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Allelopathic Effect of Datura stramonium on Germination and Some Growth Parameters of Swiss Chard *(Beta vulgaris var. cicla)*

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Abstract:- A pot experiment was conducted to investigate the possible allelopathic effect of Datura stramonium residue on germination, growth and some yield components of Swiss chard (Beta vulgaris var. cicla). The results showed that the lower level of Datura residue (0.5%, w/w) induced a stimulatory effect on the growth of shoot and root of Swiss chard. Inversely, high levels of incorporated residue (1 and 1.5%, w/w) reduced all growth parameters of shoot and root to the respective control except the number of leaves, the reduction was not significant. Similarly the lower level of Datura residue (0.5%, w/w) increased the chlorophyll content (a, b), nitrogen, phosphorus and potassium, but higher level (1 and 1.5%, w/w), residue induced negative effect in chlorophyll, nitrogen, phosphorus and potassium as compared with controls.

Keywords:- *Allelopathy, Swiss chard, Germination, Datura.*

I. INTRODUCTION

Food plants, including fruits, vegetables, cereals species are primary sources of naturally occurring nutrients essential for human health (Pellegrini et al., 2003). Vegetables are the fresh and edible portions of herbaceous plants which can be used as energy sources, body building, regulatory and protective material. In Sudan, as in most other tropical countries of Africa where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals and essential amino acids (Thompson and Kelly, 1990). Leaves along with petiole and soft stem from a wide range of plants are consumed as a leafy vegetable. Chard is one of these vegetables which is consumed by the majority of the Sudanese people, and is considered as one of the main dish in the Sudanese food. The vegetables compete with other plants for sunlight, soil nutrients and water. To reduce competition, these plants may produce chemicals that inhibit the germination and growth of neighboring plants. The plants growing together interact with each other and exert inhibitory or stimulatory effects on growth of each other through releasing compounds known as allelochemicals (Batish et al., 2007). Allelochemical released from plants affect other plants mainly at their germination and seedling growth stages (Oyerinde et al., 2009). The aim of this work was to determine the allelopathic effect of Datura stramonium on the germination, some growth parameters and yield of Swiss chard (Beta vulgaris var. cicla).

II. MATERIALS AND METHODS

- *Plant material*

The Datura plant (Datura stramonium) was collected from Shambat Campus, University of Khartoum. The plants were up rooted at maturity, then washed thoroughly with distilled water and air dried at room temperature (25oC) for 96 hours. The plants then were chopped and ground into fine powder with mortar. The seeds of the experimental plant the chard plant were obtained from the market (local cultivar).

- *Soil material*

The soil used in this experiment was river silt, moderately acid (pH 6.75), highly permeable.

- *Seed germination*

The seeds of chard plant were arranged in completely randomized design to four treatments. The first treatment the soil was without Datura residue, representing control. The second, third and fourth treatments, the soil was incorporated with 10, 20 and 30g of powder Datura stramonium representing 0.5, 1 and 1.5% (w/w, residue/soil) respectively. Each treatment was replicated three times. Each pot (35cm in diameter, 30 in depth filled with silt soil) was planted with 5 seeds of chard after emergence; the seedlings were thinned to 3 seedlings per pot. Plants were irrigated daily with tap water. During the experiment the following parameters were measured; plant height, number of leaves, leaf area, the shoot and root fresh and dry weight were taken at the end of the experiment. Part of the dried shoot of chard was used for determination of N, P, K percentage. The data were analyzed using analysis of variance (ANOVA) using SPSS version 21.

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III. RESULTS AND DISCUSSION

Table (1) showed the germination percentage of chard in the first and second experiment. It is clear that Datura plant residue concentration affect the germination negatively. The concentration 1% and 1.5% residue of Datura inhibited the chard germination completely. In this respect Singh et al. (2001) found that the aqueous leachate of Populus deltoids leaves markedly inhibited the germination and growth of all the tested crops. Rafiqul et al. (2003) reported that, the use of aqueous extracts of Excoecaria agellocha leaves inhibited seed germination and plumule and radicle elongation of rice. El-Khawas et al. (2005) found that with the increase in concentration of leaf extracts of Eucalyptus globules there was concomitant decrease in germination of green gram, black gram and cowpea. They also reported that the aqueous leaf leachate of Eucalgptus citriodora inhibited the germination and seedling growth of Vigna radiate, Vigna mungo and Arachis hypogaea. Also Suwal et al. (2010) noticed phytotoxic suppressive action of water extract of Chromolaena odorata on germination and seedling growth of rice and barnyard grass. Skinner et al. (2012) found that sunnhemp ground dried residues inhibit germination and seedling growth of various vegetables and cover crops. In connection to this, Zohaib et al. (2014) reported that rice germination and seedling growth were significantly suppressed by application of water extracts of Medicago indica compared with control.

Table (2) indicated a significant difference (P=0.05) between treatments in plant height at 15, 30 and 45 DAS (days after sowing). The lower level of Datura residue (0.5%, w/w) induced stimulatory effect on plant height, but the higher level (1, 1.5%, w/w) residue reduced plant height of Swiss chard In connection to this, Hegab et al (2016) found a stimulatory effect of Eucalyptus leaf residue in lower level (0.5%, w/w) on corn length. The results of this study was supported by the findings of Hamidi et al. (2008) who observed an inhibitory allelopathic effect of soil incorporated residues of Hordeum spontaneum on seedling length and dry weight of Triticum aestiuum. In this respect, Singh et al. (2001) reported that litter amended in the soil have a negative effect on seedling length and weight of both Triticum aestivum and L. culinaris and the length decreased with increasing amount of litter amended in the soil. The results of this Study is in agreement with that of Zohaib et al. (2014) who found that 2.5% and 5% aqueous extracts of Medicago plymorpha reduced shoot length and dry biomass of rice. Similar results were reported by Ismail and Siddique (2011) who found that seedling length and weight of Oryza sativa was suppressed by residues of Cyperus iria in soil. As seen in Table (2) the number of leaves did not exhibit significant difference between treatments. However, the leaf area expressed a significant difference (P=0.05) between treatments at 15, 30 and 45 DAS. In this respect Jayakumar et al. (1990) demonstrated that the irrigation of groundnut and maize with 5, 10, 15 and 20% water extract of abscised Eucalyptus globules leaf greatly reduced plant height and leaf area.

	Residue rate (w/w)				
	Control	0.5%	1.0%	1.5%	LSD
First experiment	35.00	3.33	0.00	0.00	0.56
Second experiment	30.00	8.33	0.00	0.00	1.85

Table 1:- Effect of different concentration of Datura stramonium residue on germina-tion of Swiss chard (Beta vulgaris var cicla)

Growth parameter	DAS (days after sowing)	Control	0.5%	1.0%	1.5%	LSD
Plant height (cm)	15	3.47	3.60	3.07	2.15	0.04
	30	4.82	7.93	4.30	3.31	0.07
	45	7.66	13.83	5.88	4.43	0.02
Number of leaves	15	2.93	2.83	280	2.73	NS
	30	3.22	3.11	3.09	3.03	NS
	45	4.31	4.18	4.14	4.11	NS
Leaf area	15	0.95	2.12	0.62	0.38	0.00
	30	4.80	9.66	2.06	1.20	0.00
	45	8.79	12.11	5.25	4.17	0.00

Table 2:- Effect of different concentration of Datura stramonium residue on growth parameters of Swiss chard (Beta vulgaris var.cicla)

The shoot fresh weight of chard as indicated in Table (3) expressed a significant difference between treatments. The Datura residue in low rate (0.5%, w/w) induced stimulatory effect and the shoot fresh weight of treatments exceeded the control value. In this respect Hegab et al. (2016) found an increase in lower level of eucalyptus residue in shoot growth parameters in corn. However, higher level of Datura residue (1 and 1.5%, w/w) reduced the shoot fresh weight. This result concurred with the results of Singh et al. (2001), Ismail and Siddique (2011) and Zohaib et al. (2014). The shoot dry weight also showed a significant difference between treatments. In this respect, El-Rokiek et al. (2010) found that the dry weight of foliage of Cyperus rotundus was inhibited and the inhibition varied significantly with different rates of mango leaf powder. Hamidi et al. (2008) observed the inhibitory allelopathic effect of soil incorporated residues of Hordeum spontaneum on seedling length and dry weight of Triticum aestiuum.

Regarding the root length, root fresh and dry weight Table (3) indicated a significant difference between

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treatments. The Datura residues with (1 and 1.5%, w/w) decreased the root length of chard plant when compared with control. In contrast the (0.5%, w/w) residue level stimulated the length of the root. This result is in agreement with results of Rafiqull et al. (2003) who found that undiluted tuber extract of Cyperus rotundus impeded the radicle elongation of cucumber, radish, onion and tomato. In connection to this Fikreyesus et al. (2011) reported that extracts of Eucalyptus camandulensis inhibited the root elongation of tomato, and Gulzar et al. (2014) found that the root length of Chenopodium album, Melilotus alba and Nicotiana plumbaginifolia decreasesed as the concentra-tion of Cassia sophere increased. In this respect Baziramakenga et al. (1995), Lehman and Blum (1999) assumed that the root length decreased as the concentration of extract increased, and the root membranes are a primary site of action for phenolics. The contact of phenolic acids with root cell membrane leads to depolarization, an efflux of ions and a reduction of hydrolic conductivity, water uptake and net nutrient uptake. Root growth is characterized by high metabolic rates and for this reason, roots are highly susceptible to environmental stresses such as allelochemical in soils (Cruz-Ortega et al., 1998). In this respect Chon et al. (2003), Chung et al. (2003), Singh et al (2003), chon and Kim (2004) attributed the highly allelopathic herbicidal potential in plant extracts to the presence of allelopathic substances e.g. Coumarin, O-coumaric acid, P-coumaric acid, benzoic acid, P-hydroxy benzoic acid and ferulic acid.

The chlorophyll content (a, b) decreased significantly as the concentration of Datura residue (1 and 1.5%, w/w) increased (Table 4). However, at low level (0.5%, w/w) of Datura residue, a stimulatory effect was observed, similar results were obtained by El-Khawas and Shehata (2005) who showed that the total chlorophyll content and consequently the soluble Sugar contents of maize and kidney-bean were reduced due to the application of Eucalyptus leaf leachates. Also Gulzar et al. (2014) found a significant reduction in chlorophyll content of Chenopodium album, Melilotus alba and Nicotiana plumbaginifolia treated with different concentration of Cassia sophera. Hegab et al. (2016) reported that a reduction was observed at higher level of the residue in chlorophyll a content of corn treated with Eucalyptus rostrata leaf residue. On contrast the lower level of leaf residue (0.5%, w/w) induced a stimulatory effect.

Parameters measures	Control	0.5%	1.0%	1.5%	LSD
Shoot fresh weight (g)	0.65	1.81	0.47	0.42	0.05
Shoot dry weight (g)	0.16	0.37	0.12	0.067	0.05
Root length (cm)	6.75	7.51	3.24	2.56	0.00
Root fresh weight (g)	0.83	0.94	0.61	0.42	0.13
Root dry weight (g)	0.43	0.53	0.21	0.13	0.00

Table 3:- Effect of different concentration of Datura stramonium residue on yield components of Swiss chard (Beta vulgaris var. cicla)

Residue rate	Chlorophyll content	
	a	b
Control	1.54	5.49
0.5%	1.74	5.96
1.0%	1.27	5.21
1.5%	0.08	4.31
LSD	0.00	0.00

Table 4:- Effect of different concentration of Datura stramonium residue on chlorophyll content (a, b) of Swiss chard (Beta vulgaris var. cicla).

The reduction in chlorophyll content may be due to the inhibition of chlorophyll biosynthesis, the stimulation of chlorophyll degrading substances or both (Yang et al., 2007). Another mechanism induced by allelochemicals is the inhibition of photosynthesis and oxygen evolution through interactions with components of photosystem II (PSII) (Einhellig, 1995). However, recently Hussain and Reigosa (2011) assumed that water content of leaves in plant initially induced stomatal closure, imposing a decrease in the supply of Co2 to the mesophyll cells and consequently photosynthesis could be lowered resulting in the decrease of chlorophyll content. Table (5) indicated a significant reduction (P=0.05) in K, N and P content when treated with higher rate of Datura residue compared with control. However, the lower level of Datura residue (0.5%, w/w) stimulated the chard and an increase in these elements was observed. Similar results were reported by Hegab et al. (2016) who found that the higher levels of Eucalyptus allelochemical (1% and 2%) reduced the amount of all phosprus fractions, and content of both soluble and insoluble nitrogen. Mersie and Singh (1988) demonstrated that Parthenium hysterophorus extract and residue greatly

reduced phosphorus content of treated 3-week old tomato plant. The allelopathic compounds are often observed to occur early in the life cycle causing inhibition of seed germination and/or seedling growth. These compounds exhibit a wide range of mechanisms of actions, from effects on DNA (alkalids), photosynthetic and mitochondrial function (aninones), phytohormone activity, ion uptake and water balance (phenolics) (Einhellig, 2002).

Residue rate (w/w)	Chemical elements		
	N %	P %	K %
Control	3.62	0.1384	18.45
0.5%	3.91	0.1504	19.75
1.0%	3.40	0.1231	9.70
1.5%	3.31	0.10557	4.68
LSD	0.00	0.00	0.01

Table 5:- Effect of different concentration of Datura stramonium residue on some elements of Swiss chard (Beta vulgaris var. cicla)

IV. CONCLUSION

The results indicate that the Datura residue in lower level can stimulate growth parameters and yield components, however the higher level of Datura residue (1%, 1.5%, w/w) induced a reduction in growth parameter and yield. Results also revealed that the lower rate of residue (0.5%) stimulate the chlorophyll pigments , nitrogen, phosphorus and potassium content, in contrast higher level induced a reduction in these parameters.

REFERENCES

[1]. Batish, D.R., Lavanya, K., Singh, H.P. and Kohli, R.K.(2007). Root mediated allelopathic interference of net leaved goose foot (Chenopodium murale) on wheat (Triticum aestiuum). Journal of Agronomy and Crop Science, 193: 37-44.

[2]. Baziramakenga, R., Simard, R.R., Leroux, G.D. and Nadeau, P. (1997). Allelopathic effects of phenolic acids on nucleic acid and protein levels in soybean seedlings. Can. J. Bot., 75: 445-40.

[3]. Chon, S.U. and Kim, Y.M. (2004). Herbicidal potential and quantification of suspected allelochemicals from four grass crop extracts. J. Agron. Crop Sci., 190(2) 145-150.

[4]. Chon, s.U., Kim, Y.M. and Lee, J.C. (2003). Herbicidal potential and quantification of causative allelochemicals from several compsitae weeds. Weed Re., 43(6): 444-448.

[5]. Chung, I.M., Kim, K.H, Ahn, J.K., Lee, S.B., Kim, S.H. and Hahn, S.J. (2003). Comparison of allelopathic potential of rice leaves, etraw, and hull extracts on barnyard grass. Agron. J., 95: 1063-1070.

[6]. Cruz-Ortega, R., Anaya, A.L., Hernandez, S., Bautista, B.E., Laguna Hernandez, G. (1998). Effects of allelochemical stress produced by Sicyos deppei on seedling root ultra structure of Phaseolus vulgaris and Cucurbita ficifolia. J. Chem. Ecol, 24: 2039-2057.

[7]. Einhellig, F.A. (1995). Mechanism of action of allelochemicals in allelopathy. In Iinderjit Einhellig F.A. Dakshini KMM. Eds. Allelopathy organisms processes and applications. Washington, DC, American Chemical Society, 96-116.

[8]. Einhellig, F.A. (2002). The physiology of allelochemical action: clues and views. Pp. 1-23, In: allelopathy, from molecules to ecosystems, Reigosa M.J., Pedrol N. Eds. Science Publishers, Enfield, New Hampshire.

[9]. El-Khawas, S.A. and Shehata, M.M. (2005). The allelopathic potentialities of Acacia nilotica and Eucalyptus rostrata on Monocat (Zeamays L.) and Dicot (Phaseoolus vulgaris L.) plants. Biotechnology, 4(1): 23-34. Cairo, Egypt. Internet document, http://www.asinet.org/biotech/ 2005/23-34pdf.

[10]. El-Rokiek, K.G, El-Masry, R.R., Messiha, N.K. and Ahmed, S.A. (2010). The allelopathic effect of mango leaves on the growth and propagative capacity of purple nuts edge (Cyperus rotundus L.). J. of American Science, 6(9): 151-159.

[11]. Fikreyesus, S., Kebebew, Z., Nebiyu, A., Zeleke, N. and Bogale, S. (2011). Allelopathic effects of Eucalyptus camaldulensis Dehnh. On germination and growth of tomato. American-Eurosian J. Agric. Environ Sci., 11(5): 600-608.

[12]. Gulzar, A., Siddiqui, M.B. and Shazia Bi (2014). Assessment of allelopathic potential of Cassia sophera L. on seedling growth and physiological basis of weed plants. African Journal of Biotechnology, 13(9): 1037-1046.

[13]. Hamidi, R., Mazaheri, D., Rahimian, H, Alizadeh, H.M., Ghadiri, H. and Zeinali, H. (2008). Phytotoxicity effect of soil amended residues of wild barley (Hordeum spontaneum Koch) on growth and yield of wheat (Triticum aestivuum L.) Desert 13(1): 1-7.

[14]. Hegab, M.M., Gabr, M.A., Al-Wakeel, S.A.M. and Hamed, B.A. (2016). Allelopathic potential of Eucalyptus rostrata Leaf Residue on some metabolic activities of Zea mays L., Universal Journal of Plant Science, 4(21): 11-21.

[15]. Hussain, M.I. and Reigosa, M.J. (2011). Allelochemical stress inhibits growth leaf water relations, PSII photochemistry, nonphoto-chemistry fluorescence quenching and heat energy dissipation in three C3 perenial species. J. Exp. Bot., 62: 4533-4545.

[16]. Ismail, B.S. and Siddique, M.A.B. (2011). The inhibitory effect of grass hoppers Cyprus (Cyperus iria L.) on the seedling growth of five Malaysian rice verities. Trop. Life Sci. Res., 22(1): 81-89.
[17]. Jayakumar, M., Eyini, M. and Pannirselvam, S. (1990). Allelopathic effect of Eucalyptu globulus Labil on groundnut and corn. Comp. Physiol, Ecol., 15: 109-113.
[18]. Mersie, W. and Singh, M. (1988). Effect of phenolic acids and ragweed parthenium (Parthenium hysterophorus) extracts on tomato (Lycopersicon esculentum) growth and nutrient and chlorophyll content. Weed Sci., 36: 278-281.
[19]. Oyerinde, R.O., Otusanya, O.O. and Akpor, O.B. (2009). Allelopathic effect of Tithonia diversifolia on the germination, growth and chlorophyll contents of maize (Zea mays L). Sci, Res. Essay 4(12): 1553-1558.
[20]. Pellegrini, N., Serafini, Colombi, B, Del Rio, D., Salvatores, S., Bianchi, M. and Brighenti, F. (2003). Total antioxidant capacity of plant foods, beverage and oils consumed in Italy assessed by three different in vitro assays. J. Nutr., 133: 2012-2819.
[21]. Rafiqul Heque, A.T.M., Ahmed, R. Uddin, M.B. and Hossain, M.K. (2003). Allelopathic effect of different concentration of water extracts of Acacia auriculiformis leaf on some initial growth parameters of five common agricultural crops. Internet document, www.asinetorg/ fulltext/ja/ja, 2292-100pdf.
[22]. Singh, H., Kohli, R. and Batish, D. (2001). Alleopathic interference of Populus deltoids with some winter season crops. Agronomie, EDP Sciences, 21(2): 139-146.
[23]. Singh, H.P., Batish, D.R., Kar, S. and Kohli, R.K. (2003). Phytotoxic interference of Ageratum conyzoides with wheat Triticum aestiuum. J. Agron. Crop Sci., 189(5): 341-346.
[24]. Skinner, E.M., Diaz-Perez, J.C., Phatak, S.C., Schomberq, H.H. and Vencill, W. (2012). Allelopethic effects of sunnhemp (Crotalaria juncea L) on germination of vegetables and weeds. Hort. Science, 47(1): 138-142.
[25]. Suwal, M.M., Devkota, A. and Lekhak, H.D. (2010). Allelopathic effects of Chromolaena odorata L King and Robinson on seed germination and seedling growth of paddy and barnyard grass. Sci. World 8(8): 73-75.
[26]. Thomposn, H.C. and Kelly, W.C. (1990). Vegetable crops. 5th Ed. New Delhi: MacDraw Hill Publishing Company Ltd, pp. 20-125.
[27]. Yang, C.M. (1991). Allelopathic potential of purple nutsedge (Cyperus rotundus L.) and barnyard grass (Echinochloa crus gali (L.) Beauv.) on corn (Zea mays L. var. Tainung No. 1). I, Inhibition of weed extracts on germination. Weed Sci. Bull., 12: 12-21.
[28]. Zohaib, A.S., Tanveer, A., Abdul Khalig and Safdar, M.E. (2014). Phytotoxic effect of water soluble phenolics from five leguminous weeds on germination and seedling growth of rice. Pak J. Weed Sci. Res., 20(4): 417-429.