# Weed management, folic acid and seaweed extract effects on faba bean plants and associated weeds under sandy soil conditions

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**Abstract:** Two field experiments were conducted during the winter seasons of 2014/2015 and 2015/2016 at the agricultural experimental station of the National Research Centre, Nubaria, Egypt. Field evaluation of the efficiency of weed-control treatments (unweeded, oxadiargyl, metribuzin and two hand hoeing) and bio-stimulants levels (folic acid at the rate of 10, 20 and 30 mg $L^{-1}$, and seaweed extract 100, 200 and 300 mg $L^{-1}$) and their interactive effects on faba bean growth, yield, yield attributes and chemical composition of seeds. Two hand hoeing achieved the highest weed depression expressed in the lowest dry matter of broadleaved, narrow-leaved and total weeds. Also, two hand hoeing was the most superior treatment in increasing plant height, shoot dry weight, leaf area index and SPAD value at 60 and 90 days from sowing as well as yield, yield attributes and chemical composition of faba bean seeds followed by that of oxadiargyl and metribuzin treatments. Folic acid at the rate of 30 mg $L^{-1}$ or seaweed extract at the rate of 300 mg $L^{-1}$ enhanced growth, yield and chemical composition of faba bean seeds. Two hand hoeing or oxadiargyl herbicide integrated with folic acid at the rate of 30 mg $L^{-1}$ or seaweed extract at the rate of 300 mg $L^{-1}$ application produced the maximum values of leaf area index, seed yield and total carbohydrate percentage. It could be concluded that two hand hoeing or herbicide oxadiargyl combined with folic acid application up to 30 mg $L^{-1}$ or seaweed extract at the rate of 300 mg $L^{-1}$ could effectively improve growth and productivity of faba bean under sandy soil conditions.

**Keywords:** herbicides, seed yield, folic acid, seaweed, Vicia *faba,* nutritive value

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## 1 Introduction

Food legumes represent a vital component of the agricultural sectors of Asia, Africa and Latin America, due to the provision of a concentrated source of high quality proteins to supplement the cereal-based diets, especially in the developing world (McWilliam and Dillon, 1987). Thus, recent surveys (FAO, 1992) highlight the expansion in the cultivation of these species in developing nations. Faba bean (*Vicia faba* L.) is the fourth most important pulse crop in the world. It is an important source of dietary protein. Faba bean is the most important food legume in the Egypt. It constitutes the main dish on the breakfast and supper tables for a large sector of the population, especially low income groups in the urban areas. In addition, it contributes to soil fertility through biological nitrogen fixation, the crop is also an important source of income for farmers in Egypt. Weeds are considered a major problem in bean crops causing great losses in seed yield due to direct weed-plant competition for light, moisture and soil nutrients. The reduction of faba bean yield due to weed infestation reached 80% (Anonymous, 2004). Hand hoeing treatment in faba bean fields is the most widespread method of weed-control, resulting in good control of weeds (El-Metwally and Shalby, 2007; El-Metwally and Abdelhamid, 2008).

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Seaweeds extracts as foliar sprays have stimulating effect on several crops because the extract contains growth promoting hormones (IAA and IBA), cytokinins and trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni) as well as vitamins and amino acids (Zodape et al., 2011). Aqueous extract of *Sargassum wightii* increased yield and quality of *Zizyphus mauritiana* (Rama Rao, 1991). Moreover, applying seaweed extract increased the response of different growth parameters and yield responses of faba bean (El-Metwally, 2016). In the same respect, Ghurbat (2013) reported that spraying seaweed extract on sweet pepper plants led to positive significant difference in plant height (cm), leaf chlorophyll content% and total yield as well as fruit diameter, fruit length, TSS%, vitamin C, fruit yield per plant and total yield as compared to untreated plants.

Folates are essential cofactors in one-carbon transfer reactions as donors and acceptors and involved in the synthesis of purines, pyrimidines, and amino acids (Krumdieck, 1990; Scott et al., 2000; Dhonukshe-Rutten et al., 2007; and Blancquaert et al., 2010). In this respect, Stakhova et al. (2000) reported that exogenous folic acid increased weight of pea seeds and yield. Amino acid analysis revealed a notable increase in the content of folate-dependent amino acids.

This study was planned to determine the effect of weed control treatment, seaweed extract and folic acid on growth, yield and quality of faba bean plants grown under sandy soil condition.

## 2 Material and Methods

Two field experiments were conducted during the two successive seasons (2014/15 and 2015/16) at the experimental research and production station of National Research Centre, Nubaria region, Egypt. The soil of experimental site is classified as sandy soil. Some physical and chemical properties of the experimental soil are shown in Tables 1a and 1b. The experiment was established with a split plot design having four replicates. The main plots included four weed control treatments (Unweeded, Metribuzin, oxadiargyl and two hand hoeing). The treatments consisted of Metribuzin, oxadiargyl and two hand hoeing {20 and 40 days after sowing (DAS)}. Metribuzin herbicide [Sencor 70% WP, 4-amino-6-tert-butyl-3-methylthio-1,2,4-triazine-5(4H)-one) at the rate of 0.75 kg $ha^{-1}$, oxadiargyl [Topstar 400 SC, 3-[2,4-dicloro-5-(2-Propynyloxy)phenyl]-5-(1,1-dimethylethyl)-1, 3, 4, oxdiazol-2(3H)-one] at the rate of 480 g $ha^{-1}$ (a.i.), were sprayed on the soil surface as pre-emergence immediately before irrigation, using Knapsack sprayer with one nozzle boom and 476 liter water $ha^{-1}$ as carrier. The 10.50 $m^2$ experimental unit area contained 5 ridges (3.5 m long and 3 m wide). Sub-plots were assigned to growth regulators. (10, 20 and 30 mg $L^{-1}$ folic acid and 50, 100 and 150 mg $L^{-1}$ seaweed extract). Folic acid produced by Mepaco Medifood Company Egypt. A commercial seaweed extract product "Alga 600" (Techno green company) mixed with three seaweed viz., *Ascophyllum nodosum*, *Laminaria spp* and *Sargassum sp*. Seaweed extract also contains N (1%), K (18.5%), Ca (0.17%), Mg (0.42%), Fe (0.06%), S (2.2%), alganic acids (10%-12%) and plant hormones (600 ppm). Folic acid and seaweed extract applied after 30, 40 and 50 days from planting as foliar application.

**Table 1a Soil physical characteristics of experimental site**

| Soil depth, cm | Particle size distribution, % | | | Texture class | Soil moisture constants | | |
|---|---|---|---|---|---|---|---|
| | Coarse sand | Fine sand | Clay+ Silt | | SP, % | FC, % | WP, % |
| 20 | 47.76 | 49.75 | 2.49 | Sandy | 21.0 | 10.1 | 4.7 |
| 40 | 56.72 | 39.56 | 3.72 | Sandy | 19.0 | 13.5 | 5.6 |
| 60 | 59.40 | 59.40 | 3.84 | Sandy | 22.0 | 12.5 | 4.6 |

Note: SP = saturation percentage; FC = field capacity; WP = wilting point.

**Table 1b Soil chemical properties of experimental site**

| Soil depth, cm | OM, % | pH (1:2.5) | EC, dS $m^{-1}$ | $CaCO_3$, % |
|---|---|---|---|---|
| 20 | 0.65 | 8.7 | 0.35 | 7.02 |
| 40 | 0.40 | 8.8 | 0.32 | 2.34 |
| 60 | 0.25 | 9.3 | 0.44 | 4.68 |

Note: OM=Organic matter; pH=acidity or alkalinity in soils; EC= electrical conductivity.

The experimental field was deep ploughed before planting. First disc harrow, then duck food was used for further preparation of the field for planting. The experimental unit was 3.5×3.0 m. Faba bean seeds (Nubaria 1) were inoculated with the specific Rhizobium strain and immediately sown in hills 25 cm apart on both sides of the ridge (150 kg $ha^{-1}$). Faba bean seeds were sown in 25th and 29th November in the first and second seasons, respectively.

All treatment plots received the same amount of total fertilizer. Compound fertilizers were applied as follow: Nitrogen fertilizer as ammonium nitrate (33.5% N) at the rate of 50 kg N $ha^{-1}$ was added after 20 days from sowing, phosphorus fertilizer was applied in the form of single super-phosphate (15.5% $P_2O_5$) during land preparation at the rate of 357 kg $ha^{-1}$ and 150 kg $ha^{-1}$ potassium sulphate (48% $K_2O$) applied once after 35 days from sowing.

### 2.1 On weeds

After 70 and 100 days from sowing in both seasons, weed samples from one square meter area were randomly collected from each plot. Dry weight of broadleaves, grasses as well as total weeds was estimated and determined after drying in a forced draft oven at 70ºC to constant weight.

### 2.2 On faba bean plants:

#### 2.2.1 Vegetative growth parameters:

After 70 and 100 days from sowing in both seasons samples of five random plants were taken from experimental plots to estimate the following characteristics:

Plant height (cm)

Shoot dry weight (g).

Leaf area index (LAI).

SPAD value of fourth faba bean leaves was determined by chlorophyll meter (SPAD-502, Minolta Camera Co., Osaka, Japan, 25).

#### 2.2.2 Yield and yield attributes

At harvest, the following data were recorded:

Number of pods / plant.

Pods dry weight / plant (g).

Seeds weight / plant (g).

100-seed weight (g)

Seed yield (ton $ha^{-1}$) for the last traits the two central ridges of each experimental unit were devoted the determination.

### 2.3 Chemical composition of seeds:

Total soluble carbohydrates were determined as described by Bogdan et al. (1993). Total carbohydrates were determined according to Smith et al. (1956). Total phenolic content was determined colorimetrically according to the method defined by Snell and Snell (1953) using Folin and Ciocalteu phenol reagent. Vicine content was determined according to the method described by Collier (1976).

### 2.4 Statistical Analyses

The combined analysis of variance for the data of the two seasons was performed after testing the error homogeneity and Fisher's Least Significant Difference (LSD) method at 0.05 level obtained data from each season were subjected to the proper statistical analysis of variance of significance was used for the comparison between means according to Gomez and Gomez (1984) .

## 3 Results and Discussion

### 3.1 Weed species

The most dominant weeds in both growing seasons were: Wild beet (*Beta vulgaris* L.), Greater ammi (*Ammi majus* L.), Dock (*Rumex dentatus* L.), Bur clover (*Medicago hispida* L.), Annual yellow sweet clover (*Melilotus indicus* L.), Wild oat (*Avena fatua* L.) and Ryegrass (*Lolium temulentum* L.).

### 3.2 Effects on weeds

Data in Table 2 reveal that all weed control treatments significantly decreased the dry weight of broadleaved, narrow-leaved and total weeds at 70 and 100 days after sowing as compared to the unweeded check. Two hand hoeing was more effective than other weed control treatments against broadleaved, narrow-leaved and total weeds. Oxadiargyl came in the second rank followed by Metribuzin herbicide. The highest significant reductions in total dry weight of weeds were obtained by two hand hoeing (89.09%) followed by oxadiargyl (83.49%) and metribuzin (78.13%) in comparison with unweeded treatment at 70 days after sowing and 87.50%, 78.12% and 73.42% respectively at 100 days after sowing. Several reports have confirmed that hoeing twice is the most effective weed control practice for reducing weed dry matter accumulation in faba bean (El-Metwally and Shalby, 2007; El-Metwally and Abdelhamid, 2008). Thus, oxadiargyl was more effective in controlling total weeds and resulted in the highest reduction of dry matter when compared with metribuzin. The reduction of weed dry weight may be due to the inhibition effect of herbicide treatments on growth and development of weeds. Our findings are consistent with those obtained by

Abd El-Razik (2006).

According to results in Table 2 dry weight of broadleaved, narrow-leaved and total weeds at 70 and 100 days after sowing were insignificantly affected by seaweed extract and folic acid spraying levels. Also, no significant effect the interaction between weed control and bio-stimulants treatments on total number and dry weight of weeds at 70 and 100 days after sowing.

**Table 2 Effect of weed control, folic acid and seaweed extract on dry weight of faba bean weeds g $m^{-2}$ at 70 and 100 days from sowing (combined analysis of two seasons).**

| At 100 days from sowing | | | At 70 days from sowing | | | Treatments |
|---|---|---|---|---|---|---|
| Total | grasses | Broadleaved | Total | grasses | Broadleaved | |
| Weed control | | | | | | |
| 214.54 | 86.51 | 128.02 | 159.64 | 67.41 | 92.23 | Unweeded |
| 57.02 | 34.23 | 22.79 | 34.91 | 21.54 | 13.37 | Metribuzin |
| 46.93 | 27.90 | 19.03 | 26.36 | 14.01 | 12.34 | Oxadiargyl |
| 26.82 | 14.29 | 12.53 | 17.42 | 9.34 | 8.09 | Two hand hoing |
| 7.56 | 3.77 | 2.57 | 3.56 | 2.14 | 1.58 | LSD 0.05 |
| Bio-stimulants | | | | | | |
| 81.60 | 38.40 | 43.18 | 56.45 | 26.53 | 29.93 | Untreated |
| 84.48 | 39.88 | 44.16 | 58.20 | 27.43 | 30.78 | 10 mg $L^{-1}$ Folic acid |
| 87.10 | 41.03 | 46.08 | 60.20 | 28.35 | 31.85 | 20 mg $L^{-1}$ Folic acid |
| 89.20 | 42.18 | 47.03 | 61.40 | 28.98 | 32.45 | 30 mg $L^{-1}$ Folic acid |
| 84.87 | 40.03 | 44.75 | 58.48 | 27.65 | 30.83 | 100 mg $L^{-1}$ Seaweed |
| 87.45 | 41.28 | 46.18 | 60.45 | 28.45 | 32.00 | 200 mg $L^{-1}$ Seaweed |
| 89.70 | 42.35 | 47.35 | 61.90 | 29.20 | 32.73 | 300 mg $L^{-1}$ Seaweed |
| NS | NS | NS | NS | NS | NS | LSD 0.05 |

## 3.3 Faba bean

### 3.3.1 Growth

Faba bean characters: plant height, shoot dry weight (g), leaf area index (LAI) and SPAD value at 70 and 100 days after sowing were significantly responded to weed management treatments, as shown in Table 3. Herein, two hand hoeing was superior treatment for increasing aforementioned characters compared with other treatments. Oxadiargyl came in the second rank followed by that of metribuzin herbicide. Such enhancements due to weeded treatments might be attributed to their high efficiency in the elimination of weeds (Table 2) and consequently, decreased their competition with faba bean plants on resources. The positive effect of weeded practices on faba bean growth and yield components has been confirmed by El-Metwally and Dawood (2016).

Data presented in Table 3 show significant increases of all the studied traits with increasing seaweed extract and folic acid spraying levels. Application of 30 mg $L^{-1}$ folic acids led to a significant increase in plant height, shoot dry weight (g), leaf area index (LAI) and SPAD value at 70 days after sowing. Spraying of 300 mg $L^{-1}$ seaweed extract came in the second rank. While, spraying of 300 mg $L^{-1}$ seaweed extract led to significant increase in plant height, shoot dry weight (g), leaf area index (LAI) and SPAD value at 100 days after sowing followed by that of spraying of 30 mg $L^{-1}$ folic acid. The increase in vegetative growth characters caused by folic acid may be attributed to its content of the most prominent of B complex vitamins besides its essential biochemical function in amino acid metabolism and nucleic acid synthesis (Andrew et al., 2000). In this respect, Stakhova et al. (2000) reported that exogenous FA increased the content of chlorophyll in the leaves and consequently weight of pea seeds and yield. In addition, amino acid analysis revealed a notable increase in the content of folate-dependent amino acids.

The increase in vegetative growth characters caused by seaweed extracts may be due to the role of seaweed extracts as bio-stimulants for plant growth and development because of its content of micro elements (Co, B, Mo, Zn, Cu) as well as macro elements, and organic substances like amino acids and plant growth regulators such as auxin, cytokine and gibberellins which improve nutritional status and vegetative growth. However, Jensen (2004) mentioned that application of seaweed extracts on plants increased root ability for growth and nutrient absorption and enhanced stem thickness and strong vegetative and root growth. These results are consistent with those recorded by Fawzy et al. (2000), Ghurbat (2013), and Shabana (2015).

The interaction between weed control treatments and some bio-stimulants significantly is affected by leaf area index (Table 4). Two hand hoeing produced the highest values of leaf area index when seaweed extract at 300 mg $L^{-1}$ or folic acid at 30 mg $L^{-1}$ treatments was used. Moreover, the minimal values of all obvious characters were obtained with unweeded and untreated plots with bio-stimulants. Similar results have been reported by El-Metwally (2016).

**Table 3 Effect of weed control, folic acid and seaweed extract on growth parameters of faba bean at 70 and 100 days from sowing (combined analysis of two seasons)**

| At 100 days from sowing | | | | At 70 days from sowing | | | | Treatments |
|---|---|---|---|---|---|---|---|---|
| SPAD value | LAI | Shoot dry weight, g | Plant height, cm | SPAD value | LAI | Shoot dry weight, g | Plant height, cm | |
| Weed control | | | | | | | | |
| 41.17 | 4.19 | 27.75 | 77.44 | 40.74 | 3.44 | 15.7 | 62.77 | Unweeded |
| 42.15 | 4.89 | 38.03 | 89.07 | 41.93 | 3.76 | 19.57 | 65.89 | Metribuzin |
| 42.63 | 5.08 | 40.41 | 92.03 | 41.79 | 3.87 | 20.87 | 67.4 | Oxadiargyl |
| 43.5 | 5.22 | 42.69 | 94.4 | 43.1 | 4.07 | 25.27 | 71.26 | Two hand hoeing |
| 0.23 | 0.14 | 1.24 | 2.11 | 0.2 | 0.11 | 1.12 | 2.17 | LSD 0.05 |
| Bio-stimulants | | | | | | | | |
| 40.81 | 4.5 | 35 | 85.98 | 40.5 | 3.56 | 18.83 | 64.8 | untreated |
| 42.02 | 4.7 | 36.43 | 87.4 | 41.63 | 3.69 | 19.85 | 65.8 | 10 mg $L^{-1}$ Folic acid |
| 42.62 | 4.91 | 37.65 | 88.75 | 42.23 | 3.81 | 20.55 | 67.28 | 20 mg $L^{-1}$ Folic acid |
| 43.29 | 5.07 | 38.25 | 89.35 | 42.63 | 3.91 | 21.2 | 68.18 | 30 mg $L^{-1}$ Folic acid |
| 42.62 | 4.74 | 36.65 | 87.55 | 41.6 | 3.74 | 19.9 | 66.1 | 100 mg $L^{-1}$ Seaweed |
| 43.07 | 4.92 | 37.95 | 88.85 | 42.23 | 3.87 | 20.68 | 67.33 | 200 mg $L^{-1}$ Seaweed |
| 43.42 | 5.09 | 38.63 | 89.75 | 42.43 | 3.94 | 21.48 | 68.33 | 300 mg $L^{-1}$ Seaweed |
| 0.27 | 0.16 | 1.15 | 2.04 | 0.2 4 | 0.12 | 0.78 | 2.16 | LSD 0.05 |

**Table 4 Effect of the interaction between weed control , folic acid and seaweed extract on LAI at 70 and 100days from sowing (combined analysis of two seasons)**

| Bio-stimulants | | | | | | | Treatments |
|---|---|---|---|---|---|---|---|
| Seaweed extract, mg $L^{-1}$ | | | Folic acid, mg $L^{-1}$ | | | Untreated | |
| 300 | 200 | 100 | 30 | 20 | 10 | | |
| LAI at 70 days from sowing | | | | | | | Weed control |
| 2.57 | 2.50 | 2.41 | 2.55 | 2.47 | 2.35 | 2.20 | Unweeded |
| 3.94 | 3.86 | 3.70 | 3.95 | 3.77 | 3.65 | 3.48 | Metribuzin |
| 4.05 | 3.95 | 3.80 | 3.99 | 3.90 | 3.75 | 3.65 | Oxadiargyl |
| 4.18 | 4.15 | 4.03 | 4.13 | 4.10 | 3.99 | 3.90 | Two hand hoing |
| 0.14 | | | | | | | LSD 0.05 |
| LAI at 100 days from sowing | | | | | | | Weed control |
| 4.50 | 4.25 | 4.01 | 4.45 | 4.30 | 3.99 | 3.80 | Unweeded |
| 5.15 | 5.02 | 4.80 | 5.10 | 4.95 | 4.70 | 4.50 | Metribuzin |
| 5.24 | 5.13 | 5.01 | 5.30 | 5.15 | 4.99 | 4.75 | Oxadiargyl |
| 5.45 | 5.27 | 5.13 | 5.41 | 5.25 | 5.12 | 4.93 | Two hand hoing |
| 0.19 | | | | | | | LSD 0.05 |

### 3.3.2 Yield and yield attributes

Results in Table 5 show significant impacts of weed management treatments on the number of pods / plant, pods dry weight / plant, seeds weight / plant, 100-seed weight and seed yield (ton $ha^{-1}$) compared to the unweeded treatment. The highest values of the yield parameters were obtained from two hand hoeing applications followed by oxadiargyl and metribuzin treatments. The increases in seed yield resulting from application two hand hoeing, Oxadiargyl and Metribuzin amounted to 30.63%, 18.61% and 13.06%, respectively over than unweeded. Such superiority of these weeded treatments may be related with minimizing weed-crop competition (Table 2). This in turns increased leave area index, plant height (Table 3) and produced more assimilates synthesized, translocated and accumulated in various plant organs which positively reflected on seed yields. The positive effect of weeded practices on faba bean yields and its components have been confirmed by El-Metwally and Shalby (2007), El-Metwally and Abdelhamid (2008).

**Table 5 Effect of weed control, folic acid and seaweed extract on yield and yield attributes as well as chemical composition of seeds (combined analysis of two seasons)**

| Vicine, mg 100 $g^{-1}$ | Phenolic content, % | Total soluble carbo-hydrate, % | Total carboh-ydrate, % | Seed yield, ton $ha^{-1}$ | 100- seed weight, g | Seed weight / plant, g | Pod dry weight, g | No. of pods /plant | Treatments |
|---|---|---|---|---|---|---|---|---|---|
| Weed control | | | | | | | | | |
| 301.48 | 2.63 | 4.31 | 53.02 | 2.687 | 47.04 | 33.96 | 41.21 | 20.97 | Unweeded |
| 263.34 | 2.53 | 4.44 | 53.39 | 3.038 | 52.57 | 38.19 | 56.36 | 29.23 | Metribuzin |
| 259.88 | 2.84 | 4.68 | 54.89 | 3.187 | 54.44 | 40.24 | 58.36 | 34.04 | Oxadiargyl |
| 243.68 | 3.32 | 5.01 | 56.58 | 3.510 | 55.50 | 44.31 | 61.40 | 36.33 | Two hand hoing |
| 4.16 | 0.14 | 0.24 | 1.06 | 0.102 | 2.21 | 2.04 | 2.11 | 1.24 | LSD 0.05 |
| Bio-stimulants | | | | | | | | | |
| 248.03 | 2.42 | 3.46 | 53.34 | 2.820 | 50.40 | 35.60 | 51.95 | 28.65 | Untreated |
| 276.12 | 2.45 | 4.26 | 53.97 | 3.055 | 51.85 | 38.58 | 53.73 | 29.43 | 10 mg $L^{-1}$Folic acid |
| 266.51 | 2.77 | 4.73 | 54.69 | 3.166 | 52.80 | 39.98 | 54.65 | 30.35 | 20 mg $L^{-1}$ Folic acid |
| 255.38 | 3.02 | 5.21 | 55.43 | 3.239 | 53.50 | 40.90 | 55.35 | 30.98 | 30 mg $L^{-1}$ Folic acid |
| 272.75 | 2.75 | 4.31 | 54.14 | 3.059 | 52.00 | 38.55 | 53.95 | 29.68 | 100 mg $L^{-1}$ Seaweed |
| 260.86 | 3.05 | 5.02 | 54.61 | 3.150 | 52.78 | 32.28 | 55.00 | 30.58 | 200 mg $L^{-1}$ Seaweed |
| 254.35 | 3.21 | 5.41 | 55.12 | 3.227 | 53.43 | 40.85 | 55.70 | 31.35 | 300 mg $L^{-1}$ Seaweed |
| 3.66 | 0.11 | 0.17 | 0.95 | 0.098 | 1.06 | 1.89 | 1.87 | 1.28 | LSD 0.05 |

The resulted data showed that all concentration of folic acid and seaweed extract caused enhancement in yield and its components if compared with control. The presented data revealed that, foliar application of the seaweed extract at the rate of 300 mg $L^{-1}$ resulted the heaviest number of pods / plant, pods dry weight / plant compared with other treatments. While, foliar application of the folic acid at the rate of 30 mg $L^{-1}$ resulted the maximum values of seeds weight, plant, 100- seed weight and seed yield ton $ha^{-1}$ compared to other treatments, followed by that of seaweed extract at the rate of 300 mg $L^{-1}$, folic acid at the rate of 20 mg $L^{-1}$ and seaweed extract at the rate of 200 mg $L^{-1}$. This increase in seed yield amounted to 14.86%, 14.43%, 12.27% and 11.70%, respectively more than untreated plants. In this respect Stakhova et al. (2000) reported that exogenous FA increased weight of pea seeds and yield. Li et al. (2015) reported that folate is one of the most important micronutrients and has many forms, but only FA form has cofactor activity. In this respect, a few literatures reported that exogenous FA has positive effect on growth, yield and quality of some plants such as flax (Emam et al., 2011), faba bean (Zewail et al., 2011) and winter wheat (Vician and Kovacik, 2013). Generally, it could be abstracted that, seaweeds have gained importance as foliar sprays for several crops because the extract contains growth promoting hormones (IAA and IBA), cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni) as well as vitamins

The results (Table 6) show that there were significant interactions between bio-stimulant and weed control treatments on seed yield. The highest values were obtained from spraying of seaweed extract at the rate of 300 mg $L^{-1}$ or folic acid at the rate of 30 mg $L^{-1}$ integrated with two hand hoeing or oxadiargyl treatment. Such superiority of herbicides treatments combined with bio-stimulant treatments, mainly due to the higher weed control efficiency and poor competition ability of weeds gave an advantage for the faba bean plants in utilizing the essential demands of nutrients and water, leading to increase the faba bean growth and yield. The results of the present investigation are in trend with those obtained by El-Metwally (2016).

### 3.3.3 Chemical composition of seeds

Considerable effects of weed control treatments on chemical composition of faba bean seeds were observed (Table 5). Two hand hoeing and all herbicide application significantly improved total carbohydrate, total soluble carbohydrate and phenolic percentage while vicine content was decreased. Two hand hoeing recorded the highest values of previous parameters followed by that of oxadiargyl and metribuzin treatments. These results may be due to less competition for environmental factors, particularly nutrients, water and light through limiting weeds infestation with herbicidal treatments leading to increase the uptake of different nutrients and reflected on chemical composition of seeds. The positive effect of weeded practices on chemical analysis of seeds have been confirmed by El-Metwally and Shalby (2007), El-Metwally and Abdelhamid (2008).

**Table 6 Effect of the interaction between weed control , folic acid and seaweed extract on seed yield and total carbohydrate% (combined analysis of two seasons)**

| Bio-stimulants | | | | | | | Treatments |
|---|---|---|---|---|---|---|---|
| Seaweed extract, mg $L^{-1}$ | | | Folic acid, mg $L^{-1}$ | | | Untreated | |
| 300 | 200 | 100 | 30 | 20 | 10 | | |
| Seed yield, ton $ha^{-1}$ | | | | | | | Weed control |
| 2.802 | 2.762 | 2.675 | 2.891 | 2.827 | 2.629 | 2.226 | Unweeded |
| 3.160 | 3.065 | 2.970 | 3.144 | 3.049 | 2.986 | 2.796 | Metribuzin |
| 3.294 | 3.208 | 3.113 | 3.287 | 3.231 | 3.144 | 3.033 | Oxadiargyl |
| 3.651 | 3.564 | 3.477 | 3.635 | 3.556 | 3.461 | 3.223 | Two hand hoing |
| 0.140 | | | | | | | LSD 0.05 |
| Total carbohydrate, % | | | | | | | Weed control |
| 53.14 | 52.98 | 52.55 | 54.38 | 53.43 | 52.53 | 52.16 | Unweeded |
| 53.71 | 53.13 | 52.97 | 54.41 | 53.78 | 53.17 | 52.62 | Metribuzin |
| 56.10 | 55.40 | 54.50 | 55.37 | 55.03 | 54.17 | 53.70 | Oxadiargyl |
| 57.54 | 56.94 | 56.56 | 57.54 | 56.52 | 56.04 | 54.90 | Two hand hoing |
| 0.45 | | | | | | | LSD 0.05 |

Averages of total carbohydrate, total soluble carbohydrate and phenolic percentage of faba bean were appreciably influenced by folic acid and seaweed extract as shown in Table 5. In this respect, with each increase in folic acid and seaweed extract dose there was a progressive increase in previous parameters except vicine content. It could be concluded that, foliar spraying with folic acid and seaweed extract had an enhancement in the chemical constituents of faba bean seeds. This might be attributed to the role of each treatment in plant metabolism which reflected on the seed yield and its properties. Many authors studied the response of crops yield to the foliar application of seaweed extract and their reports are in good accordance with that which written here (Ghurbat, 2013; Shafeek et al., 2014; and Shabana et al., 2015).

The interaction between weed control treatments and some bio-stimulants significantly affected by total carbohydrate (Table 5). Two hand hoeing produced the highest values of total carbohydrate when seaweed extract at 300 mg $L^{-1}$ or folic acid at 30 mg $L^{-1}$ treatments was used. Moreover, the minimal values of all obvious characters were obtained with unweeded and untreated plots with bio-stimulants. Similar results have been reported by El-Metwally et al. (2015).

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