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Morphological and Physiological Adaptations of *Coronopus didymus* against Herbicides

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Abstract

Weeds are the notorious plants which cause considerable damage with devastating effects on the agricultural sector of agro based economy of Pakistan. The study under consideration is well directed at studying effects of weedicides on weed and adaptations against them. One of the most detrimental weeds in Pakistan is *Coronopus didymus* which is our topic of concern in this study. Different herbicides were sprayed post emergent to study the morphological and physiological adaptive components of this species. Based on the result from experimentations it was concluded that this plant showed less resistance against weedicides. *Coropus didymus* showed significant increase in physiological parameters i.e. photosynthetic pigmentation and mineral uptake against Sulphosulfuran and Novex, while Trump and Bromoxynil caused reduction in morphological parameters. Instead of separate application of specific herbicide a mixture of two or more two herbicides produced fruitful results.

Keywords: *Coronopus didymus*; Herbicides; Weed; Morphology; Sulphosulfuran

Introduction

Coronopus didymus L. is a main element of the weed flora of family Brassicaceae which badly affects crop production in Pakistan.

Weeds are regarded as crucial pest complex affecting human beings and are generally unwanted, unappealing, or worrying plants, particularly those which grow unwantedly. Weeds are locally profuse, economically less significant and occupy agitate habitats and are not original members of plant community. Weeds show three characteristics namely,

- Growth on the unwanted areas (anthropomorphic definition)
- They occur as colonizers in succession (ecological definition) and
- Invasive plants (bio-geographical definition) [1].

Weeds compete with cereal crops for obtaining water, light, nutrients, anchorage crop pest and diseases by adopting different methods to make themselves well able to cope with often changing and uncertain environmental conditions [2]. Weeds have the ability to adjust with, produce resistance and tolerance to or completely disappear in response to any environmental conditions that may try to reshape their life and normal growth [3].

Roughly 45 weed species of different kinds are documented in the fields of wheat crops in Pakistan [4]. *Phalaris minor* Retz., *Rumex dentatus* L., *Coronopus didymus*(L.)., *Chenopodium* album L., and *Poaannua* L. Sm., *Medicago denticulata* Willd., have been documented as the weeds happening with high frequency and in dense numbers in Pakistan [5].

Earlier studies have shown that competition of weeds and cereals for various environmental resources are largely due to morphological and physiological features of plant species [6]. Significant features mainly affecting photosynthetically dynamic emission interception include size of seeds, inclination of leaves , height of plants, early growth vigor, rudimentary root and shoot growth rates along with tillering capacity [7].

Morphological changes which lead to differing survival strategies were studied long ago because they help the plants in adapting to a given environment in variable living habitats [8]. Phenotypic variability is a manifestation of the genetic rudiments of the individuals including their affiliation with the related environment. Therefore, morphological demonstrations usually have links to habitat

conditions [9,10]. Hence, the plants populations propagate occupy and are provided sustainability in often changing habitats through the demonstration of morphological parameters [11]. The variability of morphological characters is also connected with habitat conditions. Phenotypes having different plant modules demonstrate variations in environmental conditions. The population growth under comparable environment conditions manifests similar morphological parameters. In addition, the changes in different morphological traits in the field are produced by the environmental circumstances and give revolutionary outcomes which are helpful for the plants to acclimate to the environment [12,13].

The phenotypic change ability results not only because of physiological and morphological characters but also by the interrelationship of specific development plans, the genotypes of a certain environment [14]. Ability of the weeds to avoid herbicidal toxicity is gained by changes in growth habits, physical and/or physiological variations namely setting emergence time, morphological traits or by having some phonological adaptive sequences (such as changes in germination pattern).These are caused by the inherited traits by means of which plants intend to thrive against various herbicidal applications [15].

Coronopus didymus is reported to be the second highest detrimental weed, causing 75% reduction in wheat crop output and results in extreme loss to the growth of plant. Additionally, members of the same family also exhibit allelopathic interventions which result in low productivity and stunted growth of species under consideration by giving out volatile allelochemicals which cause harm to the plants [16,17].

The current research will lead to the study of morpho-physiological adaptive components against herbicides and will be helpful in the discovery of some new deterrent measures against the modifications of weeds. This will lead to the improved yield of different crops and will support the economy of Pakistan.

Materials and Methods

Pesticides are agrochemicals formulated to combat the attack of pests on agricultural crops. In modern agricultural practices, pesticides are widely used on crops for pre and post-harvest applications. In the present work post emergent spray of herbicides was done. Sulfosulfuran, Novex, Trump, Bromoxynilare the weedicides which were applied in different treatments namely T1, T2, T3 and T4 respectively and T0 was kept as control i.e. without any herbicidal application. The post emergent spray of herbicide was done in five equal parts of a selected field of wheat. After 15 days of spray, data were collected from each field. Fresh samples were collected for morphological study. The plants were carefully uprooted and placed in paper bags. They were brought back to the laboratory for morphometric analysis including shoot length (cm), root length (cm), leaf area (cm^2), number of total leaves, number of fresh leaves, number of dry leaves, fresh weight (g) and dry weight (g).

The photosynthetic pigments of *Coronopus didymus* i.e. Chlorophyll a, b, and carotenoids were measured with the Arnon's method (1949). Fresh leaves weighing 0.2 g were selected and extracted overnight by using 80% acetone at the temperature $0^{\circ}C$-$4^{\circ}C$. Centrifuging of the extract was done for 5 minutes at 10,0000 x g. Readings for chlorophyll (a,b) and carotenoids were taken at 645, 663 and 480 nm absorbance by using a spectrophotometer (Hitachi-220, Japan). The contents of chlorophyll a, b and carotenoids were calculated by using the following formulae:

Chl a (mg/g f.wt.)= (12.7(OD 663)-2.69(OD 645) × V/1000 × W)

Chl b (mg/g f.wt.)= (22.9(OD 645)-4.68(OD 663) × V/1000 × W)

Carotenoids (mg/g f.wt.)=Acar/ Em × 100

Where

V = volume of the sample

W= weight of fresh tissue

Acar=(OD 480)+ 0.114(OD 663) - 0.638(OD 645)

Em = 2500

Mineral analysis of *Coronopus didymus* was done by using nitric acid and hydrogen peroxide through wet digestion. The oven dried ground plant material (0.1 g) was digested with nitric acid and hydrogen peroxide for different mineral analysis (Ca^{2+}, Mg^{2+}, Na^{+}, and K^{+}, Mg^{2+}, Fe^{3+}, Zn^{2+}, Pb^{2+}, Cu^{+}, Cr^{3+} by using the Wolf method (1982). The extraction volume was made up to 20 mL. The extracts were filtered after digestion and the determination of Na, K, Ca, Mg, Fe, Zn, Pb, Ni, Cu and Cr ionic content was done. Different concentrations of minerals i.e. K^{+}, Mg^{2+}, Ca^{2+}, Na^{+} were determined with flame photometer (Genwiey PFP7).

Emission intensity of sodium and potassium was recorded by using their respective filters in flame photometer. Amount of each of the mineral elements was noted from the respective standard curve. Mineral content was calculated as mg kg^{-1} of the sample. Micro minerals i.e. Cu, Mg, Fe, Zn, Pb and Cr were determined by Atomic Absorption Spectrophotometer (AAS) by using the standard solutions of the above minerals and their respective cathode lamp. Uptake of different minerals was calculated by using following formula

Micro mineral (mg/L)=ppm from graph x dilution factor/Weight of Sample.

Statistical analysis

The morphological and physiological parameters are analyzed and interpreted by different statistical techniques i.e. one way and two way anova by SPSS software and Minitab along with Microsoft excel toolbox.

Results and Discussion

Plants showed a variable behavior in response to different herbicides. *Coronopus didymus* showed significant adaptive components in different morphological and physiological parameters as compared to that recorded at control level.

Photosynthetic pigments adaptations of *Coronopus didymus* against herbicides

Photosynthetic pigment analysis revealed that nearly the content of Chl a,b and carotenoids of *Coronopus didymus* from all herbicidal treatments decreased significantly as shown in the Table 1. Maximum modifications was observed in Chl b (43%)and carotenoids as 200% increase against the treatment of Trump in T3 was observed while sulfosulfuranin T1 caused a decrease in the content of Chl a,b and carotenoids by 91%, 62% and 20% respectively as compared to T0 (Figures 1-3).

Photosynthetic pigments	Chlorophyll a	Chlorophyll b	Carotenoids
F value	3.850*	2.803*	0.958 NS
NS=Non-significant (P>0.05); * = Significant (P<0.05); ** = highly significant (P<0.01)			

Table 1: Analysis of variance of the data regarding photosynthetic pigments content of *Coronopus didymus.*

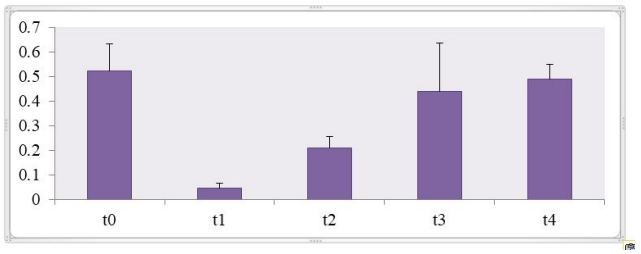

Figure 1: Comparison of means regarding chlorophyll a of *Coronopus didymus* under different treatments of weedicides.

Chl a content as shown in Figure 1 depicted a decrease in all treatments showing a decrease of 91% in T1, 21% in T2, 60% in T3 and 16% in T4. Chl b content as shown in Figure 2 against the herbicidal treatment revealed a decrease in all treatments including T1 (62%), T2 (69%) and T3 (55%). However, T4 showed an increase of 43%. Carotenoids in *Coronopus didymus,* as shown in Figure 3, decreased significantly in all treatments including T1 (10%), T2 (30%) and T4 (25%) but T3 showing an increase of 200%.

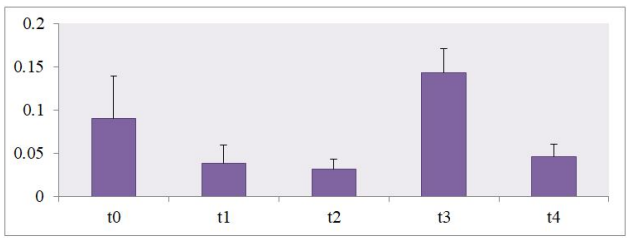

Figure 2: Comparison of means regarding chlorophyll a of *Coronopus didymus* under different treatments of weedicides.

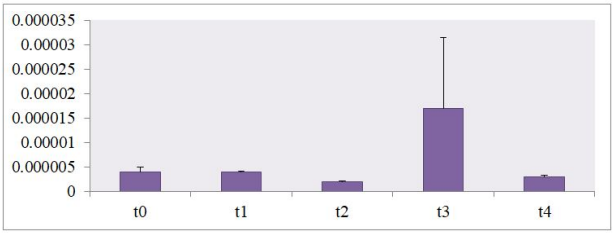

Figure 3: Comparison of means regarding carotenoids of *Coronopus didymus* under different treatments of weedicides.

Morphological parameters of *Coronopus didymus* altered non significantly except the number of dry leaves which increased significantly as shown in Table 2. All the features including shoot length, root length, fresh leaves, dry leaves, fresh and dry weight showed an increase against herbicidal treatments as in Figures 4-10, except leaf area which is reduced by 36% in T1, 10% in T2 and 31% in T4 as shown in Figure 11. Mineral analysis of *Coronopus didymus* reflected that uptake of different minerals altered significantly as shown in Table 3. Minerals including Na, Ca, K, Mg, Cu and Cr enhanced significantly against all the treatments as in Figures 12-15. While reduction occurred in the uptake of Fe, Zn, Pb and Ni as indicated in Figures 16-19. Furthermore, Figures 20 and 21, minerals such as Na, Ca, K, Mg, Cu and Cr are increased significantly against all the treatments.

Morphological Parameter	F Value
Root length (cm)	2.047NS
Shoot length (cm)	0.917NS
Leaf area (cm)	1.674NS
Total leaves No.	0.968NS
Fresh leaves No.	0.890NS
Dry leaves No.	2.392*
Fresh weight (g)	0.283NS
Dry weight (g)	0.180NS
NS=Non-significant (P>0.05); *=Significant (P<0.05); **=Highly significant (P<0.01).	

Table 2: Analysis of variance of the data regarding morphological adaptive components of Coronopus didymus.

Physiological parameter Mineral uptake (mg/l)	F value
Na	604663.828**
K	10996.570**
Ca	61389.515**
Mg	3732.746**
Fe	408.436**
Zn	65.947**
Pb	62.352**
Ni	46.737**
Cu	10.585*
Cr	15.760**
NS=Non-significant (P>0.05); *=Significant (P<0.05); **=Highly significant (P<0.01).	

Table 3: Analysis of variance of the data regarding minerals uptake of *Coronopus didymus.*

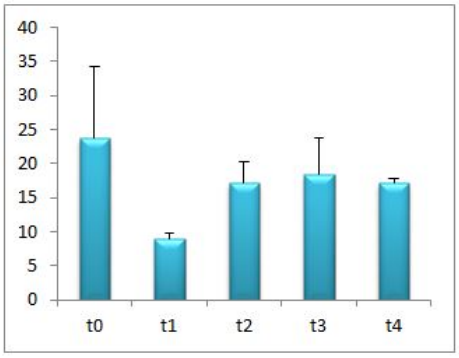

Figure 4: Comparison of means of shoot length against herbicides treatment.

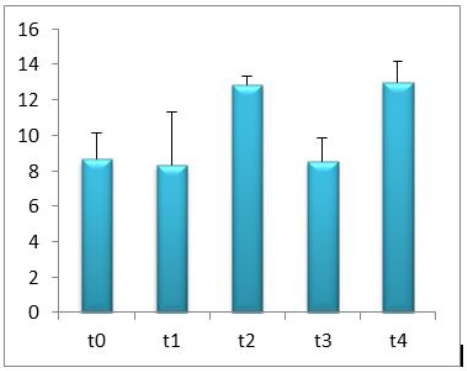

Figure 5: Comparison of means of root length against herbicides treatment.

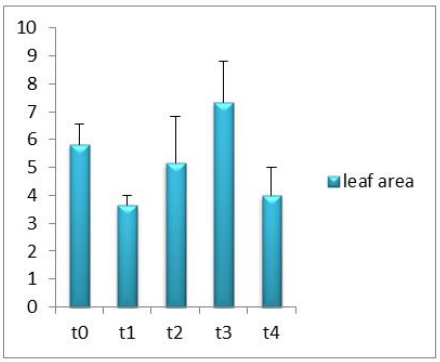

Figure 6: Comparison of means of leaf area against herbicides treatment.

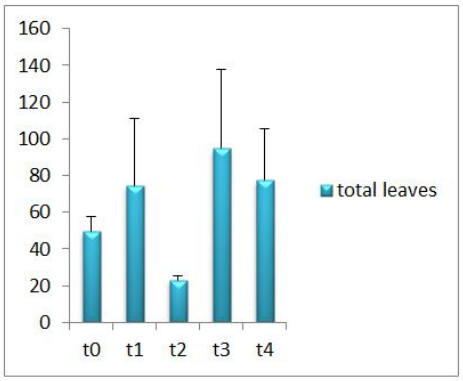

Figure 7: Comparison of means of total leaves against herbicides treatment.

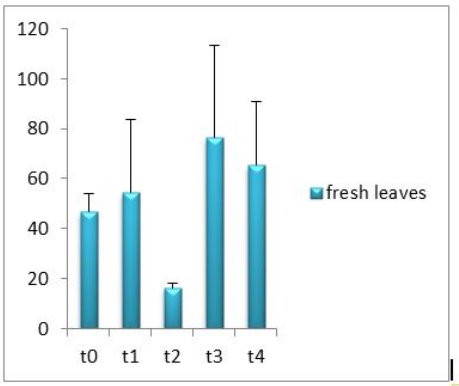

Figure 8: Comparison of means of fresh leaves against herbicides treatment.

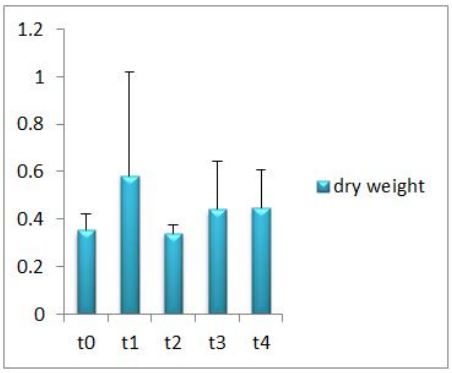

Figure 9: Comparison of means of dry weight against herbicides treatment.

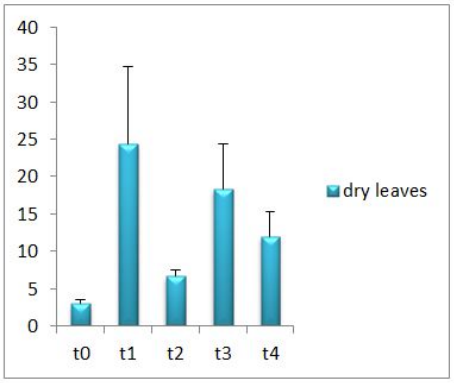

Figure 10: Comparison of means of dry leaves against herbicides treatment.

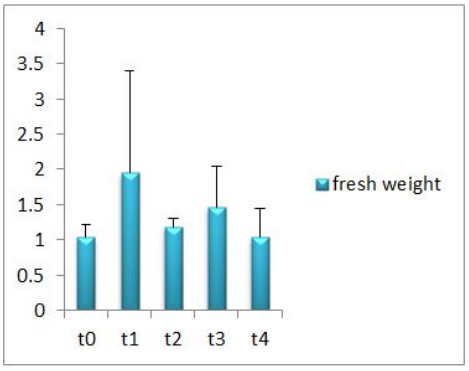

Figure 11: Comparison of means of fresh weight against herbicides treatment.

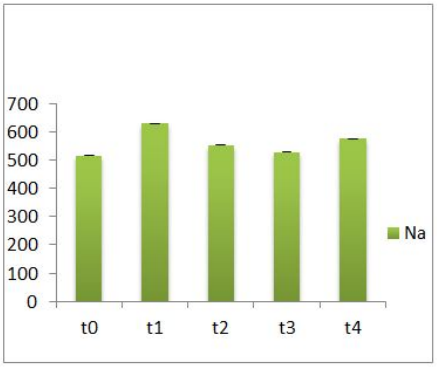

Figure 12: Comparison of means of Na uptake against herbicides treatments.

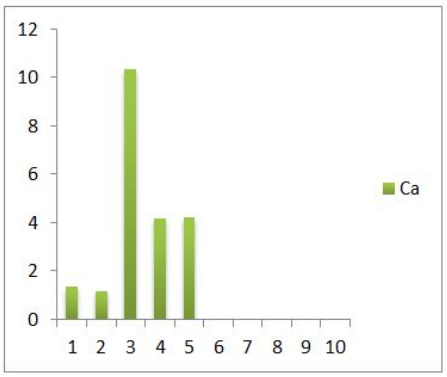

Figure 13: Comparison of means of Ca uptake against herbicides treatments.

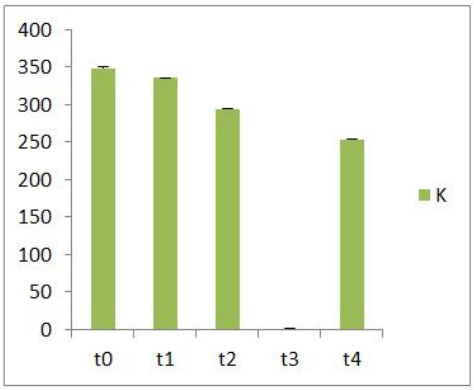

Figure 14: Comparison of means of K uptake against herbicides treatments.

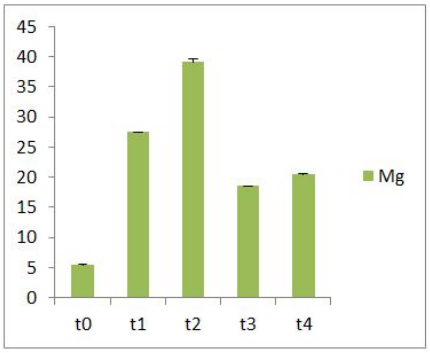

Figure 15: Comparison of means of Mg uptake against herbicides treatments.

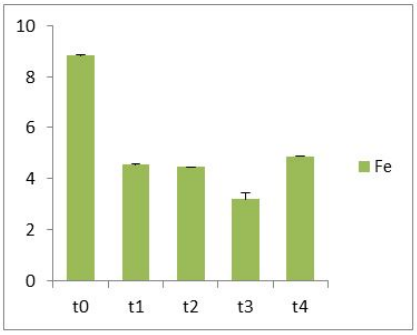

Figure 16: Comparison of means of Fe uptake against herbicides treatments.

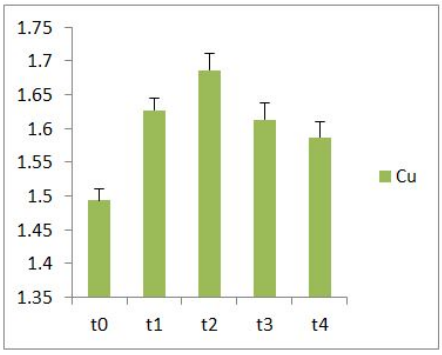

Figure 17: Comparison of means of Cu uptake against herbicides treatments.

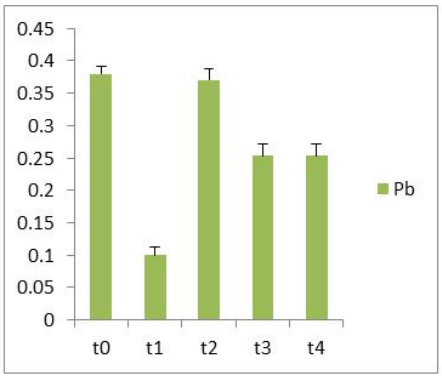

Figure 18: Comparison of means of Pb uptake against herbicides treatments.

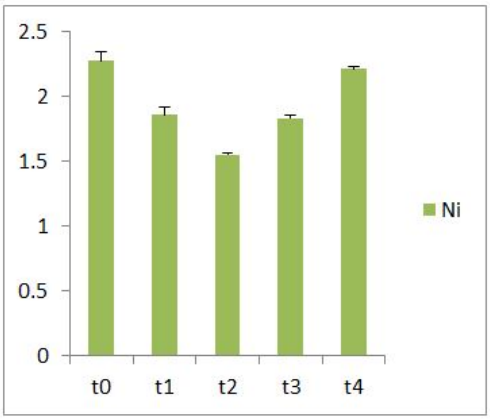

Figure 19: Comparison of means of Ni uptake against herbicides treatments.

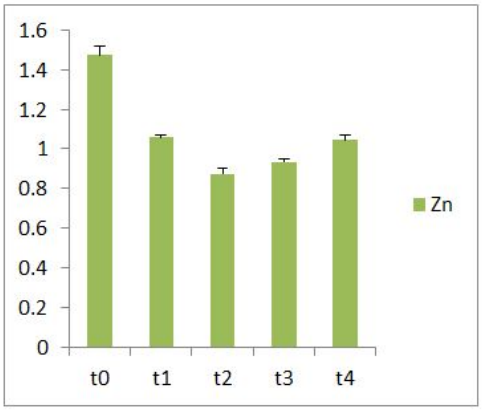

Figure 20: Comparison of means of Zn uptake against herbicides treatments.

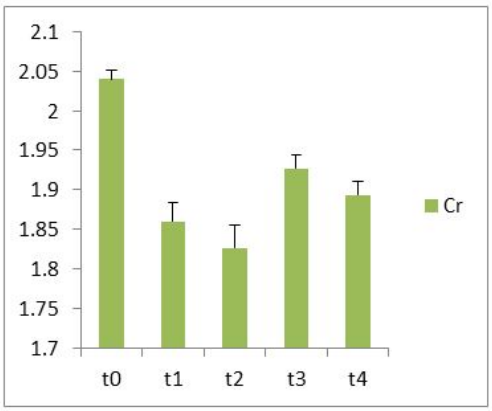

Figure 21: Comparison of means of Cr uptake against herbicides treatments.

Sulfosulfuran also caused significant alteration in *Coronopus didymus* plant morphology i.e. it increased root length, no. of leaves, fresh leaves, dry leaves, fresh weight and dry weight of plant except leaf area was reduced by the action of herbicide. Plot 2 was sprayed with weedicides Novex. Novex significantly increased no. of dry leaves and fresh and dry weight of *Coronopus didymus* and decreased shoot root length, leaf area and fresh leaves. Chlorophyll and carotenoids contents also decreased after application of weedicides. However, mineral uptake of Na, K, Ca, Mg, Cu and Cr are increased. Trump caused an increase in *Coronopus didymus* according to its mode of action. A gradual increase in both root length and dry leaves of plant before and after the application of weedicides were observed. Reason for this increase in root length was reported by Doughty [18] that the rate of growth is highly increased after the application of weedicides.

Trump caused significant adaptations in *Coronopus didymus* according to its mode of action. A gradual increase was observed in leaf area, dry leaves, fresh weight and dry weight of plant pre and post application of weedicide. Bromoxynil caused significant increase in plant morphology of *Coronopus didymus* i.e. root length, shoot length, no. of fresh/dry leaves as well as fresh and dry weight. Chlorophyll a increases while chlorophyll b reduced with the application of Bromoxynil but carotenoid contents decreased after spray. The uptake of Na, K, Ca, Mg, Cu and Cr was enhanced. Iron content was reported to be lower in grass species than in broadleaf [19,20].

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References

1. Rejmanek M, Richardson DM, Higgins SI, Pitcairn MJ, Grotkopp E (2005) Ecology of invasive plants: State of the art. Invasive alien species: A new synthesis 104–161
2. Rodenburg J, Riches CR, Kayeke JM (2010) Addressing current and future problems of parasitic weeds in rice. Crop Prot 29: 210-221.
3. Hager AG, Refsell D (2008) Weed resistance to herbicides. In: 2008 Illinois Agricultural Pest Management Handbook. Department of Crop Science, University of Illinois.
4. Qureshi R, Bhatti GR (2001) Determination of weed communities in wheat field of district Sukhur. Pak J Bot 33: 109-115.
5. Siddiqui I, Bajwa R (2001)Variation in weed composition in wheat fields of Lahore and Gujranwala divisions. Pak J Biol Sci 4: 492-504.
6. Didon UE (2002) Variation between barley cultivars in early response to weed competition. J Agron Crop Sci 188: 176-184.
7. O'Donovan JT, Harker KN, Clayton GW, Hall LM (2000) Wild oat (Avenafatua) interference in barley (Hordeumvulgare) is influenced by barley variety and seeding rate. Weed Technol 14: 624-629.
8. Gambino P, Vilela A (2011) Morphological traits and allocation patterns related to stress-tolerance and seed-yield in wild and domesticated evening primrose; Oenotherabiennis L. (Onagraceae). Ind Crops Prod 34: 1269-1276.
9. Jaleel CA, Manivannan P, Lakshmanan GA, Gomathinayagam M, Panneerselvam R (2008) Alterations in morphological parameters and photo synthetic responses of Catharanthusroseus in soil which is water deficits. Colloids Surf B Biointerfaces 61: 298-303.
10. Mandak B, Zakravsky P, Dostál P, Placková I (2011) Population genetic structure of the noxious weed Amaranthus retroflexusin Central Europe. Funct Ecol Plants 206: 697-703.
11. Urbas P, Zobel K (2000) Adaptive and inevitable morphological plasticity of three herbaceous species in a multi-species community: Field experiment with manipulated nutrients and light. Acta Oecol 21: 139-147.
12. Mahmood S, Abbas A (2003) Local population differtiation in Trifoliumalexandrium L.in response to various disturbance regimes. J Bio Sci 9: 773-781.
13. Hussain A, Mahmood S (2004) Response flexibility in TrifoliumalexendrinumL. of phenomenon of adaptation to spatial and temporal disturbed habitat. J Biol Sci 4: 380-385.
14. Bellavance ME, Brisson (2010) Spatial dynamics and morphological plasticity of common reed and cattails (Typha) in freshwater marshes and roadside ditches. Aquat Bot 93: 129-134.
15. Chen LJ, Lee DS, Song ZP, Shu HS, Lu BR (2004) Gene flow from cultivated rice (Oryza sativa) to its weedy and wild relatives. Ann Bot 93: 67-73.
16. Waddington J (1978) Growth of brome grass, barley, and alfalfa under greenhouse in soil having rape seed and wheat residues. Can J Plant Sci 58: 241-248.
17. Oleszek W (1987) Allelopathic influences of volatiles of some Cruciferae species on barnyard grass, lettuce, and wheat growth. Plant Soil 102: 271-273.
18. Doughty KJ, Porter AJR, Morton AM, Kiddle G, Bock CH, et al. (1991) Variation in the glucosinolates content of oilseed rape leaves. Ann Appl Biol 118: 469-477.
19. Owen MK, IA Zelaya (2005) Herbicide-resistant crops and weed resistance to herbicides. Pest Manag Sci 61: 301-311.
20. Siddiqui I (2010) Effect of six problematic weeds on Growth and yeild of wheat. Pak J Bot 42: 2461-2471.