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α-tocopherol-Does Play a Significant Role on Affecting the Herbicidal Efficacy of Grasp for Controlling Weeds and Increasing Growth in Barley?

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Abstract: Two greenhouse experiments were conducted in this regard on barley cv. Giza 122 during the period of (2004-2006). α-tocopherol and grasp were used in different concentrations (50, 100, 150 and 250, 500, 1000 mg L^{-1}, respectively), as a post-emergence application either alone or in combination at 3-4 leaf stage. Grasp was extremely effective for controlling grassy weeds rather than broad leaves. However, the associated phytotoxic effect against barley growth was disappointed. The bleaching effect was a distinctive feature throughout. Albeit not permanent, the effect was extended to catch yield and its attributes as compared with hand weeded control. α-tocopherol fairly increased barley growth and its productivity at the different rates of application. Increasing the competitive and allelopathic capabilities of crop plants at the expense of associated weeds could be the reasons behind this fact. Applying α-tocopherol in combination with grasp was more promising than the individual application of either of them. It caused weed growth decreased to a minimum. Barley growth and its productivity increased to their best values in this regard. The chemical analysis revealed on more superiority of the combined application treatments in increasing the photosynthetic pigments (chlorophyll a, b and carotenoids) and amino acids grain yield than the singlet or even hand weeded treatments. It has been suggested that using α-tocopherol in combination with grasp is an excellent tool for reducing the bad effect of the herbicide against growth and development of grassy crops e.g., barley. Such compensatory effect of α-tocopherol might be arise from its ability to quench herbicide's free radicals before they react with intercellular biological systems. Grasp at 500 mg L^{-1} plus α-tocopherol at 100 mg L^{-1} is highly recommendable for achieving the best result.

Key words: α-tocopherol, barley, grasp, phytotoxicity, weed control

INTRODUCTION

Reducing our reliance on synthetic pesticides (i.e., herbicides) is became a common request for several reasons related to health and environment. Stimulating the search on alternative and new approach for weed control has taken a large stride in this regard. Using plant-derived compounds with potential herbicidal activity is one of such promising approach. May be it is not precisely the real solution of the problem because of the complexity and high cost of isolating and adapting of a compound for commercial utilization, but at least open the door for new strategies for weed control. Research on plant phytotoxins for weed control has taken several ways for practical application. Pure compounds, of course, were the main task of researchers for developing a new herbicide with a novel site of action perhaps. Literatures are full of many examples of such plant derivatives that provide superiority for controlling weeds (Duke *et al*., 2002). A reasonable number of them have already been used in the same formula they isolated (without any chemical modification) such as juglone, artimisinin and podolactone E (Williams and Hoagland, 1982; Miller *et al*., 1984; Kato-Noguchi and Ino, 2005).

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Some of others, representing the majority, were used in a large scale after certain modifications using such techniques of halogenations or chlorination. Of such examples are 1,8-cineole and camphene which sold under the trade names toxaphene and cinmethylin, respectively. Benzoate derivatives are another successful example already commercialized as dicamba, cholramben and picloram (Sherman *et al*., 1983; Grayson *et al*., 1987; Duke, 1992).

Using crude extracts is another issue of benefits. There is a little interest within herbicides industry for using plant crude extracts in the practical field of controlling weeds, although the research reports around this point are numerous (Singh *et al*., 2005; Yongqing, 2005). The toxicology, quality control, economic and patent obstacles to development of crude extracts as herbicides are sever (Duke, 1992). Sorgaab, is one of such ambitious examples of using plant crude extracts in controlling weeds. It is prepared from sorghum extract (a water extract of mature sorghum plants obtained after soaking in water for 24 h) and successfully used in controlling weeds in wheat. The results recorded 35 to 49% weed reduction and 10 to 21% yield increasing under filed conditions in response to sorgaab application (Cheema and Khaliq, 2000). Moreover of the promising examples, the crude extracts of bermuda-grass (*Cynodon dactylon*), johnson-grass (*Sorghum halepense*) and pigweed (*Amaranthus albus*) weeds were found to be at the same level of the herbicidal efficiency of glyphosate and dimethyl-tetrachloroterephthlate for controlling dodder in alfalfa (Abdul-Rahman and Habib, 1986).

No way using herbicides is indispensable matter. May be, the work on reducing the herbicidal doses of the currently available herbicides is the point that should receive more attention at least for the time being, than producing a new synthetic one. With plant derivatives, this could be easily achieved. There is a considerable amount of research that using plant-derived compounds in combination with synthetic herbicides was so far effective in enhancing their efficiency in controlling weeds. Substantial results were obtained with applying fusilade in combination with rice straw extract at rates<recommended dose for controlling weeds infested soybeans (El-Rokiek *et al*., 2006). Similar results were obtained by Sharara and El-Kramany (2006) on applying fusilade and bentazone herbicides in combination with benzoic acid for controlling weeds in faba bean. El-Shazly *et al*. (1980) were also announced of the great activity of white clover (*Melilotus* sp.), toothed clover (*Medicago lipida*) and cocklebur (*Xanthium stramarium*) weed extracts on enhancing the herbicidal potential of brominal and igran herbicides. Wheat seedlings were the test organism that authors built on their investigations.

α-tocopherol is the most active form amongst eight structures of vitamin E (Munne-Bosch and Alegre, 2002). It is a natural component of the photosynthetic membranes occurring at about 25-30% of the amount of plastoquinone-A (Kruk and Strzalka, 1995). α-tocopherol is well known for its antioxidant roles within plants (Machlin, 1980). The most important function of vitamin E is to maintain the integrity of intercellular membranes by protracting its physical stability (Fryer, 1992). One more of its primary functions is to regulating the electron transport reaction (Kruk *et al*., 2000). As antioxidant, α-tocopherol is closely connected to ascorbic acid and glutathione-free radicals scavenger components. Cycling of quinone (oxidized) and quinols (reduced) using reduced ascorbate or NADPH is in its essence the main mechanism of the process (Hess, 1994). In brief, the antioxidant properties of tocopherol arise from its ability to scavenge lipid peroxy radicals before they react with lipid substrates. These reactions produce tocopheroxyl radicals that are relatively un-reactive and can be recycled by other antioxidants such as ascorbic acid and glutathione (Fryer, 1992). From this point, the plant can remove the bad effect of the free radicals such as alkaylperoxile, hydrogen peroxide, singlet oxygen and more (Alscher and Hess, 1993).

Using α-tocopherol in exploring the mode of action or probably increasing the herbicidal activity of certain herbicides is a new point of research and is the subject of our current study. Grasp (tralkoxydim) is the herbicide that has been chosen in this regard and barley is our targeted crop. Grasp is registered as a post-emergence herbicide for controlling primarily grassy weeds in cereals (Eschenbrenner, 1990). It is closely related to fluazifop-p-butyl (fusilade), Aryloxyphenoxypropionate (AOPP) and Cyclohexandione (CHD) herbicides in its mode of action (Kumar and Singh, 1997). They are all belonging to graminicide (grass-selective herbicides). Like all, grasp acting on inhibiting the enzyme acetyl-CoA Carboxylase (ACC-ase) in the susceptible grassy species (Anderson and Beardall, 1991; Leach *et al*., 1995). Inhibiting ^{14}C incorporation into fatty acids fraction *in vivo* by such herbicide is a strong evidence of interrupting ACC-ase (Matthews *et al*., 1990). As plant deprived from fatty acids and membrane lipids in consequence, it will be absolutely died (Herbert *et al*., 1996). The susceptibility or insusceptibility amongst different plant species to grasp is in its main reason due to the sensitivity or insensitivity at the level of ACC-ase. ACC-ase extracted from tolerant phenotypes of maize (*Zea mays*), for example, was found to be 12.8 fold more tolerant to inhibition by grasp than those extracted from susceptible types (Incledon and Hall, 1999). However, as a whole group where grasp is a member for, these herbicides are effective against most grasses including wheat (*Triticum aestivum*; *T. turgidum*) and barley (*Hordium spontanium*; *H. glaucum*). Using them in broad-leaved crops was then more better (Balyan *et al*., 1991; Tal *et al*., 1993). It is, therefore, a critical problem facing applying grasp in most of cereals.

Thus, the aim of the present research was to explore the assistant role of α-tocopherol in enhancing the biocidal profile of grasp in controlling weeds infested barley through answering the question: Does α-tocopherol supply target crop with enough protection against damaging effect of the herbicide with persisting toxicity as much as the same against weedy species?

MATERIALS AND METHODS

Two greenhouse experiments were conducted in this regard during two successive seasons (2004-2006). Barley (*Hordeum vulgare* cv. Giza 122) grains were obtained from Agricultural Research Center, Ministry of Agriculture, Egypt. The grains were sown in 32 cm diameter-pottery pots (102 in number; 10 grains/each) on the 1st week of November of the two seasons. The pots were simultaneously infested with certain annual broad and narrow-leaved weeds e.g., pigweed, *Amaranthus cruentus*; nettleleaf goosefoot, *Chenopodium murale*; oat, *Avena fatua*; ryegrass, *Lolium temulentum* and greater ammi, *Ammi majus*. Six replicates were used for each treatment in a completely randomized design. An extra six pots were used as controls. The grown plants were received all necessary care from watering and fertilization according to recommendations. Serial concentrations of α-tocopherol (50, 100 and 150 mg L^{-1}) were prepared by dissolving in 5% sodium hydroxide. The grasp herbicide (10% EC, Dow company) was prepared in three concentrations (250, 500 and 1000 mg L^{-1}) using absolute tap water. The two compounds were sprayed as a post-emergence application either alone or in combinations thirty five days after sowing.

After twenty days from spraying (55 days of sowing), the data on the fresh and dry weights (g) of shoot biomass of grown weeds were taken for their both types (broad and narrow-leaved weeds). One more subsequent collection was taken 3 months later (e.g., at harvest stage). Barley samples were taken once simultaneously with the first taken of weeds sampling by hand pulling of five plants each pot. The plants were subjected to determine certain vegetative characteristics including plant height (cm) and fresh and dry weights (g) of shoot biomass. At harvest stage (150 days from sowing), the remainder plants were used to determine the yield (seed weight (g)/plant) and its constituents including spike length (cm), number of spikes/plant, number of spikelets/spike, grain weight/spike (g), weight of 1000 grains/plant (g) as well as certain other growth criteria such as plant height (cm) and straw yield of the plant (g).

The photosynthetic pigments including chlorophylls (a; b) and carotenoids were estimated spectrophotometrically in the shoots (i.e., leaves) of treated and untreated plants of barley according to the methods and formulas of Saric *et al*. (1967). The samples undertaken to the study were taken 20 days after foliar application.

The grain content of amino acids was estimated according to the methods of Gehrke *et al*. (1985) by extracting in 6 N HCl at 110°C overnight. Once obtained, the extracts were filtered, evaporated to dryness under vacuum at 50°C and then exposed to Eppendrof Amino Acid Analyzer (LC 3000 model) under the conditions of: Flow rate, 0.2 mL min^{-1}; Pressure of buffer, 0-50 bar; Pressure of reagent, 0-150 bar; Reaction temperature, 123°C.

The data overall were subjected to standard analysis of variance at LSD5% according to Snedecor and Cochran (1967).

RESULTS

The effect of the individual application of α-tocopherol and grasp as well as their combinations on the growth of weeds is shown in Table 1. It was distinctly clear the significant effect of applying grasp alone in reducing grassy weeds more than the broad-leaved species. It is completely killed the grassy weeds at the moderate (500 mg L^{-1}) and highest (1000 mg L^{-1}) concentrations. At the lowest concentration (250 mg L^{-1}), the herbicide failed to achieve any satisfactory weed control. Conversely, the results obtained with applying α-tocopherol alone. The results were closest to control in some cases (at the highest concentration of the compound) and surpass it (up to 54.61% growth reduction) in another as established in the lowest and moderate concentrations.

The situation entirely differed with the combined application treatments. Applying grasp and α-tocopherol in combination achieved significant control against grassy weeds as much as the individual application of grasp. However, it was of great interest to notice such enhancement effect against broad-leaved weeds which was estimated by up to (77.17% growth reduction) as compared

Table 1: Effect of grasp, α-tocopherol and their combinations on the growth of barley and its associated weeds. (Combined analysis of two successive seasons)

		Twenty one days of foliar application							At harvest stage [weeds, Dr. Wt. (g)]	
		Weed growth				Crop growth				
		Broad leaves		Narrow leaves						
Treatments	Conc. (mg L^{-1})	Fr. wt. (g)	Dr. wt. (g)	Fr. wt. (g)	Dr. wt. (g)	Plant height (cm)	Fr. wt. (g)	Dr. wt. (g)	Broad leaved	Narrow leaved
Grasp	250	6.80	0.90	2.36	0.47	59.99	5.40	2.03	9.70	4.20
	500	6.40	0.88	Nil	Nil	63.00	6.27	2.34	8.90	Nil
	1000	6.20	0.86	Nil	Nil	52.60	2.65	1.02	8.00	Nil
α-Tocopherol	50	5.40	0.82	2.90	0.52	60.60	4.06	1.26	7.20	3.80
	100	4.80	0.75	2.70	0.52	62.00	4.46	1.33	5.90	3.70
	150	6.90	0.91	3.20	0.72	52.82	2.99	1.13	9.00	3.45
Grasp+	250+50	6.80	0.92	0.95	0.15	63.00	4.66	1.43	8.50	1.25
α-Tocopherol	250+100	4.10	0.73	Nil	Nil	66.00	4.86	1.53	5.60	Nil
	250+150	6.00	0.82	Nil	Nil	47.90	3.06	1.16	8.30	Nil
Grasp+	500+50	2.40	0.33	0.81	0.12	61.66	5.87	2.23	3.50	1.01
α-Tocopherol	500+100	1.90	0.21	Nil	Nil	65.33	7.90	2.83	2.80	Nil
	500+150	3.50	0.43	Nil	Nil	48.33	3.23	1.26	5.00	Nil
Grasp+	1000+50	5.20	0.80	0.75	0.11	60.33	5.70	2.10	7.10	1.00
α-Tocopherol	1000+100	5.00	0.80	Nil	Nil	62.66	6.10	2.16	6.90	Nil
	1000+150	6.11	0.95	Nil	Nil	45.00	2.40	0.99	10.00	Nil
Hand weeded		Nil	Nil	Nil	Nil	66.50	7.80	2.81	Nil	Nil
Control		7.00	0.92	3.50	0.76	58.49	3.26	1.22	13.00	6.70
$LSD_{0.05}$		0.64	0.05	0.41	0.03	1.92	0.51	0.11	1.01	0.72

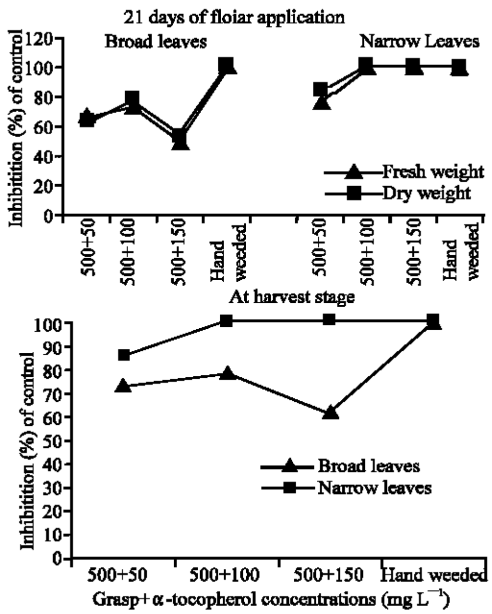

Fig. 1: Effect of moderated concentration (500 mg L^{-1}) of grasp in combination with α -tocopherol on weed growth

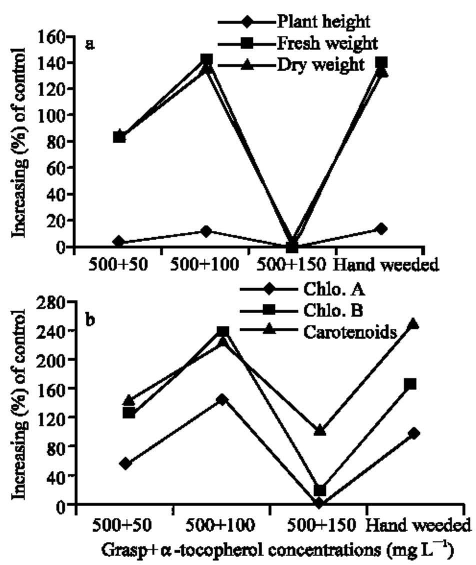

Fig. 2: Effect of moderated concentration (500 mg L^{-1}) of grasp in combination with α-tocopherol on barley growth (a) and its content from photosynthetic pigments (b).

with applying grasp alone or controls. The best in this regard was attained with the moderate combined application of grasp plus α-tocopherol, irrespective of the rate of the latter (e.g., 500+50; 500+100 and 500+150 mg L^{-1}; Fig. 1).

Of barley's growth, the plants substantially affected in response to grasp and α-tocopherol foliar application (Table 1). In general, the effect on plant height was not so far clear as shoot biomass, particularly dry weight. Applying grasp alone significantly increased the fresh and dry weight by up to 92.33%. α-tocopherol (alone) in comparison with that slightly affected all growth criteria. However, the combined application of the two compounds in particular at the moderate concentration of grasp was to some extent more effective as compared with control. We may say in whole, grasp at 500 mg L^{-1} plus α-tocopherol at any of its concentrations was the best as a group if compared with the two other set groups included lowest and highest concentration of grasp (Fig. 2). It caused fresh and dry weights increased by up to 142.33% as compared with control.

It was obvious that all treatments significantly affected the yield and its components, irrespective of the rate and sort of application (Table 2). Applying grasp alone at 500 mg L^{-1} was much more effective than the two others lowest and highest concentrations in increasing plant yield and its components. The plant yield was increased in this regard by up to 54.40% in comparison with control. Applying α-tocopherol alone fairly affected all yield parameters including plant yield and may be surpass grasp in some characters such as spike length and weight of 1000 grains. Like such trend of the effect on weed and barley growth, the combined application of grasp and α-tocopherol seriously affected the yield and its components more than any other treatment. The combined application containing the moderate (500 mg L^{-1}) concentration of grasp was the most effective in this issue, irrespective of the rate of α-tocopherol-sharing component (Fig. 3). Grasp and α-tocopherol precisely at 500+100 mg L^{-1}, respectively was the best overall not only at the level of combined treatments, but at all levels of chemical and un-chemical treatments, otherwise hand weeded.

Hand weeded indisputably comes in the first grade of the most active treatments, actively worked in eradicated all types of weeds (Fig. 1). It was also at the same efficiency of the most effective treatment (Grasp+ α-tocopherol at 500+100 mg L^{-1}) in increasing the mass vegetative growth and yield attributes of barley plants (Fig. 2). Probably, it could be at the same efficiency to the past mentioned treatment in enhancing some characters, but in general hand weeded graded after in term of total grain yield/plant.

Gathering information throughout the study referred to the good impact of the lowest and moderated concentration of all chemical treatments starting from the singlet application of grasp and α-tocopherol to the combined application of both of them together on affecting the different studied characters either for weed or barley growth. In the same time, the effect at the highest concentration was met with decreasing in the efficiency which varied in its degree according to the type of the studied character.

Table 2: Effect on yield and its constituents into response foliar application of grasp, α-tocopherol and their combinations

		Yield/yield components						
Treatments	Conc. (mg L^{-1})	Spikes length (cm)	No. of spikes/ plant	No. of spikelets/ spike	Grain weight/ spike (g)	Weight of 1000 grain (g)	Grain weight/ plant (g)	Straw yield/ plant (g)
Grasp	250	5.9	4.6	17.8	1.41	44.66	5.33	29.40
	500	6.8	4.9	20.6	2.35	48.00	7.72	36.15
	1000	5.3	4.4	16.3	0.80	39.00	3.99	26.90
α-Tocopherol	50	6.2	4.6	17.7	1.33	45.62	5.74	30.30
	100	6.6	4.7	18.0	1.72	46.71	6.01	33.00
	150	5.2	4.0	16.6	1.05	42.18	4.82	27.05
Grasp+α-Tocopherol	250+50	8.1	4.9	19.6	1.65	46.77	5.61	36.70
	250+100	8.5	5.0	20.1	1.73	48.62	7.61	40.40
	250+150	5.5	4.3	16.8	1.08	41.55	4.76	27.50
Grasp+α-Tocopherol	500+50	7.6	5.6	18.8	2.21	47.66	8.06	39.70
	500+100	9.0	5.9	23.0	2.76	70.73	12.29	43.50
	500+150	5.3	4.3	16.0	1.09	43.76	4.86	28.33
Grasp+α-Tocopherol	1000+50	6.4	5.0	18.3	1.75	46.56	6.44	30.90
	1000+100	6.9	5.3	19.2	2.10	49.66	8.66	36.66
	1000+150	5.0	2.8	15.1	0.95	38.00	3.36	27.08
Hand weeded		8.5	5.9	22.0	2.60	55.32	9.56	42.50
Control		5.6	4.5	17.0	1.10	43.50	5.00	28.90
$LSD_{0.05}$		0.6	0.21	1.2	0.13	4.05	1.09	1.79

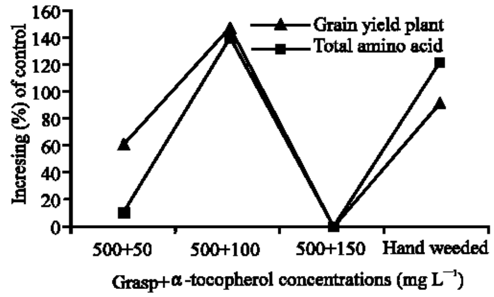

Fig. 3: Effect of moderated concentration of grasp (500 mg L^{-1}) in combination with α-tocopherol on grain yield and its components from total amino acids

Table 3: Effect of different treatments on the photosynthetic pigments of barley's shoots

		Photosynthetic pigments (mg g^{-1} Fr. Wt.)				
		Chlorophyll				
Treatments	Conc. (mg L^{-1})	a	b	a/b ratio	Carotenoids	Total
Grasp	250	0.63	0.38	1.65	0.32	1.33
	500	0.89	0.58	1.53	0.42	1.89
	1000	0.49	0.27	1.81	0.30	1.06
α-Tocopherol	50	0.59	0.42	1.40	0.37	1.38
	100	0.68	0.46	1.47	0.52	1.66
	150	0.47	0.29	1.62	0.33	1.09
Grasp +α-Tocopherol	250+50	0.93	0.63	1.47	0.40	1.96
	250+100	1.08	0.48	2.25	0.73	2.29
	250+150	0.51	0.32	1.59	0.28	1.11
Grasp +α-Tocopherol	500+50	0.90	0.56	1.60	0.39	1.85
	500+100	1.43	0.67	2.13	0.52	2.62
	500+150	0.54	0.29	1.86	0.32	1.15
Grasp +α-Tocopherol	1000+50	0.65	0.54	1.20	0.52	1.71
	1000+100	1.13	0.50	2.26	0.64	2.27
	1000+150	0.43	0.27	1.59	0.33	1.03
Hand weeded		1.15	0.58	1.90	0.57	2.30
Control		0.58	0.42	1.38	0.16	1.16
LSD 0.05		0.07	0.05	-	0.04	-

The data in Table 3 are shown the effect on the chlorophyll and carotenoid contents of the treated and untreated plants of barley. Firstly, it was distinctly cleared to be noticed the bad effect of grown weeds on decreasing the plant constituents of chlorophylls (a, b) and carotenoids. The total pigments losses due to weed infestation were estimated by 49.56% (a result deduced in comparison with hand weeded treatment). This on the assumption that free weed situation is the standard case that pigment measurements should be accounted for. It was also noticed from the greenhouse observations and the data recorded here how badly the herbicide affected the plant content of the chlorophyll and carotenoid components. The yellowness appearance was a common feature throughout. In this regard, applying grasp caused chlorophyll and carotenoids biosyntheses decreased by up to 57.39%. However, impartially, a full recovery was observed 4 weeks after treatment (Table 3).

Applying α-tocopherol alone was not good enough in enhancing the chlorophyll and carotenoid contents as compared with hand weeded control. However, in comparison with weed infested control the data recorded a reasonable increasing, particularly at the lowest (50 mg L^{-1}) and moderate (100 mg L^{-1}) concentrations. Applying α-tocopherol at the highest concentration (150 mg L^{-1}) showed retreated in the activity to be the closest to the control. Again the combined application of grasp plus α-tocopherol was the best amongst all the others in particular those containing the moderate concentration of α-tocopherol (100 mg L^{-1}); irrespective of the rate of grasp-sharing component. In this regard, the data recorded 97.41% increasing in the total pigments in response to applying grasp plus α-tocopherol at 250+100 mg L^{-1} and 125.86 % with applying grasp plus α-tocopherol at 500+100 mg L^{-1} and finally 95.68% for grasp+ α-tocopherol at 1000+100 mg L^{-1} as compared with infested control. We may say by end that grasp plus α-tocopherol at 500+100 mg L^{-1} was the best over the masses (Fig. 2).

Of amino acids and their influence by the foliar application of grasp and α-tocopherol either applied alone or in combination, the data have taken place in Table 4. The treatments were fluctuated in their response of affecting the different components of the amino acids. But, in general they have the same trend as much as established before. It is common to see the good impact of the lowest and moderated concentrations (particularly the latter) of all applied treatments. Yet, the highest concentration was retreated to register the lowest value against all investigated components. Grasp showed superiority at the moderate concentration more than the lowest or highest concentration. α-tocopherol has a similar position around this point. However, the most significant results were of

Table 4: Effect of different treatments on grain yield components of amino acids

		Amino acids components (mg/100 g Dr.Wt.)							
Treatments	Conc. (mg L^{-1})	Aspartic	Therionine	Serine	Glutamic	Proline	Glycine	Alanine	Valine
Grasp	250	21.38	7.94	13.45	103.73	18.63	4.12	14.16	20.82
	500	37.06	14.57	30.13	176.27	82.99	23.03	25.47	30.08
	1000	13.25	0.92	12.13	76.67	0.94	6.34	9.12	11.30
α-Tocopherol	50	21.38	5.85	10.32	99.51	15.43	4.12	15.11	18.20
	100	30.03	13.24	27.18	135.48	25.08	19.90	21.35	23.66
	150	15.41	0.54	1.35	118.27	35.16	1.54	4.88	16.24
Grasp+	250+50	22.42	9.52	10.14	101.33	21.85	8.40	15.24	16.12
α-Tocopherol	250+100	31.97	15.18	40.94	252.63	87.21	24.49	27.82	29.46
	250+150	13.87	0.99	2.54	101.59	18.44	0.88	10.26	14.47
Grasp+	500+50	2.16	8.54	17.15	103.24	23.54	10.31	20.33	18.55
α-Tocopherol	500+100	43.57	20.28	47.07	273.76	67.14	22.31	26.67	41.63
	500+150	10.57	5.21	0.89	111.53	36.21	2.54	9.21	3.55
Grasp+	1000+50	24.53	6.54	14.22	111.66	16.77	2.93	13.26	19.26
α-Tocopherol	1000+100	39.95	17.28	35.70	199.15	45.12	13.32	27.97	31.99
	1000+150	10.72	1.85	4.44	113.22	5.14	1.25	3.56	7.54
Hand weeded		29.87	10.19	45.80	240.12	89.52	35.27	28.55	30.34
Control		16.87	3.10	4.66	141.5	0.00	9.89	12.86	17.78

Table 4: Continued

		Amino acids components (mg/100 g Dr.Wt.)									
Treatments	Conc. (mg L^{-1})	Methionine	Leucine	Isoleucine	Phenyl alanine	Tyrosine	Histidine	Lysine	Arginine	NH_4	Total
Grasp	250	9.72	17.19	34.83	7.67	15.57	5.82	10.13	137.78	13.28	456.22
	500	0.41	27.29	61.34	19.65	28.47	12.14	21.82	185.99	29.65	806.35
	1000	1.72	6.36	16.32	3.69	8.31	4.79	8.25	28.94	81.28	290.33
α-Tocopherol	50	7.62	16.20	32.41	6.61	13.23	7.56	15.11	140.48	11.22	440.36
	100	0.66	24.31	39.81	11.31	15.49	9.03	9.89	152.75	21.40	580.57
	150	5.21	3.19	18.55	4.11	24.13	19.20	13.54	106.33	31.58	419.23
Grasp+	250+50	5.63	18.10	33.23	5.99	10.14	8.73	16.20	143.25	27.51	473.80
α-Tocopherol	250+100	3.08	37.85	65.64	33.74	36.31	9.22	19.42	253.62	27.37	995.95
	250+150	2.11	9.12	36.22	5.09	21.33	10.25	13.28	108.35	20.43	389.22
Grasp +	500+50	8.51	20.24	40.76	9.25	15.44	7.82	17.36	115.26	19.17	478.63
α- Tocopherol	500+100	7.79	40.99	77.25	32.76	31.84	13.41	25.34	223.51	39.80	1035.12
	500+100	4.81	15.12	15.61	5.34	13.26	11.38	22.46	123.05	28.16	418.19
Grasp +	1000+50	1.47	24.31	40.28	5.73	12.44	5.63	10.22	148.30	16.59	474.14
α- Tocopherol	1000+100	5.10	31.08	60.24	33.16	37.54	14.84	22.27	180.04	30.10	824.85
	1000+150	12.11	1.48	22.59	8.11	10.23	8.09	11.25	116.66	38.47	376.71
Hand weeded		1.09	36.15	70.18	23.69	25.23	5.09	27.38	245.27	17.18	960.92
Control		1.78	11.16	26.71	7.08	11.55	14.85	23.92	113.05	18.49	435.25

the combined applications. As documented before in different other places, applying grasp at 500 mg L^{-1} in combination with α-tocopherol precisely at 100 mg L^{-1} with the most effective in this regard, caused 137.82% increasing in the total amino acids in comparison with weed-infested control (Fig. 3). Hand weeded treatment is coming after to register 120.77% increasing over control.

DISCUSSION

Grasp, particularly at 500 mg L^{-1}, was very effective in controlling grassy weeds infested barley. However, the associated phytotoxic effect was disappointed. The bleaching effect on barley leaves was a distinctive feature. Even though, the injured plants were fully recovered within 4 weeks of the treatment, the problem sustains to catch yield and its attributes (comment deduced in comparison with hand weeded control). In spite of that, the outcome of using grasp still more promising than the case of weeded control. The research reports that dealt with the phytotoxic action of grasp against grassy weeds or even associated crops (cereals in particular) are fabulous. Several field trials demonstrated the reliability of grasp for controlling grassy weeds species. Officially, grasp was registered for post-emergence grass control in cereals (Eschenbrenner, 1990). Salembier (1990) found grasp to be an effective herbicide for controlling troublesome grassy species (e.g., blackgrass) in wheat. Similarly the results obtained by Faris *et al*. (1989) when used at 750 mL $donam^{-1}$. Using grasp 60 at 300 g ha^{-1} showed excellent selective control of the grassy species of *Avena*, *Lolium* and *Alopecurus* genus when used in autumn-sown soft, hard wheats and barley (Eschenbrenner, 1990). In combination with atplus herbicide (2 L ha^{-1}), grasp at 1 L achieved significant control of *Avena fatua* in barley and wheat (Hallgren, 1990). Of its activity against resistant types e.g., little seeds canary-grass and hood canary-grass widespread in Mexico, grasp was found to be effective only at 200% of the commercial rate. Recently, Sharara *et al*. (2006) recorded incompatible results for using grasp in controlling grasses in wheat. Even with all of that, however, the damaging effect on the associated crop still remains the bad side of grasp and many questions have been raised around the possibility of using it. Numerous researches were gone deeper through this point. Tal *et al*. (1990) found the foliar application of grasp at 100-300 g ha^{-1} severely injured the barley type of *Hordium glaucum* which completely died afterwards, in converse with the type *H. spontanium* which comparatively was more tolerant. The mode of action seems to be the same on crop as weeds. The toxicity is due to, in the first standing, to disrupting the enzymatic function of ACC-ase (Leach *et al*., 1995). The activity in most cases is, therefore, a selectively-dose dependant. Incledon and Hall (1999) reported that the sensitivity or insensitivity to grasp amongst weeds or even crops would be at the level of ACC-ase (Herbert *et al*., 1994). The cases that discovered of many phenotypes resistant species were ascribed to the site of action insensitivity except in a few cases (Smit and Villiers, 1998). The resistance in *Lolium multiflorum*, for example, to AOPP or CHD herbicides (members of the same group) was found to be due to the presence of some resistant forms of ACC-ase or to the overproduction of the enzyme as in *Sorghum halepense* (Prado *et al*., 2000; Bradely *et al*., 2001). In contrary to diclofop-methyl herbicide and wheat, where the latter is tolerant to the former via metabolic degradation (Shimabukuro *et al*., 1979).

Applying α-tocopherol alone fairly affected crop growth and its yield. It caused barley growth and yield increased simply because of its physiological known part. Obviously, such promoting effect should be the same as crop as weed, but this wouldn't happen. The crop growth was increased in the same time that weed was suppressed. Increasing the competitive or probably the allelopathic capability of crop plants at the expense of the associated weeds could be the reasons behind this fact. There is a considerable amount of research that dealt with the physiological roles of α-tocopherol in the plant that might have a relation with the above discussed point. Of its appreciated part is what well established about its antioxidant role (Hess, 1994). One of the primary functions is to maintain the integrity of cell membrane by protecting its physical stability (Fryer, 1992). The compound is also implicated in several biological activities that are in total or partially resulted in increasing growth and yield in consequence (Kruk *et al*., 2000). This, undoubtedly, gives the plants the opportunity to grown well facing any troubles associated in their vicinity. The allelopathic activity of barley was studied extensively and accumulated evidences revealed that barley plants and its residues as well containing one or more of the phytotoxin components. In their searching of the allelochemical responsible components in grassy crops, Chon and Kim (2004) found barley extract as much as wheat, oat and rice severely inhibited growth of alfalfa, barnyard-grass, and eclipta assayed seeds. Caffeic acid, hydro-cinnamic acid, ferulic acid, m-coumaric acid, p-coumaric acid and coumarin were detected in all plant species including barley and hydro-cinnamic acid was reported to be as the highest amount.

The combined application of grasp and α-tocopherol was much more promising than the individual application of either of them. Albeit the effect was fluctuated following the concentration of both components, it achieved the best results for either controlling weeds or enhancing barley growth especially at the moderate concentration of the herbicide (500 mg L^{-1}) and irrespective of the rates of its partner, α-tocopherol. In converse with the results obtained with the individual application of grasp, the damaging effect on barley plants was disappeared under this category of treatment. It was clear from the visual seeing that the barley plants grown under the first case were more healthy, greenest and productive than in the latter. The *in vitro* analysis of photosynthetic pigments (Chl. a, b and carotenoids) has proved the proof of this fact. Increasing the amino acids content in barley grains of the plants under the combined application more than those under the individual treatments was another strong evidence supporting this assumption.

Seem to be α-tocopherol counteracted the harmful effect of grasp against barley plants with keeping the toxicity on weeds as the same. As α-tocopherol caused protein increased, the enzymes quantity including ACC-ase are also expected to be increased and hence neutralize the grasp bad effect. This is probably one reason explaining what actually happened. It may also conclude that the interrupting effect against ACC-ase is not the only mechanism of which grasp is working on, but probably the herbicide broken down to certain oxidant free radicals that damage the life of the cell. With saving α-tocopherol in enough quantity, the plant can overcome this impasse. This property arises from its ability to quench both singlet oxygen and peroxides before they react with lipid substrates (Fryer, 1992). Based on this and the one suggested before, we can find a way for the good explanation for the protecting role of α-tocopherol against the damaging effect of grasp. The results we obtained may agree with those of others which implicated on using different substances to reduce herbicides-damaging effect. Mineral oils, inorganic salts, growth regulators and amino acids were successfully used for this purpose (Ruiter *et al*., 1987; Nalewaja and Matysiak, 1991; Kislin, 1995). Flavonoids, pyridazinone herbicides, salicylic acid, dihydroguaiaretic acid, salicylhydroxamic acid, propyl gallate, monophenylbutazone and diphenylalanine were also found to be having highly antagonistic property against the damaging effect of Haloxyfop and alloxydim, a grasp related herbicides, when examined against wheat seedlings (Banas *et al*., 1990). A common feature of most of these substances is that they can act as scavengers of free radicals and inhibitors of lipoxygenases (Terol *et al*., 1986; Larson, 1988).

It has been suggested that using α-tocopherol in combination with grasp is considered to be an excellent tool to reduce the damaging effect of the herbicide against growth and development of grassy crops e.g., barley. Grasp at 500 mg L^{-1} plus α-tocopherol at the moderate concentration (100 mg L^{-1}) is highly recommendable for achieving the best result.

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