1.96d	35.3a-c	5.1c-e	48.5b-d	2.96c	24.7c-e	5.1c-e	49.5b-e
	Stomp extra 45.5 % at 1.7 L	Post-sowing	4.04cd	36.7ab	4.6e-g	44.3de	4.64c	25.0c-e	4.6e-g	44.5ef
	Stomp extra plus Roundup	Post-sow. + pre em.	1.04d	43.6ab	5.6a-c	51.7ab	2.48c	40.4a	5.6a-c	54.7ab
	Sencor 70% at 300 g	pre em.	5.8cd	34.9b-c	4.6e-g	42.9de	5.6c	22.5d-f	4.6e-g	45.0ef
	Sencor plus Roundup	pre em.	2.52cd	43.6ab	5.3b-d	47.0b-d	2.88c	32.0b	5.3b-d	52.0a-d
	Roundup 48% at 1.0 L	pre em.	2.96cd	35.6ab	4.5e-g	45.3cd	2.76c	25.4c-e	4.5e-g	44.3ef
	Hand hoeing twice	After 25-40days	3.2cd	37.9ab	5.0d-g	46.3b-d	3.04c	27.5c	5.0d-g	48.5c-f
	Untreated check	-	57.32a	22.3e	3.5h	32.3f	80.88a	11.6g	3.5h	33.5g

**Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence , hand hoeing after 25 and 40 days from sowing.

Values within the same column followed by the same letters are not significantly different at 5% level Duncan's multiple range test.

4. Herbicide residues in corms of taro plants

Data in Table (9) and Fig (3-8) demonstrated the stability of the three soil applied herbicides under this study and indicated that residues level of Pendimethalin, Acetachlor and Metribuzin were analyzed in corm taro at harvesting. The results were less than the allowable level according to European Food Safety Authority (EFSA) (2012) and this means that there is no fear from herbicide residues in taro corms at harvesting.

Table 9. Residues for Pendimethalin, Metribuzin and Acetachlor in taro corms.

Sample No.	Residual in taro corms (mg/ kg)	Maximum allowable residues level (mg/ kg)
Pendimethalin	0.0001	0.005
Metribuzin	0.000095756	0.0029
Acetachlor	0.0091	0.019

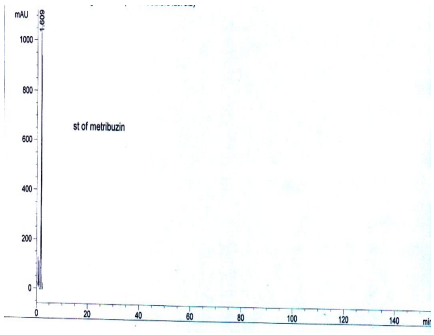

Fig. 3. Standard of Metribuzin.

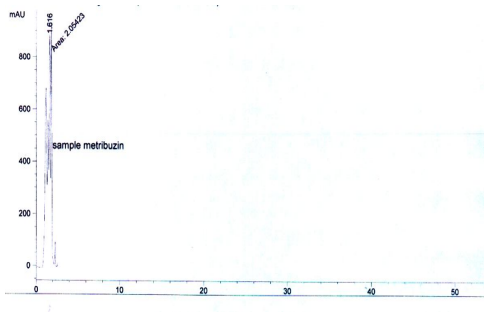

Fig. 4. Sample of Metribuzin

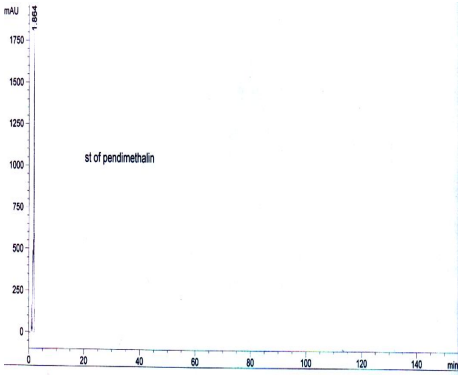

Fig. 5. Standard of Pendimethalin.

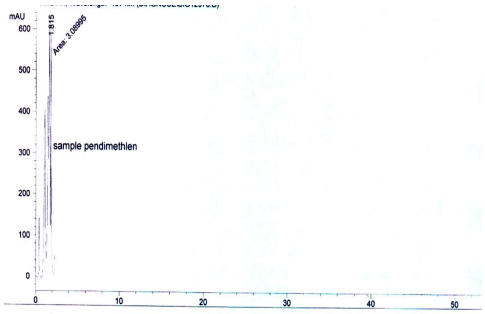

Fig. 6. Sample of Pendimethalin.

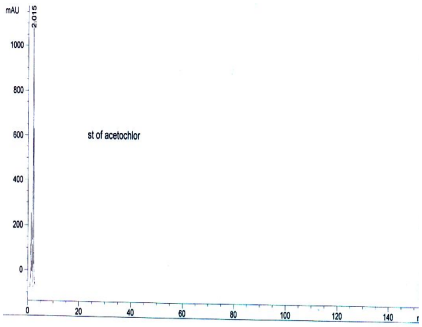

Fig. 7. Standard of Acetachlor

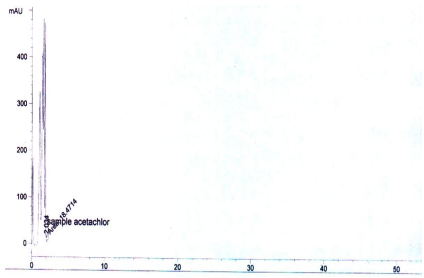

Fig. 8. Sample of Acetachlor

5. Economic feasibility

Data in Table (10) showed that the total costs tended to increase with various weed control treatments and nitrogen fertilizer rates than untreated check due to the increase of price of herbicides or additional amounts of nitrogen rate/ fed. The budget value of cost and gross income of growing taro crop of the total cost of the weeded check was 13.85 and 13.98 thousand L.E. for 90 or 120 kg N/ fed. in 2015 season, respectively. In the second season the total cost of the weeded check was 15.36 and 15.48 thousand L.E., respectively for 90 or 120 kg N/ fed., which considered as fixed cost (land preparation, sowing, fertilization, irrigation, insect control and harvesting) in addition to the variable cost of weed control treatments.

Table 10. Economic determination feasibility for weed control treatments in taro plants under two rates of nitrogen fertilizer during 2015 and 2016 seasons

Nitrogen rates (kg/ fed.)	Weed control treatments rate/ fed.	Time of application*	Total cost Thousand L.E.	Gross income Thousand L.E.	Net benefit Thousand L.E.	Benefit/ cost	Total cost Thousand L.E.	Gross income Thousand L.E.	Net benefit Thousand L.E.	Benefit/ cost
			2015season				2016 season			
90	Harness 84% at 1.0 L	Post-sow.	14.1	23.2	9.1	1.65	15..61	20.8	5.19	1.33
	Harness plus Roundup	Post-sow. + pre em.	14.21	26.8	12.59	1.89	15.81	23.8	7.99	1.51
	Stomp extra 45.5 % at 1.7 L	Post-sowing	13.98	24.8	10.82	1.77	15.49	22.6	7.11	1.5
	Stomp extra plus Roundup	Post-sow. + pre em.	14.18	30.2	16.02	2.13	15.69	25.8	10.11	1.64
	Sencor 70% at 300 g	pre em.	13.93	23.8	9.85	1.71	15.45	23	7.55	1.49
	Sencor plus Roundup	pre em.	14.13	26.8	12.67	1.89	15.65	24.2	8.55	1.55
	Roundup 48% at 1.0 L	pre em.	14.05	26.12	12.07	1.86	15.46	22.8	7.34	1.47
	Hand hoeing twice	After 25-40days	14.35	24	9.65	1.67	15.86	21.8	5.94	1.37
	Untreated check	-	13.85	18.6	4.75	1.34	15..36	18.8	3.44	1.22
120	Harness 84% at 1.0 L	Post-sow.	14.13	22.94	8.81	1.62	15.73	20.94	5.21	1.33
	Harness plus Roundup	Post-sow. + pre em.	14.33	26.68	12.35	1.86	15.93	24.34	8.41	1.53
	Stomp extra 45.5 % at 1.7 L	Post-sowing	14.1	25.02	10.92	1.77	15.61	22.46	6.85	1.44
	Stomp extra plus Roundup	Post-sow. + pre em.	14.3	29.78	15.65	2.08	15.81	25.7	9.9	1.63
	Sencor 70% at 300 g	pre em.	14.05	23.68	9.63	1.69	15.67	22.89	7.22	1.46
	Sencor plus Roundup	pre em.	14.25	27	12.75	1.89	15.87	24.6	8.73	1.55
	Roundup 48% at 1.0 L	pre em.	14.08	25.54	11.46	1.81	15.58	23.94	8.36	1.54
	Hand hoeing twice	After 25-40days	14.48	23.14	8.66	1.6	15.98	22.16	6.18	1.39
	Untreated check	-	13.98	18.94	4.96	1.35	1548	17	1.52	1.1

*Time of application herbicides: Harness as post sowing, Stomp extra as post sowing, Sencor as post emergence after 15 days from sowing, Roundup as post emergence after 25 days from sowing and before taro emergence , hand hoeing after 25 and 40 days from sowing.

Stomp extra at 1.7 liter/ fed. plus Round up at one liter/ fed. with 90 or 120 kg N /fed. gave the highest increasing percentage of gross income, net benefit and the percentage of benefit/ cost more than untreated with 90 or 120 kg/ fed. Whereas,

using Sencor at 300 g/ fed. plus Roundup at one liter/ fed. with 90 or 120 kg N /fed. gave the second highest increasing percentage in gross income, net benefit and the percentage of benefit/ cost more than untreated treatment with 90 or 120 kg N/ fed. then treatment Harness at one liter/ fed. plus Roundup at one liter/ fed. with 90 or 120 kg N/ fed. gave the following increasing percentage of this characters in both seasons.

CONCLUSION

Results of this work demonstrated that taro planting performs better at low nitrogen fertilization at rate of 90 N kg/ fed. and it is very sensitive to weed competition allovers its growing season and thus needs weeds control treatments especially during its first half-life periods. So, Stomp extra at 1.7 liter/ fed., Sencor at 300 g/ fed. and Harness at one liter/ fed. each plus Roundup at one liter/ fed. treatment with 90 N kg/ fed. can be recommended to solve broad leaved and grassy weeds problems through the first half life period of weed competition in taro fields without any phytotoxicity and thus the highest yield (taro corms ton/ fed.) could be obtained. Furthermore, the above herbicide treatments gave the highest values of gross income and net benefit and the residues in corms were less than allowable. Also, there were minor differences between 90 or 120 N kg/ fed. fertilization on all studied parameters, thus the lower rate can be used.

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تأثير التسميد النتروجينى ومعاملات مكافحة الحشائش على نمو الحشائش وإنتاجية وجودة محصول القلقاس والجدوى الإقتصادية له

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أجريت تجربتان حقليتان لمحصول القلقاس بمحطة بحوث البساتين بالقناطر الخيرية بمحافظة القليوبية –مصر باستخدام تصميم أحصائى قطع منشقة مرة واحدة خلال موسمى زراعة 2015 و2016، هذا البحث يهدف لدراسة تأثير معدلين من التسميد النتروجينى موزعه فى القطع الرئيسية وهما 90 أو 120 وحدة نيتروجين للفدان و تسع معاملات لمكافحة الحشائش موزعه فى القطع التحت رئيسية وهى هارنس بمعدل واحد لتر/ فدان تضاف بعد الزراعة وقبل الرى و ستومب أكسترا بمعدل 1.7 لتر/ فدان تضاف بعد الزراعة وقبل الرى و سنكور بمعدل 300جم/ فدان تضاف بعد 15 يوم من الزراعة وقبل الأنبات أى منهم منفرداً أو مع مبيد راونداب بمعدل واحد لتر/ فدان تضاف بعد 25 يوم من الزراعة ومعاملة مبيد راونداب بمعدل واحد لتر/فدان منفرداً بالإضافة الى معاملة العزيق مرتين الأولى بعد 25 يوم من الزراعة والثانية بعد 40 يوم من الزراعة وكذلك معاملة المقارنة (بدون معاملة) على نمو الحشائش والصفات الخضرية وكمية وجودة محصول القلقاس والجدوى الإقتصادية له.

أوضحت النتائج مايلى:

– أعطى التسميد بمعدل 90 وحده نتروجين للفدان اعلى نقص فى الوزن الجاف للحشائش الحولية عريضة وضيقة الأوراق والحشائش الكلية فى موسمى الزراعة وزيادة فى قطر ووزن كورمة القلقاس فى الموسم الثانى فقط، بينما طول نبات القلقاس وعدد أوراق نبات القلقاس وأمتصاص النتروجين فى الحشائش كانت الزيادة مع التسميد بمعدل 120 وحدة للفدان عن التسميد بمعدل 90 وحدة نيتروجين للفدان فى كلا الموسمين، وكانت باقى الصفات المدروسة تحت الدراسة لايوجد بها فرق معنوى تحت المستويين، كما أعطت معاملة ستومب أكسترا بمعدل 1.7 لتر/ فدان بعد الزراعة مضافاً إليه مبيد راونداب بمعدل واحد لتر/فدان بعد 25 يوم من الزراعة أعلى مكافحة للحشائش الحولية الكلية هى 96.9 و 95.1% فى الموسم الأول والثانى على التوالى، وأتبع ذلك أستخدام مبيد سنكور بمعدل 300 جم / فدان تضاف بعد الزراعة مضافاً إليه مبيد راونداب بمعدل واحد لتر/فدان بعد 25 يوم من الزراعة بزيادة تبلغ 93.3 و94.5% فى كلا الموسمين وإنعكس ذلك على نسبة الزيادة فى محصول الكورمات والتى تقدر بـــــــ (43.6 و43.5%) باستخدام المبيدين فى كلا الموسمين، وكذلك أعلى القيم لصفات القلقاس الخضرية مثل طول وعدد أوراق

النبات ومحتوى الكلورفيل لاوراق النبات مثلما أعطى أعلى زيادة معنوية لطول وقطر ووزن كورمة القلقاس ومحصول الكورمات ونسبة المادة الجافة وأمتصاص النتروجين فى الحشائش وكورمات القلقاس وكذلك نسبة البروتين والنشا للقلقاس، ويلى تلك المعاملة فى أعطاء أعلى القيم للصفات السابقة هارنس بمعدل واحد لتر للفدان مضافاً إليه راونداب بمعدل 1 لتر للفدان ثم معاملة العزيق مرتين وراونداب بمعدل 1لتر للفدان والثلاث مبيدات الأرضية كلاً منفرداً على الترتيب فى كلا الموسمين، بتحليل كورمات القلقاس تبين وجود أثر متبقى للمبيدات المستخدمة فى هذه الدراسة ولكن أقل من المستوى المسموح به دوليا، كما أدى إستعمال مبيد الحشائش ستومب اكسترا مع راوند اب أعلى قيم لإجمالى الدخل وصافى الربح ونسبة الربح /التكلفة، بينما كانت متساوية تقريباً تحت تأثير المستويين من النتروجين تحت الدراسة.

توصى هذه الدراسة بإستخدام مبيد ستومب أكسترا بمعدل 1.7 لتر/فدان وهارنس بمعدل واحد لتر/ فدان كلاهما بعد الزراعة وقبل الرى أو سنكور بمعدل 300 جرام /فدان تضاف بعد15 يوم من الزراعة وقبل الإنبات متبوعة بأضافة مبيد الراونداب بعد 25 يوم من الزراعة وقبل إنبات القلقاس لأى منهما و التسميد بمعدل 90 وحده نتروجين للفدان لأعطاء أفضل أنتاجية إقتصادية وجودة لمحصول القلقاس للفدان بدون مخاطر من متبقيات المبيدات.