EVALUATION OF *Psidium guajava* LEAVES AND ACETIC ACID AS NATURAL HERBICIDES FOR CONTROLLING SOME WEEDS OF *Capsicum annuum* CROP

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ABSTRACT

Allelopathy and natural products are safe non-chemical modern techniques that are applied as alternative to synthetic herbicides for controlling weeds. So, two pot experiments were conducted to evaluate the allelopathic effect of Psidium guajava leaf powder (PLP) and Acetic acid 5% as a natural products on the growth and yield of Capsicum annuum plants and both associated weeds: Phalaris minor (grassy weed) and Malva parviflora (broad-leaf weed). PLP was mixed with in the soil surface at successive rates (15, 30, 45 and 60 g pot^{-1}). In the corresponding treatments PLP at the same sequenced rates were mixed with the soil then sprayed with acetic acid 5% immediately. Moreover, sole spraying of acetic acid 5% treatment was sprayed on the soil surface. All treatments were applied before transplanting directly. Results revealed that the maximum inhibition of both weeds in both seasons (2018 and 2019) was recorded by PLP at 60g + Acetic acid 5% as compared to unweeded control. Concerning C. annuum growth parameters and yield traits, sole application of PLP at successive rates is more effective than PLP at the same successive rates with acetic acid 5%. So, it was observed that PLP at 60g pot^{-1} and 45 g pot^{-1} significantly developed most of growth parameters and yield traits of C. annuum than the healthy plants in both seasons. On the contrary, acetic acid treatment alone recorded the lowest value of all growth parameters and yield traits of C. annuum plants.

Keywords: Allelopathy, *Capsicum annuum*, acetic acid, guava, *Psidium guajava* leaves powder, *Phalars minor*, *Malva parviflora.*

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INTRODUCTION

Fruity vegetable *Capsicum annuum* L. (Pepper or chili, Family: Solanaceae) is one of the most important, popular and favorite vegetable crops cultivated in Egypt. In Arabic it is commonly called "filfil akhdar", where "filfil" means pepper and "akhdar" means green. In Egypt it was cultivated on an area of 42.136 ha during the year 2007 that yielded 684.64 tons according to Ministry of Agriculture Statistics (El-Bassiony *et al.*, 2010). *C.* fruit is an excellent source of natural micronutrient antioxidants (vitamins C and E and carotenoids) which appear to be critically important in preventing or reducing chronic and age-related diseases (Palevitch and Craker, 2012). Weeds are often a major problem in crop production systems of food, vegetables, medicinal and ornamental crops (Hasanuddin *et al.,* 2000). Weeds are considered a serious pest that leads to huge damage to agricultural production approaching 34% (Oerke, 2006), besides the consumption of the nutrients from the soil. It reduces the yield of the crop by competing for nutrients, water, space, light and gases. Additionally, weeds produce toxic substances that weaken the growth of the associated crops which consequently reduce the quality and quantity of these crops (Chikoye *et al.,* 1995; Siddiqui *et al.,* 2009; Messiha *et al.,* 2018; EL-Masry *et al.,* 2019).

There is no doubt that the application of chemical herbicides is effective in controlling weeds, but it results in a negative impact on humans and animals (Vyvyan, 2002). Moreover, widespread use of herbicides causes soil and ground water pollution with the toxic residues which accumulate in agricultural products and weeds become resistant to these herbicides (Jabran *et al.,* 2015). In recent years, scientists have been looking for alternative methods to manage weeds and enhance crop production (Marambe and Sangakkara, 1996).

Many plants are found to produce secondary metabolites; known as allelochemicals which have selective herbicidal properties (El-Rokiek *et al.,* 2014; El-Masry *et al.,* 2019 and El-Wakeel *et al.,* 2019 a and b). This harmful or beneficial effect is known as allelopathy phenomenon (Reigosa *et al.*, 2006) Some of these compounds at certain concentrations are phytotoxic to some plants and stimulatory to others at the same concentration. Consequently, the allelopathic extracts could be used to control the growth of weeds (Singh *et al.,* 2003 and El-Wakeel *et al.,* 2019 a and b). *Psidium guajava* (guava) leaves have been identified to contain chemical products belonging to the groups with allelopathic properties (Monteiro and Vieira, 2002). Begum *et al.* (2002) ensured that guava leaves contain terpenoids, flavonoids, coumarins and cyanogenic acids. Gutierrez *et al.* (2008) also identified chemical products belonging to the groups with allelopathic properties such as terpenoids, flavonoids, coumarins and cyanogenic acids. Some of these compounds such as terpenoids can be leached from the leaves by rain (Monteiro and Vieira, 2002).

Diaz (2002) explained that vinegar or acetic acid can be applied as a natural herbicide. Acetic acid (CH_3COOH) which is the main component of vinegar does not remain in the environment, but degrades producing water as a byproduct (Evans *et al.,* 2011). The application of acetic acid is found in soil (on microbial biomass or adsorbed to soil particles) of about 26% in the form of-COOH and 36% as-CH3. Microbes have the special use of the C-CH3 in their growth, while the C-COOH groups tend to decarboxylation. Acetic acid in the soil provides a source of carbon for the decomposition process in producing carbon dioxide (Fischer and Dan Kuzyakov, 2010). Non-chemical weed control is a big problem in organic agriculture (Anonymous, 2006), so research efforts have been intensified to find safe ways to control weeds without the use of synthetic herbicides. Radhakrishnan *et al.* (2003) achieved significant control of pigweed with 10 and20% acetic acid concentration with early application.

The aim of this study was to study the effect of *Psidium guajava* leaf powder and Acetic acid on two selected annual weeds: *Phalaris minor* (grassy weed) and *Malva parviflora* (broad-leaved weed) associated with *Capsicum annuum* L. plants.

MATERIALS AND METHODS

Two pot experiments were carried out during two successive summer seasons of 2018 and 2019 in the greenhouse of the National Research Centre, Dokki, Giza, Egypt. *Capsicum annuum* L. (pepper) seedlings cultivar 'Omega' and both weeds under investigation *Phalaris minor* Retz. (littleseed canarygrass) and *Malva parviflora* L. (cheese mallow) were obtained from the Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt.

Preparation of Material Powder

Healthy *Psidium guajava* L. (guava) leaves were collected from Egyptian gardens and washed thoroughly with running tap water to remove dust and other undesired materials and air dried in shadow then grinded to fine powder.

Experimental procedure

Ground dried *P. guajava* leaves materials were mixed thoroughly with the surface of the potted soil mixture at a rate of 15, 30, 45 and 60 g pot^{-1} which had 30 cm diameter and 17 cm height (0.07m^2). All pots except healthy control were infested with *Phalaris minor* (littleseed canary grass) ((grassy weed) and *Malva parviflora* (cheese mallow weed) (broad-leaved weed) at a consistent weight (0.5 g pot^{-1}). Weed seeds were sown and mixed thoroughly at 2 cm depth in the soil. Three homogenous *C. annuum* seedlings were sown pot^{-1} in the first week of May in both test seasons. The experiment consisted of 12 treatments. The first main 8 treatments, which immediately treated before transplanting, classified into two equal groups. The first group treated with *Psidium guajava* leaf powder (PLP) only at successive rates (15, 30, 45 and 60 g pot^{-1}). Whereas, the second group also treated with PLP at the same aforementioned successive rates then all pots in this second group were sprayed with 5% acetic acid (50ml pot^{-1}). Additionally, acetic acid 5% applied solely (50ml pot^{-1}). For comparison three untreated treatments were designed, that are uninfected *C. annuum* plants only, two weeds (*P. minor* + *M. parviflora*) and *C. annuum* + two weeds (*P. minor* + *M. parviflora*). Each treatment was applied in nine replicates. The pots were arranged in a completely randomized design (CRD). Three replicates were collected from each treatment at 50 and 80 days after transplanting (DAT) and at harvest. The normal cultural practices of growing *C. annuum* plants were followed especially fertilization and irrigation.

Parameters studied

Weeds growth parameters

The infested weeds were collected from each pot at 50 and 80 (DAT) (all weed samples in each pot were pulled up).The data on fresh and dry weight of both grown weeds were recorded (g pot^{-1}).

Capsicum annuum growth parameters

Samples of *C. annuum* plants at 50 and 80 (DAT) were collected from each treatment, some morphological and growth characteristics of pepper plants were recorded for each individual plant. The recorded characteristics included: Shoot length (cm), Number of leaves plant^{-1}, Number of branches plant^{-1}, Fresh weight of plant (g), Dry weight of plant (g), Number of Internodes plant^{-1} and SPAD value (Minolta, 2013).

Capsicum annuum Yield Traits

At harvest, samples of *C. annuum* plants were taken from each treatment to determine: Number of pods plant^{-1}, Length of pod (cm) and Weight of pods plant^{-1} (g).

Chemical analysis of *Psidium guajava* leaf powder

Total phenolic and total flavonoid contents (mg g^{-1} DW) of *Psidium guajava* leaf powder were determined colorimetrically using Folin and Ciocalteu phenol reagent according to the method defined by Srisawat *et al.* (2010).

Statistical Analysis

The data obtained were subjected to standard analysis of variance procedure of complete randomized design; LSD values were obtained when F values were significant at 5% level (Snedecor and Cochran, 1980).

RESULTS

Weed Growth Parameters

At 50 days after transplanting (DAT) it was clearly observed that the presence of acetic acid either alone or with *Psidium guajava* leaf powder (PLP) suppressed the weed especially *Malva parviflora* broad leaved weed (Table-1). Therefore, PLP at 60g + Acetic acid 5%, Acetic acid 5% alone and PLP at 45g + Acetic acid 5% were the most efficient treatments in reducing both weeds under investigation. Whereas, the grassy *Phalaris minor* weed differed in response, depending on the age, to the applied treatments (Table-2) or possible selectivity to the applied treatments. However, PLP at 60g + Acetic acid 5%, remained as the best treatment in controlling *P. minor* grassy weed, followed by sole mixing of PLP at 60g and PLP at 45g + Acetic acid 5%. Concerning to *M. parviflora* broad leaved weed took the same response trend of the first age that PLP at 60 g + Acetic acid 5%, Acetic acid 5% alone and (PLP) at 45g soil + Acetic acid 5% were still the superior treatments in controlling *M. parviflora* as compared to control. On the other side, treatment *(Phalaris minor* + *Malva parviflora*) followed by unweeded check (*Capsicum annuum* + *Phalaris minor* + *Malva parviflora*) recorded the highest values of fresh and dry weight of both weeds in both seasons of study and (Figs. 1 and 2).

2. *C. annuum* Growth Parameters

The data in Table-3 exhibited at 50 DAT that PLP at 60g pot^{-1} and PLP at 45g pot^{-1} treatments achieved the highest values of all *C. annuum* growth parameters (except SPAD values). Healthy treatment (*C. annuum* plant alone) ranked these superior treatments. With regard to SPAD values, results also cleared that healthy treatment progressed on PLP at 60g and PLP at 45g most inducing treatments as compared to untreated pots (control) in both seasons. On contrary, acetic acid scored the lowest growth parameters that are lower than untreated control.

The data on the growth parameters of *C. annuum* plants at 80 DAT in both seasons as presented in Table-4. The data further indicated the application PLP at 60g pot^{-1}, PLP at 45g pot^{-1}, healthy plants and (PLP) at 60g + Acetic acid 5%, respectively were the best treatments in growth parameters as compared to unweeded pots (control). These treatments had increased dry weight of plant by 99.47, 71.88, 69.50 and 65.52 %, respectively in the first season and by 102.31, 73.78, 71.47 and 67.61% during the successive season over the corresponding unweeded treatment (control). Concerning to the sole application of acetic acid 5% as shown in Table-4, *C. annuum* treated plants recovered in the second age to exceed the untreated control plants in both seasons. On the other hand, untreated pots recorded the lowest values of all growth parameters of *C. annuum* plants in both 2018 and 2019 seasons.

Table-1. Effect of some weed control treatments on fresh and dry weight of *Phalaris minor* and *Malva parviflora* associating *Capsicum annuum* plants (g pot^{-1}) at 50 days from transplanting (2018 and 2019 seasons).

Treatment			**2018**						**2019**					
			Fresh weight (g pot^{-1})			**Dry weight (g pot^{-1})**			**Fresh weight (g pot^{-1})**			**Dry weight (g pot^{-1})**		
			P. minor	***M. parviflora***	***Total***	***P. minor***	***M. parviflora***	***Total***	***P. minor***	***M. parviflora***	***Total***	***P. minor***	***M. parviflora***	***Total***
C. annuum + P. minor + M. parviflora			12.49	12.08	24.57	1.61	1.77	3.38	13.62	13.22	26.84	1.75	1.98	3.73
P. minor +M. parviflora			12.73	19.56	32.29	2.00	3.49	5.49	13.90	21.55	35.45	2.21	3.88	6.09
C. annuum + P. minor + M. parviflora	PLP	15	12.37	11.23	23.60	1.59	1.68	3.27	13.48	12.26	25.74	1.72	1.86	3.58
		30	7.71	10.05	17.76	0.95	1.56	2.51	8.35	10.82	19.17	1.05	1.74	2.79
		45	6.01	7.86	13.87	0.73	1.32	2.05	6.52	8.51	15.03	0.81	1.45	2.26
		60	3.80	7.32	11.12	0.56	1.12	1.68	4.06	7.90	11.96	0.60	1.33	1.93
	PLP+ acetic acid 5%	15	6.94	10.57	17.51	0.82	1.58	2.40	7.53	11.47	19.00	0.90	1.78	2.68
		30	4.75	9.46	14.21	0.57	1.40	1.97	5.11	10.32	15.43	0.62	1.56	2.18
		45	3.65	7.04	10.69	0.51	1.02	1.53	3.90	7.58	11.48	0.56	1.23	1.79
		60	2.42	0.30	2.72	0.23	0.10	0.33	2.56	0.40	2.96	0.25	0.12	0.37
	Acetic acid 5%		3.23	6.75	9.98	0.49	0.49	0.98	3.45	7.28	10.73	0.53	0.56	1.09
$LSD_{0.05}$			0.72	0.91	1.41	0.23	0.24	0.18	0.96	1.48	1.53	0.34	0.28	0.65

Table-2. Effect of some weed control treatments on fresh and dry weight of *Phalaris minor* and *Malva parviflora* associating *Capsicum annuum* plants (g pot^{-1}) at 80 days from transplanting (2018 and 2019 seasons).

Treatment			2018						2019					
			Fresh weight (g pot^{-1})			Dry weight (g pot^{-1})			Fresh weight (g pot^{-1})			Dry weight (g pot^{-1})		
			P. minor	***M. parviflora***	**Total**	***P. minor***	***M. parviflora***	**Total**	***P. minor***	***M. parviflora***	**Total**	***P. minor***	***M. parviflora***	**Total**
C. annuum + P. minor + M. parviflora			18.45	18.93	37.38	5.59	3.92	9.51	19.88	21.18	41.06	6.05	4.29	10.34
P. minor +M. parviflora			45.97	31.20	77.17	13.01	6.70	19.71	47.66	33.95	81.61	14.21	7.38	21.59
C. annuum + P. minor + M. parviflora	PLP	15	18.36	18.44	36.80	5.50	3.70	9.20	19.75	20.52	40.27	5.94	4.10	10.04
		30	12.95	12.35	25.30	3.89	3.31	7.20	13.86	13.77	27.63	4.18	3.60	7.78
		45	7.98	9.14	17.12	2.75	2.05	4.80	8.53	10.21	18.74	2.96	2.25	5.21
		60	1.69	8.50	10.19	0.68	1.93	2.61	1.81	9.47	11.28	0.74	2.09	2.83
	PLP+ acetic acid 5%	15	17.78	15.10	32.88	4.48	3.44	7.92	18.99	16.85	35.84	4.89	3.77	8.66
		30	10.84	11.66	22.50	3.32	2.81	6.13	11.62	12.83	24.45	3.62	3.03	6.65
		45	7.45	6.75	14.20	1.62	1.76	3.38	7.99	7.50	15.49	1.75	1.94	3.69
		60	0.53	5.35	5.88	0.14	1.19	1.33	0.58	5.96	6.54	0.16	1.28	1.44
	Acetic acid 5%		10.45	5.40	15.85	3.02	1.39	4.41	11.20	6.03	17.23	3.31	1.53	4.84
LSD $_{0.05}$			1.35	1.29	1.82	0.67	0.34	0.75	1.34	1.19	1.58	0.73	0.90	1.11

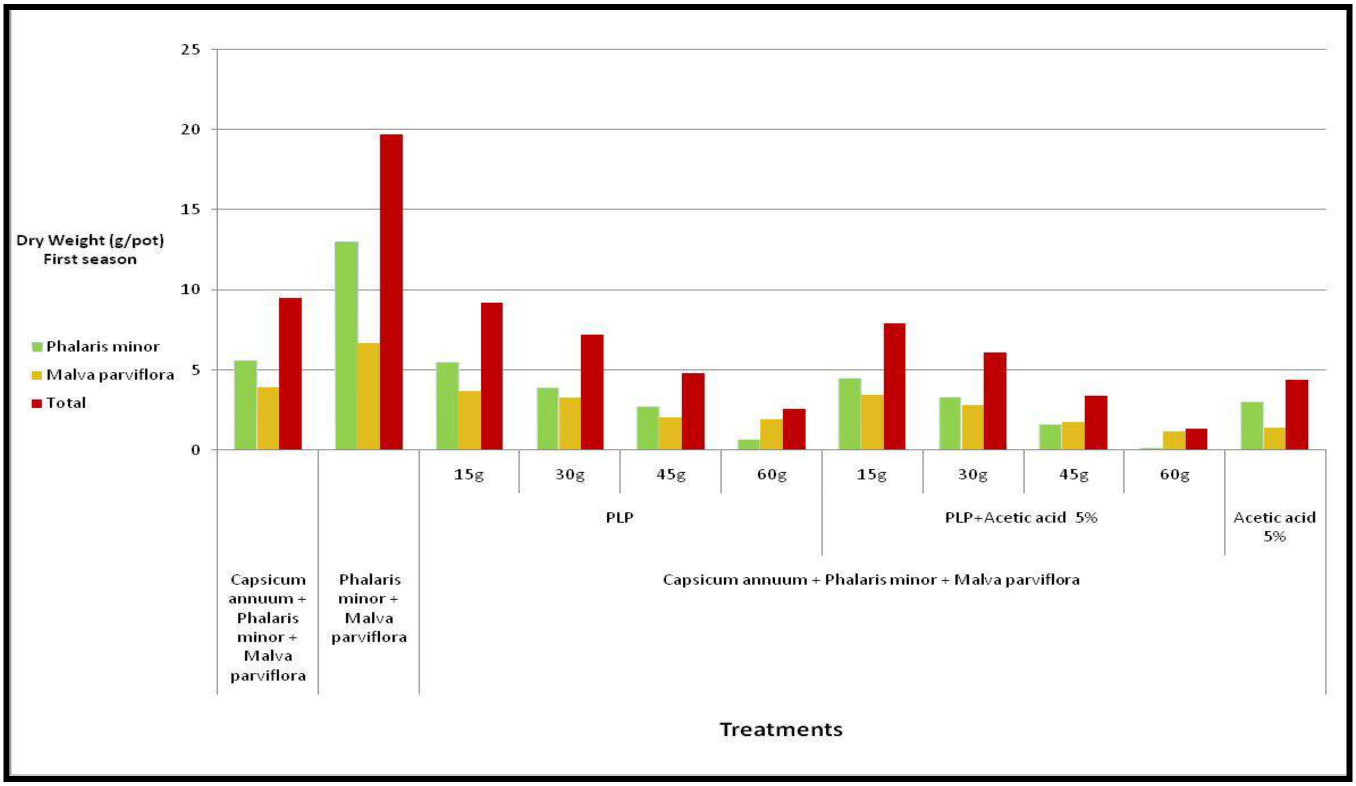

Fig. 1. Dry weight of *P. minor*, *M. parviflora* and total weeds at 80 DAT at 2018 season.

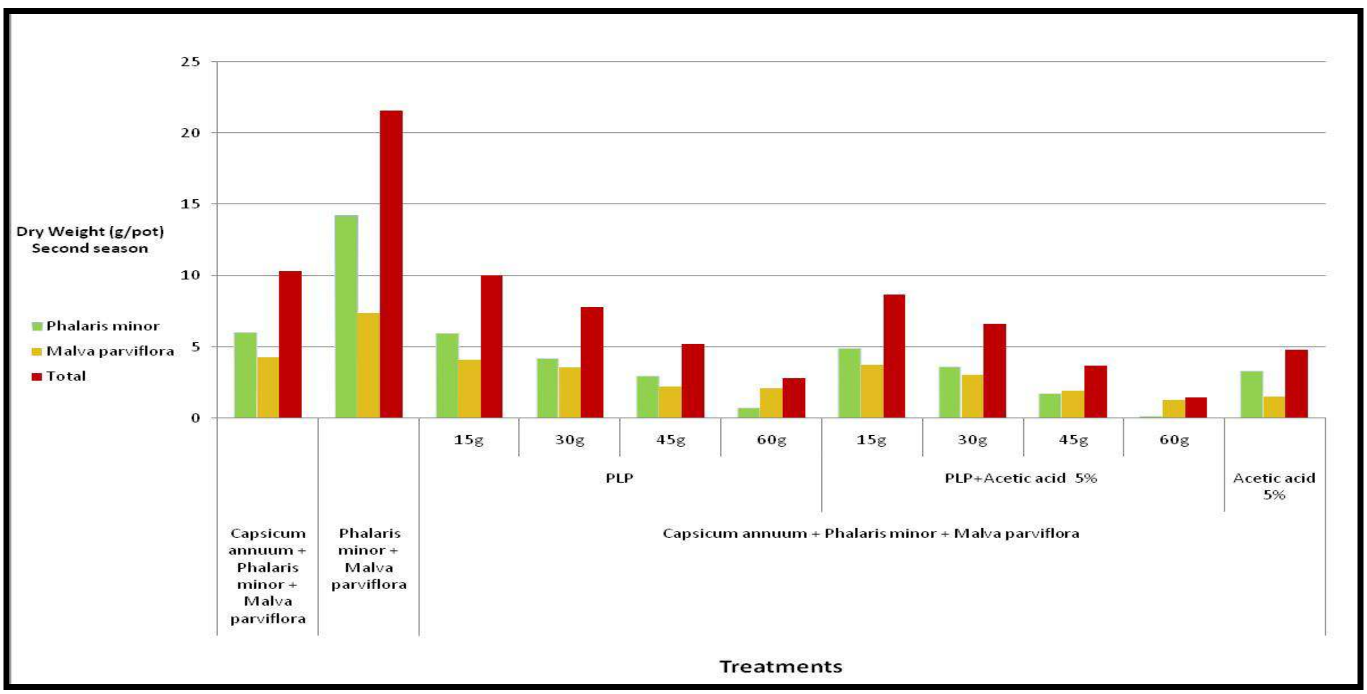

Fig. 2. ***Dry weight of P. minor, M. parviflora and total weeds at 80 DATs at 2019 season***.

Table 3. Growth parameters of *Capsicum annuum* plants as affected by some weed control treatments at 50 days from transplanting (2018 and 2019) seasons).

Treatment			2018							2019						
			Shoot length (cm)	**Leaves plant^{-1}**	**Branches plant^{-1}**	**Plant F. W. (g)**	**Plant D. W. (g)**	**Internodes plant^{-1}**	**SPAD value**	**Shoot Length (cm)**	**Leaves plant^{-1}**	**Branches plant^{-1}**	**Plant F. W. (g)**	**Plant D. W. (g)**	**Internodes plant^{-1}**	**SPAD value**
C. annuum alone			47.75	17.00	1.75	13.06	4.13	15.5	48.80	49.2	17.6	1.75	13.85	4.18	16.53	49.18
C. annuum + *P. minor* + *M. parviflora*			35.70	12.50	1.00	9.21	2.97	11.3	34.35	38.7	12.9	1.00	9.75	3.09	11.97	34.55
C. annuum + *P. minor* + *M. parviflora*	PLP	15	45.20	16.00	1.60	10.79	3.45	14.0	37.47	46.5	16.5	1.65	11.42	3.60	14.90	37.72
		30	47.20	16.50	1.75	11.95	3.80	14.5	38.33	48.6	17.1	1.75	12.67	3.95	15.41	38.61
		45	48.50	17.75	1.90	14.50	4.57	16.1	39.14	50.4	18.4	2.00	15.43	4.33	17.15	39.44
		60	54.50	19.00	2.00	18.62	5.71	18.0	44.88	56.3	19.7	2.10	19.81	6.02	19.22	45.20
	PLP+ acetic acid 5%	15	42.80	14.25	1.25	9.74	3.13	12.8	35.40	44.0	14.8	1.30	10.30	3.24	13.53	35.62
		30	43.00	14.75	1.50	9.93	3.19	13.2	36.10	44.3	15.3	1.50	10.52	3.32	14.00	36.33
		45	45.00	15.00	1.50	10.13	3.25	13.5	37.20	46.1	15.5	1.60	10.70	3.38	14.31	37.45
		60	46.50	16.30	1.70	11.92	3.79	14.2	37.82	47.9	16.9	1.70	12.61	3.95	15.12	38.10
	Acetic acid 5%		37.50	12.10	1.00	8.93	2.88	11.1	34.21	36.8	12.3	1.00	9.47	3.01	11.74	34.13
$LSD_{0.05}$			1.16	1.63	0.16	1.15	0.88	1.03	1.61	1.54	1.24	0.30	1.21	0.78	1.13	1.31

Table 4. Growth parameters of *Capsicum annuum* plants as affected by some weed control treatments at 80 days from transplanting (2018 and 2019) seasons).

Treatment			2018							2019						
			Shoot length (cm)	**leaves plant^{-1}**	**Branches plant^{-1}**	**Plant F. W. (g)**	**Plant D. W. (g)**	**Internodes plant^{-1}**	**SPAD value**	**Shoot length (cm)**	**No. of leaves plant^{-1}**	**Branches plant^{-1}**	**Plant F.W. (g)**	**Plant D.W. (g)**	**Internodes plant^{-1}**	**SPAD value**
C. annuum only			59.8	37.3	2.3	25.96	6.39	16.00	68.5	62.5	37.7	2.4	27.06	6.67	16.30	69.1
C. annuum + P. minor + M. parviflora			39.8	13.8	1.1	14.90	3.77	12.00	47.5	40.9	14.0	1.2	15.35	3.89	12.13	48.2
C. annuum + P. minor + M. parviflora	PLP	15	47.5	28.3	2.0	18.61	5.26	14.30	61.6	49.9	28.8	2.0	19.24	5.48	14.49	62.5
		30	50.5	32.0	2.1	21.62	6.22	15.50	65.0	52.8	32.4	2.2	22.40	6.49	15.71	66.2
		45	61.3	38.5	2.4	27.60	6.48	16.95	68.7	64.4	38.9	2.5	28.68	6.76	17.30	69.7
		60	64.5	41.0	2.7	28.38	7.52	18.60	68.9	66.7	41.8	2.7	29.59	7.87	19.00	70.1
	PLP+ acetic acid 5%	15	43.9	18.3	1.7	15.85	5.14	13.70	58.5	44.9	18.6	1.7	16.44	5.35	13.97	59.4
		30	44.5	26.5	1.8	18.21	5.16	14.00	61.5	46.3	26.9	1.8	18.92	5.38	14.18	62.0
		45	50.3	28.8	2.0	18.97	5.86	15.00	61.9	51.8	29.0	2.1	19.53	6.11	15.30	63.0
		60	54.0	35.0	2.3	23.62	6.24	15.70	67.1	56.7	35.2	2.3	24.40	6.52	16.00	68.2
	Acetic acid 5%		41.3	17.0	1.5	15.45	4.09	12.50	55.2	43.1	17.7	1.5	15.92	4.25	12.65	56.1
$LSD_{0.05}$			1.7	1.8	0.3	1.54	0.92	1.47	1.9	1.48	1.81	0.3	1.59	0.98	1.49	1.62

Capsicum annuum yield attributes

As shown in Tables (5 and 6), the application of PLP at successive rates (15 – 60 g pot^{-1}) either alone or with Acetic acid 5% in both seasons significantly increased all yield traits of *C. annuum*as compared to their corresponding untreated control. The most efficient treatments that promoted *C. annuum* yield were recorded by PLP at 60g pot^{-1},PLP at 45g, *C. annuum* plant alone (healthy) and (PLP) at 60 g + Acetic acid 5%, respectively as compared to other treatments. Application of PLP at 60g and (PLP) at 45g pot^{-1} recorded increase in weight of pods plant^{-1} reached to 70.53 and 22.11%, in 2018 season and to 76.28 and 25.89%, in 2019 season respectively, over the corresponding healthy plants. With regard to application of acetic acid at 5% alone, the results in Tables (5 and 6) and Fig.3 showed that yield parameters of *C. annuum* were significantly increased when compared to untreated pots except number of pods plant^{-1} in both seasons. On the contrary, unweeded pots gave the lowest values of all yield attributes of *C. annuum.* It is worth mentioning that although PLP at 60 and 45 g pot^{-1} were not the most efficient treatments in controlling both investigated weeds, but it suppressed weeds at the limit which has no effect on the induction of yield. Whereas, 60 and 45 g pot^{-1} + acetic acid 5% were the effective treatments in controlling weeds didn't achieve the highest level of *C. annuum* yield.

Chemical analysis of *Psidium guajava* shoot powder

The data in Table-6 ensured the presence of phenolic compounds (21.22 mg g^{-1} DW) and flavonoids (0.0018 mg g^{-1} DW) in *Psidium guajava* leaf powder (PLP) which could be responsible for the allelopathic inhibitory effect on both investigated weeds. Further studies are suggested to explore the allelopathic compounds and their mode action.

Table-5. Effect of some weed control treatments on yield and its attributes of *Capsicum annuum* plants (season 2018 and season 2019).

Treatment			2018			2019		
			Pods plant^{-1}	Pod Length (cm)	Pod Weight plant^{-1} g	Pods plant^{-1}	Pod Length (cm)	Pod Weight plant^{-1} (g)
C. annuum only			8.5	9.3	47.5	9.4	10.1	50.6
C. annuum + P. minor + M. parviflora			2.0	2.5	10.0	2.2	3.0	11.5
C. annuum + P. minor + M. parviflora	PLP	15	4.0	5.0	25.5	4.5	5.5	28.3
		30	7.0	6.6	41.5	7.6	7.3	45.3
		45	9.5	9.8	58.0	10.3	10.9	63.7
		60	12.0	11.0	81.0	13.1	12.1	89.2
	PLP+ acetic acid 5%	15	3.0	5.0	24.5	3.4	5.4	27.1
		30	6.0	5.5	35.5	6.4	6.0	39.8
		45	6.3	6.0	39.0	6.8	6.5	43.9
		60	8.0	7.2	47.0	8.7	8.1	50.2
	Acetic acid 5%		2.5	4.3	16.0	3.0	5.1	19.4
LSD $_{0.05}$			1.2	1.1	1.9	1.3	1.2	1.9

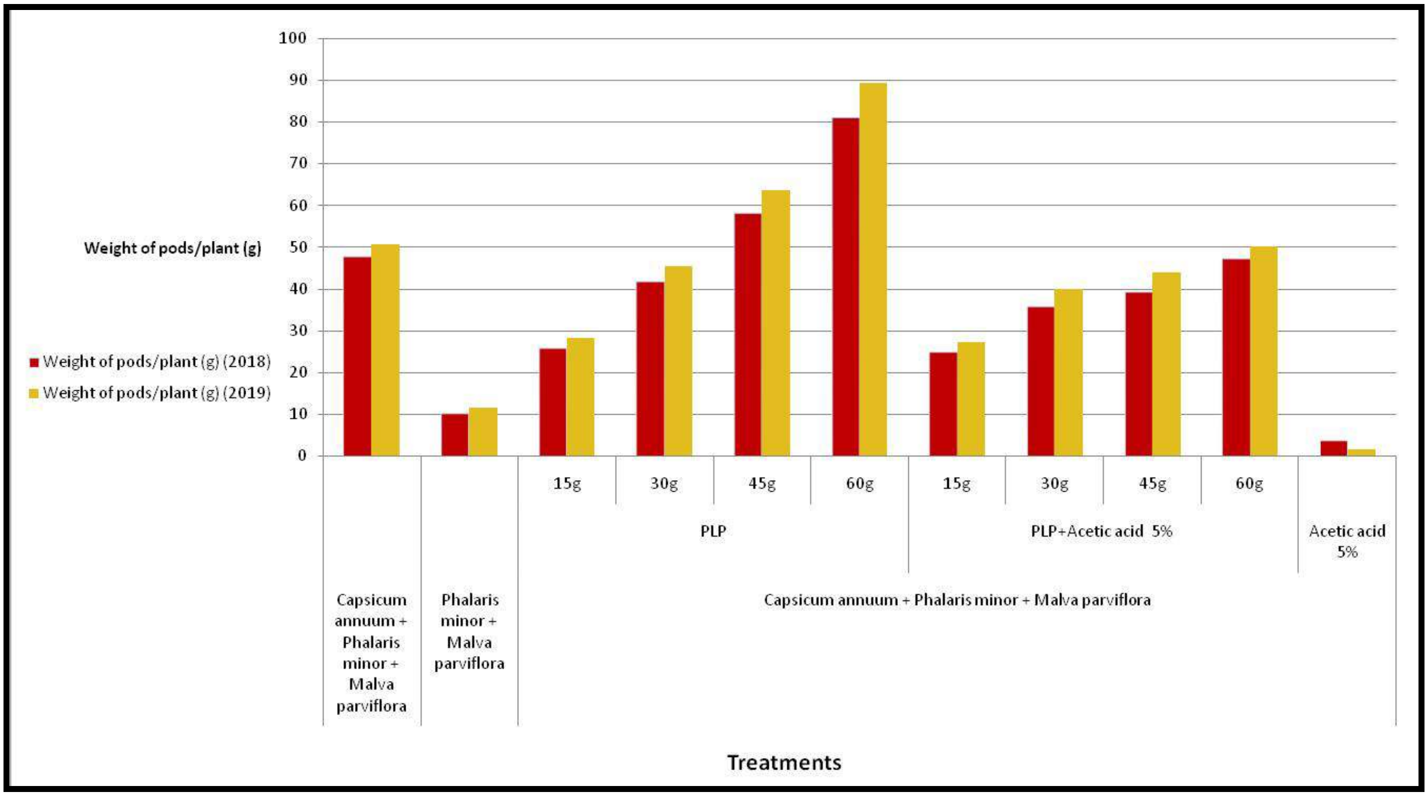

Fig. 3. Weight of pods plant^{-1} at 2018 and 2019 seasons.

Table-6. Total phenolic contents (mg g^{-1} DW) and total flavonoids in *Psidium guajava* leaf powder (PLP).

Alleopathic plant material	Total phenolic compounds (mg g^{-1} DW)	Total flavonoids (mg g^{-1} DW)
Psidium guajava leaf powder (PLP)	21.22	0.0018

DISCUSSION

The allelopathic compounds are secondary metabolites known as allelochemicals that release from plants into the environment. Allelochemicals positively or negatively affect on the other plants (Zhou *et al.,* 2011). Allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, amino acids and glucosinolates were found in allelopathic plants (Velasco *et al.,* 2008 and Ahmed *et al.,* 2012). Recently, several researches showed the potential of using the allelopathic technique as a safe approach to suppress weeds in crops (Zaji and Majd, 2011). Also, modern weed management strategies seek non-chemical solutions to minimize the harmful effects resulted from the use of herbicides in agricultural systems. Therefore, allelochemicals could be considered as an important tool for sustainable weed management (El-Metwally *et al.,* 2014; El-Wakeel, 2015).

The results of the present study in Tables (1 and 2) exhibit that the growth of both *P. minor* (grassy weed) and *M. parviflora* (broad-leaf weed) was significantly reduced by the application of PLP at successive rates either alone or with acetic acid as well as acetic alone at 5% in both seasons. The inhibitory effect of PLP increased with the increase of its rate. These results are in consistence with other results of different plant extracts that were found to suppress growth of different weed species (El-Rokiek *et al.,* 2014). Released active allelopathic compounds in *P. guajava* extracts were documented by Dawood *et al.* (2012). Moreover, Begum *et al.* (2002) and Gutierrez *et al.* (2008) reported that the allelopathic activity in *P. guajava* leaves may be related to terpenoids, flavonoids, coumarins, cyanogenic acids. In addition, El-Rokiek *et al.* (2012) found that the extract of *P. guajava* dry leaves contains some phenolic acids e.g., ferulic, coumaric and chlorogenic acids. Acetic acid efficacy as a natural product for controlling weeds depends on the absorption of acetic acid by the foliar part of plant followed by translocation to other parts of plant can cause damage. Therefore, acetic acid was considered to be a contact and as post-emergence herbicide as glyphosate. Abouziena *et al.* (2009) showed that acetic acid 5% and citric acid 10% were effective against broadleaf weeds, while the narrow leaf weeds required a higher concentration of acetic acid 30%. Acetic acid is a contact type herbicide and its effect can be seen within hours (1-2 hours after application). Another advantage of acetic acid as a herbicide is biodegradable, so it does not lead to residues on crops. Webber and Shrefler (2005) found that the pre-emergence application at 10% and 20% of the glacial acetic acid solution on *Arachis hypogaea* L. inhibited seed germination.

Results recorded in Tables 3,4 and 5 indicated that the highest values of *C. annuum* growth parameters and consequently yield were enhanced by the application of PLP alone at the highest rates 60 and 45g pot^{-1}. Stimulatory response of *C. annuum* plants can be explained by the selectivity of allelochemicals which is similar to that in synthetic herbicides (Weston, 1996). Additionally, many scientists ensured that controlling weeds in *C. annuum* increased its growth parameters as a result of limiting the competitor agents (El-Rokiek *et al.,* 2014; El-Masry *et al.,* 2015; El-Wakeel *et al.* (2019 a and b). Acetic acid alone negatively affected *C. annuum* plants at 50 DAT. While, *C. annuum* plants recovered itself at 80 DAT and gave the lowest increase in growth parameters of *C. annuum* as compared to other treatments may be related to non-selective mode of action of acetic acid (Bighetti *et al.,* 1999). Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents were reported to be the leaf age dependent. The highest activity was reported from the young leaves. Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents were reported to be the leaf age dependent. The highest activity was reported from the young leaves. Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents were reported to be the leaf age dependent. The highest activity was reported from the young leaves. Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents were reported to be the leaf age dependent. The highest activity was reported from the young leaves. Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents were reported to be the leaf age dependent. The highest activity was reported from the young leaves. Nunes *et al.* (2016) extract 31 falvaoind from the guava leaves. Terpenes were the predominant component. Earlier studies of Nantitanon (2010) concluded ultrasonication as the best method for guava leaf extraction and the contents

were reported to be the leaf age dependent. The highest activity was reported from the young leaves.

CONCLUSION

The application of *P. guajava* leaf powder (PLP) by mixing with the soil is a safe effective method to manage *Phalaris minor and Malva parviflora* infesting *C. annuum* plants that consequently developed growth and yield of the plants. The most PLP effective rates of (60 and 45 g pot^{-1}) are recommended to be investigated at the field level to manage *Phalaris minor* and *Malva parviflora* infesting *C. annuum*.

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