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Allelochemicals Effect of Aqueous Sweet Basil (*Ocimum basilicum* L.) on Weed Control in Peanut and Cowpea Crops

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Abstract

Four experiments were conducted during 2019 and 2020 summer seasons at Weed Research Central Laboratory, Giza and Ismailia Research Stations, to exploit of the allelochemicals potential of aqueous extract derived from aboveground parts of *Ocimum basilicum* on controlling some annual weeds and the growth of cowpea and peanut crops. Aqueous extract applied at 40% concentration as pre-emergence and/or apportionment as 30%+10%, 20%+10%+10% and 10%+10%+10%+10% starting at pre-emergence with one week interval for the estimation of effective periods. The main findings showed that essential oils of aerial parts of *Ocimum basilicum* were 41 compounds which were analyzed by GC-MS. The major compounds were Eugenol, phenol, 2methoxy-3-(2-propenyl), 1,3,6,10-Cyclotetra decate traene, 14-Isopropyl-3,7,11-trimethyl(+), genranyl-a-terpinene, Retinol, acetate, 3-ethyl-3-hydroxy and drostan, 2-(7-hepta decynyloxy) tetrahydro 2h-pyran and M&P-Camphorene. These compounds have allelopathic effect on weeds. On the other hand, *Ocimum* extract at 40% concentration as pre-emergence was superior over other extract treatments on controlling annual weeds and increasing the growth characteristics and yield of peanut and cowpea plants. Furthermore, *Ocimum* extract treatment at 40% as pre- emergence was of the same potential of pendimethalin as soil-herbicide at 4.2 l/ha. These results were true in pot and field experiments.

Keywords: Allelopathy, Allelochemicals, Bio-herbicide, Weed control, Peanut, Cowpea

1. Introduction

Weeds are known to cause numerous losses due to their interference in agro-ecosystems. The herbicides for weed control have negative impact on environment and human health, so the use of natural products can be reducing negative impacts on the environment. Allelopathy, expressed as plant species releasing chemicals which can be the used for weed management in sustainable agricultural [1]. In this sense, allelopathy is considered as promising method for biological control. However, the effects of allelopathic substances remain low tested in laboratory and field conditions [2]. Allelopathy is a biological phenomenon where a plant species chemically influence the germination, growth or development of other plant species. Aqueous extract of the plant may interfere with tested crops germination and seedlings growth by (i) Causing plant growth inhibition (allelopathy); (ii) Causing nutrient transformation, and (iii) By influencing the microbial population that can be affect the crop seedlings [3, 4, 5]. The allelopathy phenomenon of the *Ocimum* essential oil through (i) different plant parts (seed, root and leaves) (ii) concentration of phytotoxic material; (iii) involvement of organic molecules, (iv) different evaluation of crops parameters as germination, shoot and root growth. *Ocimum* extracts inhibited overall shoot growth of tested crops (wheat, gram lentil, mustard, barley, okra and pea) by 37% compared to water control [6]. Allelochemicals have a high potential for noxious weeds management including parasitic and aquatic weeds [1]. Addition of 7.5g basil leaf powder to 100g of sand inhibited completely the germination of guineagrass, redroot pigweed, hairy beggarticks and radish as compared to plants which grown in sand only [1, 7]. Germination reduction of *Amaranthus* by 50% was obtained from *Ocimum* extracts at 0.2-0.9 mg/pot; at 10-30 mg/pot for maize crop, and at 17-23 mg/pot for soybean crop. In field experiment, the crude *Ocimum* extract by acetone alone and the extract plus camphor oil were more effective against

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the annual weeds. The extract from 40-48 kg/ha fresh weight of *Ocimum* plant gave 97 to 99% reducing of weed biomass when applied as post emergence [8]. *Ocimum basilicum* L. is an aromatic herb and rich in secondary metabolites like phenols, alkaloids, terpenoids, aldehydes, flavonoids, steroids, glyphosids, essential oil, saponins and tannins [9]. *Ocimum basilicum* leaf water extracts at 25% concentration caused reduction exceed 80% in weeds biomass and increase the growth characters and yield of pea crop [10]. Qualitative and quantitative analysis of extracts obtained from sweet basil (*Ocimum basilicum* L.) by hydro-distillation and supercritical fluid extraction, indicated that the major compounds of basil were linalool (content from 10.14 to 49.79%, w/w), eugenol (from 3.74 to 9.78%) and δ-cardinene (from 3.94 to 8.07%). *O. tenuiflorum* plant extracts have phytotoxic properties and contain phytotoxic substances, four essential oil chemo-types (methyl cinnamate, linalool, methyl eugenol and methyl chavicol) and also numerous sub-types of oils extracted from O. *basilicum* [8, 11, 12]. Sweet basil (*Ocimum basilicum* L.) and *O. tenuiflorum*, in the field were reduced emergence of common lambsquarters, common purslane and barnyardgrass by 58 - 83%, 26-79% and 11-50% in green manure-treatment of *Ocimum basilicum* plots, respectively, as compared with green manure-free plots (control) [13]. The extract contents of phenolic and flavonoid differ according to the extraction technique, solvent polarity and extraction time, [14]. The aqueous extracts of orange juice peel waste (ORPW), mango leaves waste (MLW), and olive oil mill waste (OLMW) contained many phenolic compounds, and can inhibit the germination and growth of *Phalaris minor* Retz. and *Malva parviflora* L. weed species. Among the three tested extracts, ORPW aqueous extract caused the most inhibition in germination and growth of the mentioned weeds followed by MLW and OLMW and can be used as natural herbicides to control weeds, [15]. The allelopathic plants could be used in several mean to weed control: (i) sowing them with main crops (inter cropping) (ii) direct using of their compost and/or cured extracts (iii) isolation their allelochemicals to use them a promising natural herbicide [16].

The objectives of the present work:

1- Investigating the effect of aqueous extract of sweet basil (*Ocimum basilicum* L.) on weed control in peanut and cowpea crops and the possibility to be used as a natural herbicide.

2- Finding applicable method for utilizations from allelopathic potentiality of sweet basil (*Ocimum basilicum* L.) and its possible use to control weeds under farmers' field conditions.

2. Experimental

Two pot experiments and two field trials were conducted, to study the allelopathic effects of aqueous sweet basil extract on controlling annual weeds and the growth of cowpea and peanut crops during 2019/2020 summer seasons in wire house of Weed Research Central Laboratory (WRCL) and in farm at Giza and Ismailia Research Stations.

2.1. Ocimum extract preparation act as allelopathic doner

Six kilograms of fresh weight of *Ocimum* leaves and flowers (aboveground parts) were collected from Giza Agriculture Research Station, Agricuture Research Center (ARC) during spring season, 2019. The six kg foliage were washed well under tap water and kept for one month in deep freezer to make a crude material. Afterwards, the crude material soaked in three liters of tap water, grond in a grinder and filterated by Whatmann paper No. 1 in glass basin. Then another three liters of tap water were added to leacha. To protect the extract from fungal infection 90 cm^3 comphor oil was added to 6 liters of the aqueous extract and *Ocimum* extract becom ready for experimental tests.

2.2. Tested crops

Cowpea variety Cream 7 and peanut variety Giza 6 act as alleopathic receptors.

2.3. The studied annual weeds

Annual weeds were presented in clay soil of Giza Farm and sandy soil of Ismailia Farm as natural infestation of weed species and act as alleopathic receptors.

2.4. Pot experiments

Two pot experiments were conducted during the periods from 1/4/20 to15/5/20 and 20/5/20 to 2/7/20, in wire house of WRCL. The pots (25 cm diameter) were filled with clay soil infested by natural weeds, to study the aqueous extract of *Ocimum* effect on cowpea, peanut and their associated weeds. Peanut and cowpea, each was sowed by four seeds/pot. Then *Ocimum* extract was sprayed by hand sprayer at water volume 476.2 l/ha. The treatments were the following:

1. Untreated check.
2. Spraying extract at 4 cm^3/pot as pre emergence (equivalent 40%).
3. Spraying extract at 3 cm^3/pot as pre emergence (equivalent 30%) + spraying once at 1 cm^3/pot as post emergence (equivalent 10%).

4. Spraying extract at 2 cm^3/pot as pre emergence (equivalent 20%) + spraying twice each at 1 cm^3/pot as post emergence (each equivalent 10%) with one week interval between them.
5. Spraying extract at 1 cm^3/pot as pre emergence (equivalent 10%) + spraying thrice each at 1 cm^3/pot as post emergence (each equivalent 10%) with one week interval between them.

After 45 days from sowing the recorded data was:

I- Weed categories: annual broadleaf and grassy weeds were classified and their fresh weight were estimated by g/pot.

II- Crops characteristics: Plant height (cm), Root length (cm/ plant), Fresh weight (g/plant) and pods weight (g/plant)**.**

2.5. Field experiments

2.5.1. Giza experiments (clay soil)

Two field experiments were carried out at Giza Research Station, ARC, Egypt, during summer season 2020, to study the effect of *Ocimum* extract (which applicated as pre and post-emergence) on growth of peanut and cowpea crops and weed control.

2.5.1.1. The presented dominant weed species

Green foxtail (*Setaria viridis*) as grassy weeds and *Amaranthus* spp. as broadleaf weeds in the first location and common purslane (*Portulaca oleracea*), Galius (*Trianthema portulacastrum*) as broadleaf weeds and Green foxtail (*Setaria viridis)* and Jungle rice (*Echinochloa colonum*) as grassy weed in the second location.

Each experiment was designed in randomized complete block design with three replicates. Plot size (2.0 m wide×1 m long), included three rows of each crop. The *Ocimum* treatments were as follows:

1. Untreated check.
2. Spraying *O.* extract at 40 cm^3/plot applied as pre-emergence.
3. Spraying *O.* extract at 30 cm^3/plot applied as pre-em.+ *O.* extract at 10 cm^3/plot applied after one week.
4. Spraying *O.* extract at 20 cm^3/plot applied as pre-em.+ *O.* extract twice at 10 cm^3/plot applied as post-em., with one week interval between them.
5. Spraying *O.* extract at 10 cm^3/plot applied as pre-em.+ *O.* extract thrice at 10 cm^3/plot applied as post-em., with one week interval between them.

2.5.2. Ismailia field experiment (sandy soil)

One field experiment was conducted at Ismailia Agricultural Research Station ARC, during summer season 2020, to study the effect of *Ocimum* extract, which was applied as pre and post-emergence, compared with the effect of Stomp Extra EC 48% herbicide as pre emergence on weed control in peanut crop.

2.5.2.1. The dominant weed species

Common purslane (*Portulaca oleracea*) and Malta cross (*Tribulus terrestris*, L.) as broad leaved weeds. The plot area was 21 m^2 (3 m length × 7 m width). Seven treatments in three replicates were distributed in a complete randomized block design as follows:

6. Untreated check.
7. Spraying *O.* extract at 400 cm^3/plot applied as pre-emergence.
8. Spraying *O.* extract at 300 cm^3/plot applied as pre-em.+ *O.* extract at 100 cm^3/plot applied after one week.
9. Spraying *O.* extract at 200 cm^3/plot applied as pre-em.+ *O.* extract twice at 100 cm^3/plot applied as pos-em., with one week interval between them.
10. Spraying *O.* extract at 100 cm^3/plot applied as pre-em.+ *O.* extract thrice at 100 cm^3/plot applied as post-em., with one week interval between them.
11. Stomp 48% EC (pendimethalin) sprayed pre sowing at the rate of 4.2 l/ha.
12. Hand hoeing twice (at 21 and 35 day from sowing)

Ocimum extract and stomp herbicide were sprayed by knapsack sprayer CP_3 at water volume of 476.2 l/ha. All plots were sprayed by Fusilade Super herbicide at rate 2.4 l/ha for control bermuda grass (*Cyndon dactylon* (L), Pers) after 25 days from sowing which was infested in some experimental plots.

2.5.3. In field experiments a recorded data were as follows:

2.5.3.1. Weed survey

Weeds were hand pulled from one square meter which was chosen randomly from each plot at 60 days after sowing. Weed species were classified and then their fresh weights were recorded.

2.5.3.2. Crops characteristics

Plant height (cm), number of branches/plant, number of pods/plant, pods weight (g/plant), seeds weight (g/plant), 100 pods weight (g), pods yield (ton/hectare) of peanut and seed yield of cowpea (ton/ hectare).

2.5.4. Statistical analysis

Pot and field experiments were arranged in completely block randomized design, with four

replicates in wire house and three replicates in field experiments. All data were statistically analyzed according to analysis of variance (ANOVA) technique as mentioned by Gomez and Gomez [17] by using "Genstate 19th Edition" computer software package and revised least significant difference means were separated according to significance difference using Duncan`s Multiple Range Test at probability level 0.05.

2.5.5. Mass Spectrometry (MS) analysis

GC Analysis: Compact Mass Spectrometer with m/z 2000 mass range. Single quadrupole analyzer with liquid interface, it consists of, manual flow injection valve. Also contain Mass Express system control software program and Data Express software program for data processing. Edwards, R. V. 12 rotary vane pump with oil mist filter and oil return (110-240 V. A. C.). GC Analysis was finished with a Hewlett-Packard 6890 equipment geared up with FID and an intermediately polar Supelco SPB-20 cap. Column (30m×0.32 m i.e., film thickness 0.25 µm). The oven temperature became programmed Isothermal at 35°C for 1 min, rising from 35 to 250°C at 5°/min, after that held Isothermal at 250°C for three min; injector temp., 250°C; detector temp., 280°C; carrier gas, N_2 (1.2 ml/min). The volume injected was 1 µl (10% essential oil in purified hexane). The relative concentration has been determined using the software program HP Chemstation, which allowed assimilating the percentages of the different kinds of compounds. Retention indices (RI) have been determined according to the retention times (RT) of a series of n-alkanes (C9-C28), Nawah Scientific Center*.

2.5.6. Trace Gas Chromatograph System Specifications

Thermo Scientific™ TRACE™ 1310 GC system: Complete icon-driven touch screen user interface for direct local instrument control connected with Thermo Scientific™ AI/AS 1310, Thermo Scientific 300 sample positions, Oven Operating Range: Ambient more than 3 °C to 450 °C. GC Analytical Performance, Retention Time Repeatability: <0.0008 min, Peak Area Repeatability: <0.5 % RSD, Instant Connect Helium as carrier gas.

2.5.7. GC/MS Analysis

The essential oils have been analyzed with a Hewlett-Packard 5890 series II equipment geared up with a 5972 mass-selective detector and an intermediately polar Supelco SPB-20 cap. column (30m × 0.32mm i.d., film thickness 0.25 µm) has been used as a carrier gas. The operating conditions of the mass spectrometer have been: ionization voltage, 70 V; ion source, 230°C. The GC analysis conditions were as described in GC Analysis [18].

2.5.8. Compound Identification

The identification of the compounds was based on comparing of their RI and mass spectra with those of principal constituents by means of the NBS75K.L., and Wiley 275, databases and with literature [19].

The GC-MS analysis confirmed the presence of forty one compounds within the *Ocimum* extract by comparing their retention times by mass spectra. The identified compounds and their retention time (RT), molecular weight (MW), and peak area% are shown in Table (1).

Table 1:Compound, retention time (RT), molecular weight (MW), and peak area% in *Ocimum* extract

Compound	RT	Area %	Formula and molecular weight (MW)
Tricyclo[6.3.0.0(4,7)]undec-2-en-5-one, 9-[(2-methoxyethoxy) methoxy]-8-methyl	5.01	0.59	C16H24O4, 280
Trimethylsilyl ethaneperoxoate	5.14	0.25	C5H12O3Si, 148
Tetradecane	8.8	0.31	C14H30, 198
Camphor	9.95	0.46	C10H16O, 152
Citronellol	12.37	1.42	C10H20O, 156
2,6-Octadien-1-OL, 3,7-dimethyl-, (Z)-	13.09	0.34	C10H18O, 154
Eugenol	15.79	9.79	C10H12O2, 164
Phenol, 2-methoxy-3-(2-propenyl)-	15.79	9.79	C10H12O2, 164
1-Chloroundecane	18.67	0.28	C11H23Cl, 190
1,2-Benzenedicarboxylic acid, diethyl aster	21.67	0.48	C12H14O4, 222
3-Hydroxy-à-ionene	22.76	0.65	C13H20O2, 208
Norethindrone	22.76	0.65	C20H26O2, 298
5à-Cholestan-3á-ol, 2-methylene	23.06	0.49	C28H48O, 400
1-(4-isopropylphenyl)-2-methylpropyl acetate	23.23	0.62	C15H22O2, 234
Gazaniolide	23.35	0.48	C15H18O2, 230
Methyl 9,11-octadecadiynoate	23.35	0.48	C19H30O2, 290
9,10-Secocholesta-5,7,10(19)-triene-3,25,26-triol, (3á,5Z,7E)-	23.7	0.43	C27H44O3, 416
Benzamide, 4-[5-(2,4,6-trimethylbenzylthio)-1-tetrazolyl]-	24.26	0.29	C18H19N5OS, 353

Cycloisolongifolene, 8,9-dehydro-9-vinyl	24.47	0.41	C17H24,	228
Falcarinol	24.99	0.87	C17H24O,	244
(3S,6S)-2,2,6-Trimethyl-6-((S)-4-methylcyclohex-3-en-1-yl)tetrahydro-2H-pyran-3-ol	25.05	0.61	C15H26O2,	238
11-Phenyl-10-heneicosene	25.15	1.41	C27H46,	370
2,6-Dimethyl-4-nitro-3-phe nyl-cyclohexanone	25.15	1.41	C14H17NO3,	247
3-Methyl-3H-cyclonona[def]biphenylene	25.6	1.95	C18H14,	238
9,10-Dimethoxy-2,3-dihydroanthracene-1,4-dione	26.19	0.77	C16H12O4,	268
2-(1-Methylethyl)-11-oxo-1H-pyrido[2,1-b]quinazoline-8-methanol	26.19	0.77	C16H16N2O2,	268
14-Isopropyl-3,7,11-trimethyl-1,3,6,10-cycloteradecatetraene	26.57	1.09	C20H32,	272
1,3,6,10-Cyclotetradecatetraene, 14-isopropyl-3,7,11-trimethyl-, (+)-	26.89	1.79	C20H32,	272
(4aS,4bR,10aS)-7-Isopropyl -1,1,4a-trimethyl-1,2,3,4,4a, 4b,5,6,10,10a-decahydrophe nanthren	27.16	1.51	C20H32,	272
1,3,6,10-Cyclotetradecatetraene, 14-isopropyl-3,7,11-trimethyl-, (+)-	27.55	6.39	C20H32,	272
1,3,6,10-Cyclotetradecatetraene, 14-isopropyl-3,7,11-trimethyl-, (+)-	28.27	8.69	C20H32,	272
14-Isopropyl-3,7,11-trimethyl-1,3,6,10-cycloteradecatetraene	28.27	8.69	C20H32,	272
geranyl-à-terpinene	28.53	6.87	C20H32,	272
3-Ethyl-3-hydroxyandrostan-17-one #	28.67	4.62	C21H34O2,	318
2-(7-Heptadecynyloxy)tetrahydro-2h-pyran #	28.67	4.62	C22H40O2,	336
Retinol, acetate, all-trans	29.07	2.51	C22H32O2,	328
Retinol, acetate	29.07	2.51	C22H32O2,	328
m-Camphorene	29.35	5.45	C20H32,	272
p-Camphorene	29.35	5.45	C20H32,	272
Geranyl-à-terpinene	29.74	1.46	C20H32,	272
Retinol, acetate, all-trans	30.03	6.77	C22H32O2,	328
Retinol, acetate	30.03	6.77	C22H32O2,	328
Abieta-8(14),9(11),12-triene#	31.08	1.72	C20H30,	270

* https://nawah-scientific .com/directory/analytical-services/mass-spectrometic-analysis/gas-chromotography-tandem-mass- spectrometry-gc-ms/

3. Results and Discussion

Fig (1) and Table (1) reported that the analysis of presented compounds in the *Ocimum* sample by GC-MS analysis shows fifteen peaks. The major compounds were Eugenol (9.79%), Phenol, 2-methoxy-3-(2-propenyl)- (9.79%), 1,3,6,10-Cyclotetra decate traene, 14-Isopropyl-3,7,11-Trimethyl(+)-(8.69%), geranyl-à-terpinene (6.87%), Retinol, acetate (6.77%), -Ethyl-3-hydroxyan drostan-17-one (4.62%), 2-(7-Heptadecynyloxy)tetrahydro-2h-pyran (4.62), m-Camphorene (5.45%) and p-Camphorene (5.45%).

These allelochemical compounds such as phenolic compounds have allelopathic effect, which inhibit root and shoot lengths of three perennial species [20], through interaction with the mitochondrial membrane and impairing mitochondrial respiration directly. The limonene, terpinene, and monoterpenes camphor strongly affect the respiratory activity of soybean [21]. The compounds carvacrol and geraniol have phytotoxic effects on plants and can be used as bio-herbicide [22].

Pot experiments at Giza Research Station

It was notice that from Table (2), spraying *Ocimum* extract either in single dose as pre-em. or apportionment the same dose to pre-em. and post-em. at different times significantly decreased the fresh weight of total weeds (g/pot) compared with untreated control treatment in the two pot experiments of peanut and cowpea crops.

In the first experiment, the reduction of the fresh weight of total weeds was obtained by *Ocimum* extract treatments in descending order as following: *Ocimum* extract at 10% as pre-em. plus 10% thrice as post-em. (T5) by 84.1%, *Ocimum* extract at 40% as pre-em. (T2) by 83.7%, *Ocimum* extract at 30% as pre-em. plus 10% once as post-em. (T3) by 69.8% and *Ocimum* extract at 20% as pre-em. plus 10% twice as post-em. (T4) by 56.9% with sowing peanut. Whilst, the reduction reached 95.3% by T2, 80.1% by T5, 62.4% by T3 and 57.4% by T4, with sowing cowpea.

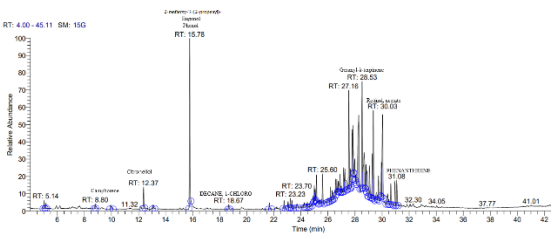

Fig. 1: The presented Compounds in the *Ocimum* sample

by Chromatogram-GC- MS analysis, show a major fifteen peaks.

In the second experiment, the reduction in the fresh weight of total weeds reached 79.7% by T4, 75.3% by T2, 59.5% by T3 and 55.5% by T5 with sowing peanut; and reached 73.7%, 72.0%, 67.0% and 65.8% by T3, T5, T4 and T2, respectively, with sowing cowpea. These results were due to the application of *Ocimum* extract pre emergence which suppressed the germination and the growth of weeds in the early stages, which reflect the reduction of the weed biomass and the increase in the vigor growth characteristics of sowing crops, [8, 13].

Spraying *Ocimum* extract pre-em. resulted in the highest reduction of total weeds with both peanut and cowpea crops. These results may be due to allelopathic potentiality of sweet basil (*Ocimum basilicum* L.) interference mediated by the additional phytotoxins affecting neighbouring plants [23], and competitive crops which have speedy emergence, faster growth and compete for sun-light and plant nutrients help the extract effect to prevent the new weed seeds emergence till the end of crop cycles. These results agreement with [8, 24, 25, 26, 27].

All tested treatments of *Ocimum* extract significantly reduced the total weeds fresh weight without significant difference between these treatments.

Results in Table (3), showed that the *Ocimum* extract, either in single dose as pre-em. or apportionment the same dose to pre-em. and post-em. at different times increased significantly the plant characteristics of both peanut and cowpea crops in the two pot experiments. That is a reflection of the decrease in the annual weeds as mentioned before in table (2).

In the first experiment, the highest values of plant height, root length, plant weight and pods weight were obtained by T4 which were 34.9cm, 8.3cm,

14.0g and 135.8g, respectively, followed by T3 which were 30.8cm, 9.9cm, 14.6g and 97.8g, respectively, and T5 which were 35.9 cm, 9.6cm, 10.8g and 94.0g, respectively, with peanut crop. Whilst, the highest values of the previous respective characteristics were obtained by T3 which were 56.9cm, 7.5cm, 34.6g and 86.3g, respectively, followed by T5 which were 72.3cm, 1.3cm, 34.1g and 63.5g, respectively, and T4 which were 55.3cm, 4.0cm, 21.4g and 37.5g, respectively, with cowpea crop.

In the second experiment, the highest values of plant height, root length, plant weight and pods weight were obtained by T2 which were 21.6cm, 8.8cm, 13.4g and 64.8g, respectively, followed by T3 which were 16.5cm, 7.8cm, 14.5g and 58.0g, respectively, and T5 which were 11.1cm, 6.7cm, 5.1g and 22.3g, respectively, with peanut crop. Whilst, the highest values of the previous respective characteristics were obtained by T2 which were 54.8cm, 33.3cm, 11.2g and 104.3g, respectively, and followed by T3 which were 42.8cm, 19.1cm, 8.0g and 58.3g, respectively, and T5 which were 42.8cm, 12.1cm, 6.4g and 37.5g, respectively, with cowpea crop. These results were in agreement with those obtained by [8, 24, 25, 26, 27]

Table 2: Effect of *Ocimum* extract on fresh weight of grassy, broadleaf and total weeds (g/pot) in cowpea and peanut crops in the two pot experiments

Crop	% of *Ocimum* extract and times of the spraying	Fresh weight (g/pot)			Reduction %
		Broadleaf weeds	Grassy weeds	Total	
	First Exp.				
Peanut	T1: Untreated Control	3.2 a	52.7 b	55.8 b	0.0
	T2: 40% Pre emergence	6.5 a	2.6 a	9.1 a	83.7
	T3: 30% pre em. + 10% once as post em.	5.0 a	11.9 a	16.9 a	69.8
	T4: 20% pre em.+10% twice as post em.	1.2 a	22.9 a	24.1 a	56.9
	T5: 10% pre em.+ 10% thrice as post em.	1.8 a	7.2 a	8.9 a	84.1
	CV%	132.1	61.3	66.1	
Cowpea	T1: Untreated Control	2.0 a	44.0 b	46.0 b	0.0
	T2: 40% Pre emergence	0.3 a	1.9 a	2.2 a	95.3
	T3: 30% pre em. + 10% once as post em.	0.4 a	16.9 ab	17.3 ab	62.4
	T4: 20% pre em.+10% twice as post em.	1.1 a	18.5 ab	19.6 ab	57.4
	T5: 10% pre em.+ 10% thrice as post em.	0.5 a	8.7 a	9.2 a	80.1
	CV%	200	67.4	72.16	-

	Second Exp.				
Peanut	T1: Untreated Control	10.8 a	120.8 b	131.5 b	0.0
	T2: 40% Pre emergence	0.0 a	32.5 a	32.5 a	75.3
	T3: 30% pre em. + 10% once as post em.	20.3 a	33.0 a	53.3 a	59.5
	T4: 20% pre em.+10% twice as post em.	16.5 a	10.3 a	26.8 a	79.7
	T5: 10% pre em.+ 10% thrice as post em.	8.5 a	50.0 a	58.5 a	55.5
	CV%	98.9	22.2	14.9	-
Cowpea	T1: Untreated Control	10.0 a	121.0 b	131.0 b	0.0
	T2: 40% Pre emergence	1.5 a	43.3 a	44.8 a	65.8
	T3: 30% pre em. + 10% once as post em.	2.3 a	32.3 a	34.5 a	73.7
	T4: 20% pre em.+10% twice as post em.	4.0 a	39.3 a	43.3 a	67.0
	T5: 10% pre em.+ 10% thrice as post em.	0.0 a	36.8 a	36.8 a	72.0
	CV%	86.0	25.5	24.9	-

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

Table 3:Effect of *Ocimum* extract on peanut and cowpea characteristics in the two pot experiments, at WRCL

Crop	% of *Ocimum* extract and times of the spraying	Growth characteristics			
		Plant height (cm)	Root length (cm)	Plant weight (g)	Pods weight (g/plant)
	First Exp.				
Peanut	T1: Untreated Control	23.4 a	6.3 a	2.0 a	22.3 a
	T2: 40% Pre emergence	22.2 a	9.3 a	11.9 b	34.3 a
	T3: 30% pre em. + 10% once as post em.	30.8 b	9.9 a	14.6 b	97.8 b
	T4: 20% pre em.+10% twice as post em.	34.9 b	8.3 a	14.0 b	135.8 c
	T5: 10% pre em.+ 10% thrice as post em.	35.9 b	9.6 a	10.8 b	94.0 b
	CV%	3.7	7.5	15.8	4.7
Cowpea	T1: Untreated Control	28.3 a	2.9 b	6.6 a	12.3 a
	T2: 40% Pre emergence	42.9 b	4.5 b	21.1 b	18.6 a
	T3: 30% pre em. + 10% once as post em.	56.9 c	7.5 c	34.6 c	86.3 d
	T4: 20% pre em.+10% twice as post em.	55.3 c	4.0 b	21.4 b	37.5 b
	T5: 10% pre em.+ 10% thrice as post em.	72.3 d	1.3 a	34.1 c	63.5 c
	CV%	6.4	13.0	15.8	1.8
	Second Exp.				
Peanut	T1: Untreated Control	20.6 d	10.0 d	6.0 b	48.8 c
	T2: 40% Pre emergence	21.6 d	8.8 c	13.4 c	64.8 e
	T3: 30% pre em. + 10% once as post em.	16.5 c	7.8 bc	14.5 d	58.0 d
	T4: 20% pre em.+10% twice as post em.	8.8 a	5.4 a	3.8 a	28.5 b
	T5: 10% pre em.+ 10% thrice as post em.	11.1 b	6.7 b	5.1 b	22.3 a
	CV%	3.4	3.1	1.0	2.2
Cowpea	T1: Untreated Control	40.7 b	11.8 b	9.3 d	37.8 a
	T2: 40% Pre emergence	54.8 c	33.3 d	11.2 e	104.3 c
	T3: 30% pre em. + 10% once as post em.	42.8 b	19.1 c	8.0 c	58.3 b
	T4: 20% pre em.+10% twice as post em.	35.9 a	7.4 a	4.8 a	38.5 a
	T5: 10% pre em.+ 10% thrice as post em.	42.8 b	12.1 b	6.4 b	37.5 a
	CV%	2.2	1.7	6.0	2.8

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

3.1. Field experiments at Giza and Ismailia Stations

Data in Table (4) indicated that all *Ocimum* extract treatments caused high reduction in the fresh weight of the two categories weeds and their total. The reduction percentages of the broadleaf weeds fresh weight by *O.* extract treatments could be arranged in a descending order as follows: *O.* extract at 30% as pre em. + 10% once as post em. (T3) 99.5%; *O.* extract at 20% as pre-em. + 10% twice as post em. (T4) 97.8%; *O.* extract at 10% pre em.+ 10% thrice as post em. (T5) 96.8%; and *O.* extract at 40% as pre em. (T2) 95%, compared to untreated check.

The reduction percentages of the fresh weight of grassy weeds by *O.* extract treatments could be arranged in a descending order as follows: T2 (79.8%), T4 (77.4%), T5 (71.2%), and T3 (71.0%) compared to untreated check. Whilst, the reduction percentages of the fresh weight of total weeds resultant on the reduction of the previous weeds was reached to 79.2% (T5), 79.8% (T3), 83.7% (T4) and 84.5% (T2) compared to untreated check.

These results were in agreement with those obtained in the pervious pot experiments.

Table 4 : The effect *Ocimum* extract on fresh weight of grassy, broadleaf and total weeds (g/m^2) with peanut crop at Giza Research Station, 2020 summer season

% of *Ocimum* extract and times of the spraying	Weeds fresh weight (g/m^2)			
	Broadleaf weeds	Grassy weeds	Total	% of reduction
T1: Untreated control	133.7 b	296.3 b	430.0 b	0.0
T2: 40% Pre emergence	6.7 a	60.0 a	66.7 a	84.5
T3: 30% pre em. + 10% once as post em.	0.7 a	86.0 a	86.7 a	79.8
T4: 20% pre em.+10% twice as post em.	3.0 a	67.0 a	70.0 a	83.7
T5: 10% pre em.+ 10% thrice as post em.	4.3 a	85.3 a	89.7 a	79.2
CV%	76.2	32.2	40.9	-

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

It can be seen in Table (5) that all *Ocimum* extract treatments except T5 gave a significant increase in the growth characteristics and yield of peanut throughout the growing season. *O.* extract treatment T4 gave the highest increased values of number of pods/plant, pods weight/plant, seeds weight/plant and pods yield (ton/ha) which were 15.8, 20.1g, 15.3g and 1.81 ton/ha, respectively; followed by *O.* extract treatment T2 which gave the values 11.6, 12.1g, 7.2g and 1.09 ton/ha of the previous respective characteristics, respectively, followed by *O.* extract treatment T3 which were 11.0, 9.3g, 6.4g and 0.84 ton/ha, respectively, compared to untreated check (5.8, 7.5g, 6.1g and 0.68 ton/ha, respectively).

On contrary, *O.* extract treatment T5 gave the lowest values of all the previous respective growth characteristics and yield which were 2.6, 5.8g, 1.4g and 0.53 ton/ha, respectively. But for 100 pods weight (g) the highest value was reported with T5 followed by T4, T3, T2, respectively. These results were due to *Ocimum* extract treatments reduced the weed biomass and increased the valuable nutrient of sowing crops due to reduction of the competitiveness of weeds and increased the competitiveness of crop plants [24, 27].

Table (6) showed that all *Ocimum* extract treatments gave significant reduction in fresh weight of broadleaf weeds, grassy weeds and their total with cowpea crop, compared to untreated check in both field experiments at Giza Research Station.

In the first experiment, *Ocimum* extract treatment at 30% as pre em. + 10% once as post em. (T3) gave the highest reduction percentage of broadleaf weeds by 100% followed by 20% pre em.+ 10% twice as post em. (T4) by 97.8%, 10% pre em.+ 10% thrice as post em. (T5) by 94.6% and 40% Pre em. (T2) by 68.1% compared to untreated check. Whilst, the highest reduction percentage of grassy weeds was reported with *O.* extract treatment T2 by 83.2% followed by T5 (77.3%), T4 (75.5%) and T3 (73.3%) compared to untreated check. Consequence to the previous reduction percentages of broadleaf and grassy weeds, the highest reduction percentage of total weeds was recorded with T2 which was 81%

followed by T5 (79.9%), T4 (78.8%) and T3 (77.2%) compared to untreated check. The results indicated that applying *O.* extract treatments improved cowpea yield significantly, the highest cowpea yield which was reported by T2 (2.96 ton/ha) followed by T3 (2.58 ton/ha), T5 (2.04 ton/ha) and T4 (1.77 ton/ha) compared to untreated check (1.22 ton/ha).

In the second experiment, *O.* extract treatment T2 gave the highest reduction percentage of broadleaf weeds which was 75.2% followed by T3 (74.6%) and T4 (65.3%) compared to untreated check. For the grassy weeds also T2 gave the highest reduction percentage which was 56.2% followed by T4 (17.2%) and T3 (0%) compared to untreated check. As a result to the previous reduction percentages of both broadleaf and grassy weeds, the *O.* extract treatment T2 gave the highest reduction percentage of total weeds which was 70.9% followed by T3 (54.8%) and T4 (54.3%) compared to untreated check. *O.* extract treatments improved cowpea yield significantly, the highest cowpea yield (ton/ha) was reported by T2 which was 3.19 ton/ha followed by T3 (3.05 ton/ha) and T4 (2.04 ton/ha) compared to untreated check (1.67 ton/ha).

These results indicated that *O.* extract treatments 40% as Pre-em. (T2) and 30% as pre-em. + 10% once as post em. (T3) significantly improved the cowpea yield compared to untreated check yield without significant difference between both treatments in the two experiments.

Table 5:The effect *Ocimum* extract on peanut characteristics and yield at Giza Research Station, 2020 summer season

% of *Ocimum* extract and times of the spraying	Growth characteristics and yield of peanut				
	Pods number /plant	Pods weight /plant	Seeds weight /plant	100 pods weight (g)	Pods yield (ton /ha)
T1: Untreated control	5.8 b	7.5 ab	6.1 b	110.5 ab	0.68 ab
T2: 40% Pre emergence	11.6 c	12.1 c	7.2 b	109.2 ab	1.09 c
T3: 30% pre em. + 10% once as post em.	11.0 c	9.3 bc	6.4 b	91.8 a	0.84 bc
T4: 20% pre em.+10% twice as post em.	15.8 d	20.1 d	15.3 c	122.8 ab	1.81 d
T5: 10% pre em.+ 10% thrice as post em.	2.6 a	5.8 a	1.4 a	140.0 b	0.53 a
CV%	6.8	9.4	5.8	17.3	9.4

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

Table 6:The effect *Ocimum* extract on fresh weight of grassy, broadleaf and total weeds (g/m^2) and cowpea in the first and the second Giza Research Station

% of *Ocimum* extract and times of the spraying	Broadleaf weeds	Grassy weeds	Total	% of reduction	Seed yield of cowpea ton/ha
First Exp.					
T1: Untreated control	31.3 a	180.7 b	212.0 b	0.0	1.22 a
T2: 40% Pre emergence	10.0 a	30.3 a	40.3 a	81.0	2.96 c
T3: 30% pre em. + 10% once as post em.	0.0 a	48.3 a	48.3 a	77.2	2.58 bc
T4: 20% pre em.+10% twice as post em.	0.7 a	44.3 a	45.0 a	78.8	1.77 ab
T5: 10% pre em.+ 10% thrice as post em.	1.7 a	41.0 a	42.7 a	79.9	2.04 abc
CV%	139.9	46.8	56.9	-	13.1
Second Exp.					
T1: Untreated control	452.3 b	131.3 b	583.7 b	0.0	1.67 a
T2: 40% Pre emergence	112.3 a	57.3 a	169.7 a	70.9	3.19 c
T3: 30% pre em. + 10% once as post em.	114.7 a	149.3 b	264.0 a	54.8	3.05 bc
T4: 20% pre em.+10% twice as post em.	157.0 a	108.7 ab	265.7 a	54.5	2.04 ab
CV%	28.4	16.6	19.7	-	5.3

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

Table (7) showed that Stomp herbicide at the rate 4.2 l/ha and all *Ocimum* extract treatments gave significant reduction in the percentage of the fresh weight of broadleaf weeds in peanut crop. The highest reduction percentage of broadleaf reported by Stomp at the rate 4.2 l/ha (T6) which was 91.6% followed by *O.* extract treatment at 40% as Pre em. (T2): 90.8%, Hand hoeing twice (T7): 85.6%, *O.* extract treatment at 30% pre em. + 10% once as post em. (T3): 73.3%, *O.* extract treatment at 20% pre em.+10% twice as post em. (T4): 65.7% and *O.* extract treatment at 10% pre em.+ 10% thrice as post em. (T5): 60.7% compared to untreated check, at Ismailia Research Station. Stomp herbicide and *Ocimum* extract at 40% as Pre em. (T2) treatments cause the highest reduction in broadleaf weeds without significant different between both treatments.

Tables (8) showed that all tested treatments caused significant improvement in the growth characteristics and yield of peanut, except for the peanut plant height. The highest peanut yield was resulted from *O.* extract treatment at 40% as pre emergence followed by herbicide treatment Stomp at 4.2 l/ha, hand hoeing, *O.* extract treatment at 30% pre em. + 10% once as post em., *O.* extract treatment at 20% pre em.+10% twice as post em. and *O.* extract treatment at 10% pre em.+ 10% thrice as post em., respectively.

Table 7:The effect *Ocimum* extract on fresh weight of broadleaf (g/m^2) at Ismailia Research Station, 2020 summer season

% of *Ocimum* extract and times of the spraying	Weeds fresh weight (g/m^2)	
	Broadleaved weeds	% of reduction
T1: Untreated control	384.7 f	0.0
T2: 40% Pre emergence	35.3 a	90.8
T3: 30% pre em. + 10% once as post em.	102.7 c	73.3
T4: 20% pre em.+10% twice as post em.	132.0 d	65.7
T5: 10% pre em.+ 10% thrice as post em.	151.0 e	60.7
T6: Stomp herbicide at 4.2 l/ha	32.3 a	91.6
T7: Hand hoeing twice	55.3 b	85.6
CV%	5.6	-

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

Table 8:The effect *Ocimum* extract on peanut characteristics and yield at Ismailia Research Station, 2020 summer season

% of *Ocimum* extract and times of the spraying	Growth characteristics and yield of peanut						
	Plant height	Number of branches	Pods number /plant	Pods weight /plant	Seeds weight /plant	100 pods weight	Pods yield ton/ha
T1: Untreated control	54.0 c	6.4 a	5.7 a	7.6 a	4.1 a	149.2 a	1.5 a
T2: 40% Pre emergence	50.6 a	11.1 e	15.8 f	22.9 e	15.0 f	167.6 g	2.66 e
T3: 30% pre em. + 10% once as post em.	51.0 ab	9.9 c	12.9 d	20.4 d	12.7 d	161.6 d	2.27 d
T4: 20% pre em.+10% twice as post em.	51.3 ab	8.6 b	11.7 c	17.3 c	10.8 c	154.7 c	2.00 c
T5: 10% pre em.+ 10% thrice as post em.	51.6 ab	7.9 b	10.4 b	14.8 b	8.8 b	151.3 b	1.75 b
T6: Stomp herbicide at 4.2 l/ha	50.2 a	10.9 de	15.3 ef	22.3 e	14.2 e	166.5 f	2.61 e
T7: Hand hoeing twice	52.0 b	10.3 cd	14.7 e	21.2 d	13.3 d	164.6 e	2.32 d
CV%	0.3	0.5	1.4	0.9	2.1	0.3	2.1

Means within a column followed by the same letter are not different according to LSD Test at p = 0.05.

4. Conclusion

This study explored the phytotoxic potential of aqueous extract of Ocimum basilicum on controlling some annual weeds such as green foxtail, jungle rice, common purslane, galius, *Amaranthus* spp. and malta cross and improvement of the growth characters of peanut and cowpea crops. The analysis of the aqueous extract of above ground parts of sweet basil indicated that it contained several compounds have allelopathic effect on weeds. The water extract of *Ocimum basilicum* at 40% as pre-emergence application significantly reduced the weight of some annual weeds and this reduction exceed the reduction caused by the application of Stomp herbicide at 4.2 l/ha furthermore improved the growth characteristics and yields of peanut and cowpea crops. The water extract of *Ocimum basilicum* could be utilized as natural herbicide for weeds control to lessen the use of chemical herbicides and reduce environmental deterioration moreover, the preparation method of the extract is very easy to be prepared and used by farmers for weed management in farmers' fields.

5. Conflicts of interest

The authors declare that they have no competing interests.

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