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EFFICACY OF SOME SELECTED MEDICINAL PLANTS FOR THEIR POSSIBLE ALLELOPATHIC ACTIVITY ON BARNYARD GRASS AND OKRA

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ABSTRACT

Medicinal plants have been known as candidates of allelopathic potential to their ability to exhibit allelochemicals. An experiment was conducted to evaluate the effect of allelopathic activities of five medicinal plants, i.e., asparagus (*Asparagus racemosus wild.*), lebbeck (*Albizia lebbeck*), devil's cotton (*Abroma augusta*), scarlet gourd (*Coccinea cordifolia*), and spreading hogweed (*Boerhavia diffuse* linn.) on the root and shoot growth of okra and barnyard grass. Five concentrations of each medicinal plant extract *viz*. T_0 (control; no extract), T_1 (0.01 mg dry wt. eq. extract/mL), T_2 (0.03 mg dry wt. eq. extract/mL), T_3 (0.1 mg dry wt. eq. extract/mL) and T_4 (0.3 mg dry wt. eq. extract/mL) were used for the interference test. The experiment was laid out in a completely randomized design (CRD) with three replications. Results indicated that all concentrations of plant extract showed an inhibitory effect on okra and barnyard grass. Among the concentrations of plant extract, T_4 (0.3 mg dry wt. eq. extract/ mL) showed the highest interruptive effect on both okra and barnyard grass. In terms of root length of okra, spreading hogweed and scarlet gourd extract at T_4 (0.3 mg dry wt. eq. extract/ mL) showed the highest allelopathic effect and gave the lowest root length (0.533 mm). The spreading of hogweed extract at T_4 (0.3 mg dry wt. eq. extract /mL) concentration on barnyard grass seeds showed the highest allelopthic effect for the shoot and root length (i.e., 1.9 mm and 0.93 mm, respectively). The interference results above suggest that *Coccinea cordifolia* and *Boerhavia diffuse* L. might have allelopathic potential due to some native allelochemicals. Therefore, *Coccinea cordifolia* and *Boerhavia diffuse* L. could be used as mulch or soil additives to suppress weeds for sustainable crop production.

Keywords: allelochemicals, allelopathic activity, barnyard grass, inhibition, medicinal plants

INTRODUCTION

Allelopathy is defined as a delay or interfere in germination, inhibition or stimulation of plant growth, nutrient uptake, or any adverse effect on nearby plants caused by specific secondary metabolites known as allelochemicals. These allelochemicals are dispersed into the soil by allelopathic plants (Singh *et al*., 2003; Aliotta *et al*., 2006; Khan and Kato-Noguchi, 2016; Chris Blok *et al*., 2019; Khan *et al*., 2021). Allelochemicals present in all plant tissue, e.g., leaves, roots, fruits, stems, flowers including pollen, and released from the plant into the environment by major ecological processes e.g. volatilization, leaching, root exudation, and decomposition of plant residues (Mutlu and Atici, 2009). Medicinal plants contain a large number of various secondary metabolites, e.g., alkaloids, flavonoids, tannins, and some other phenolic compounds (Shao *et al*., 2004). Many medicinal plants in Bangladesh have a strong possibility of having allelopathic activity on other plants. The increasing interest in medicinal plants could be due to the possibility of having more secondary metabolites in medicinal plants than in other plants (Gilani *et al*., 2010). These allelopathic plants could be used in several ways to control weeds (Piyatida and Kato-Noguchi., 2010). Weed is very harmful to our crop production and yield. In Bangladesh, an average of 37.33% of crop production and approximately 59665.70 million Taka might be lost annually if weeds are not controlled (Karim, 1998). The allelochemicals can be used as bioherbicides to control weeds. Allelochamicals show phytotoxicity effect on other monocot or dicot plants, which are renewable and easily degradable. Therefore, recently allelochemicals have received the attraction as environmentally friendly and safer natural herbicides for weed control (Khan *et al*., 2011; Khan *et al*., 2021). As a medicinal plant, asparagus is a perennial herb that belongs to the family Asparagaceae and has many types of secondary metabolites, e.g., isoflavones, asparagamine, racemosol,

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and polysaccharides (Mishra *et al*., 2017). Lebbek is also used to treat ringworms and wounds by washing the affected areas, gonorrhea, leucorrhoea, bronchitis and other genital diseases and contains melacacidin, D-catechin, β-sitosterol, albiziahexoside, betulnic acid etc. which are secondary metabolites (Varma *et al.*, 2013). Devils cotton, Scarlet gourd, and Spreading hogweed also have a myriad of secondary metabolites, e.g., abromin, friedelin, abromasterol, taroxerylacetate, taraxeral, rotenoids, flavonoids, xanthones, alkaloids, sterol, β-sitosterol etc. (Chowdhury *et al.*, 2019). Although those medicinal plants produce a number of secondary metabolites, very little research on allelopathic activity has been published. Therefore, the current research was conducted to assess the probable allelopathic effect of five medicinal plants on root and shoot growth of two test species, i.e., barnyard grass and okra.

MATERIALS AND METHODS

The experiment was conducted at the Department of Agricultural Chemistry laboratory, Sher-e-Bangla Agricultural University, Dhaka, from 2020-2021 in a CRD (Completely Randomized Design). Okra (*Abelmoschus esculentus*) and barnyard grass (*Echinochloa crus-galli* (L.) P. Beauv) were considered for the experiment. Asparagus (*Asparagus racemosus* wild.), Lebbeck (*Albizia lebbeck*), Devils cotton (*Abroma augusta*), Scarlet gourd (*Coccinea cordifolia*), and Spreading hogweed (*Boerhavia diffusa* linn.) have been selected as a medicinal plants to study their allelopathic interaction on the growth of test plants. T_0 (control without extract), T_1 (0.01 mg dry wt. eq. extract/mL), T_2 (0.03 mg dry wt. eq. extract/mL), T_3 (0.1 mg dry wt. eq. extract/mL) and T_4 (0.3 mg dry wt. eq. extract/mL) treatments are selected for the experiment. The medicinal plant parts (leaves) were washed with tap water, dried under the sun for two days, and then oven-dried at 40°C for 72 hours.Then the samples were cut and ground in a mechanical grinder to prepare them as powder. 5 g of each sample was weighed with an analytical balance (model: ATX224, Shimadzu, Tokyo, Japan) and extracted with 100 mL of 70% (v/v) aqueous methanol for 48 hours. After filtration using one layer of filter paper (number 2; Advantec Toyo Roshi Kaisha, Ltd., Tokyo, Japan), the residue was re-extracted with the same volume of aqueous methanol for 24 hours and then filtered. Two filtrates were mixed together and evaporated by a rotary evaporator (Hahnvapor, HS-2005S, Hahnshin S&T Co., Ltd, Korea) at 40°C. The extracts were diluted into 100 mL methanol and prepared into four assay concentrations 0.01, 0.03, 0.1 and 0.3 mg of dry weight equivalent extract ml^{-1} added to a sheet of filter paper (number 2) in 28 mm Petri dishes. The methanol was evaporated in a draft chamber followed by adding 0.6 ml of 0.05% (v/v) aqueous solution of polyoxyethyl-enesorbitan-monolaurate (Tween 20: a nontoxic surfactant for germination and growth of all test plants). The effects of aqueous extracts on root and shoot growth were tested by placing 10 seeds of each test crop (okra and barnyard grass) in petri dishes (three replicates) containing three layers of filter paper saturated with the aqueous extracts. A separate control series was set up using distilled water. The petri dishes were then incubated in growth chamber (RGX-250E, Huanghua Faithful Instrument Co., Ltd, China) at 25°C. Moisture in the Petridishes was maintained by adding distilled water as required. The length of the root and shoot of the test specimens were measured after 96 hours. After 96 hours of germination duration, shoot (plumule) length and root (radical) length were measured with a slide caliper carefully and recorded in mm.

RESULTS AND DISCUSSION

Effect of Asparagus on root length of barnyard grass

Significant variation was found in the root length of barnyard grass seeds affected by different levels of extract of Asparagus (Fig. 1). Results indicated that the highest root length (9.26 mm) was recorded from control treatment T_0 (no extract) followed by T_1 (0.01 mg dry wt. eq. extract/ml), extract (4.167 mm). The lowest root length (3.53 mm) was observed from seed treatment with T_4 (0.03 mg dry wt. eq. extract/ ml). At the highest concentration of T_4 (0.3 mg dry wt. eq. extract/ ml), root length (3.53 mm) was significantly variable than control. It was observed that root length was decreased significantly from the lowest concentration T_1 (0.01 mg dry wt. eq. extract/ml) to the highest concentration T_4 (0.3

mg dry wt. eq. extract/ ml). Similar trend of results were described by Varsha *et al*. (2013) who found that alkaloids were responsible for the growth inhibition.

Effect of Lebbeck on root length of barnyard grass

Lebbeck also showed allelopathic activity on the root length of barnyard grass seeds (Fig. 1). Results indicated that the highest root length (10.4 mm) was recorded from control treatment T_0 (no extract), followed by T_1 (0.01 mg dry wt. eq. extract/ml) extract (8.1 mm). The lowest root length (2.667 mm) was observed from both seed treatments with T_4 (0.3 mg dry wt. eq. extract/ml) and T_3 (0.1 mg dry wt. eq. extract/ml) (Fig. 1). Our results were corroborated by the study of Verma *et al.* (2013). They reported that the presence of many secondary metabolites like melacacidin, D-catechin, β-sitosterol, albiziahexoside etc. may be contained in Lebbeck, which interferes with the growth of barnyard grass.

Effect of Devil's cotton extract on root length of barnyard grass

The root length growth of barnyard grass has been disturbed by the Devil's cotton extract (Fig. 1). The highest root length (13.3 mm) was recorded from control treatment T_0 (no extract) followed by T_1 (0.01 mg dry wt. eq. extract/ ml) extract (10.833 mm). The lowest root length (1.567 mm) was observed with T_4 (0.03 mg dry wt. eq. extract/ ml) treatment. At the highest concentration T_4, root length (1.567 mm) was significantly decreased compared to the control treatment. Similar results were described by Chowdhury *et al.* (2019) who found some secondary metabolites such as abromin, friedelin, abromasterol, taroxerylacetate etc. which have the potentiality to act as allelochemicals.

Effect of Scarlet gourd extract on root length of barnyard grass

Scarlet gourd showed significant variation in root length of barnyard grass seeds at different concentrations (Fig. 1). According to the result, the highest root length (15.267 mm) was recorded from control treatment T_0 (no extract). The lowest root length (3.433 mm) was observed from seed treatment with T_4 (0.03 mg dry wt. eq. extract/ ml). The scenario of growth inhibition started at T_2 concentration. The results were supported by the results which were performed by Khan *et al*. (2021) and Islam and Kato-Noguchi (2013) that the growth of barnyard grass was suppressed by the medicinal plants due to the presence of allelochemicals, i.e., phenolic compounds, flavonoids etc.

Effect of Spreading hogweed extract on root length of barnyard grass

Significant variation was recorded in the root length of barnyard grass seeds affected by different levels of extract of spreading hogweed (Fig. 1). A 16 mm root length was recorded from control treatment

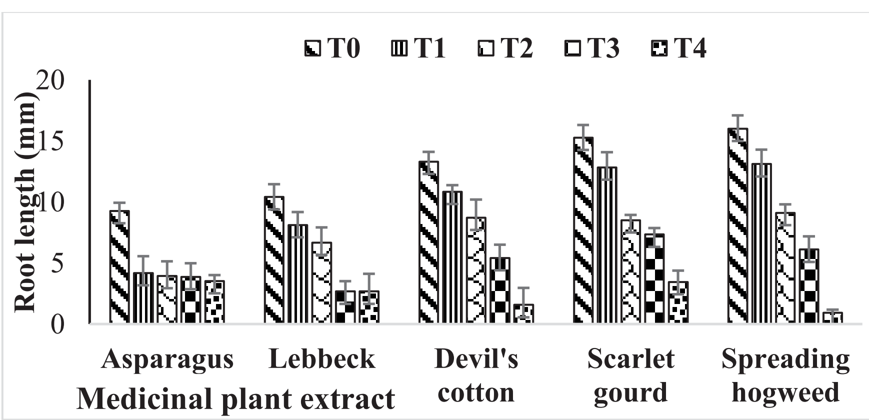

Fig. 1. Root length (mm) of barnyard grass at 96 hours affected by different medicinal plants.

T_0 = 0 (control without extract), T_1 = 0.01 mg dry wt. eq. extract/ ml, T_2 = 0.03 mg dry wt. eq. extract/ml, T_3 = 0.1 mg dry wt. eq. extract/ ml, T_4 = 0.3 mg dry wt. eq. extract/ ml

T_0 (no extract) followed by T_1 (0.01 mg dry wt. eq. extract/ml) extract (13.1 mm). The lowest root length (.933 mm) was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ml). The result was observed root length of barnyard grass was decreasing with increasing extract concentration. For example Khan *et al.* (2021); Khan and Kato-Noguchi (2016) and Qasim *et al*. (2019) all found similar types of findings on different types of medicinal plants.

Effect of Asparagus extract on shoot length of barnyard grass

Shoot length of Asparagus also significantly varied like the root length of barnyard grass seeds affected by different levels of extract (Fig. 2). The highest shoot length (9.1 mm) was recorded from control treatment T_0 (no extract) followed by T_1 (0.01 mg dry wt. eq. extract/ ml) extract (7.433 mm) and T_2 (0.03 mg dry wt. eq. extract/ ml) (5.3 mm). The lowest shoot length (3.16 mm) was observed from seed treated with T_4 extract (0.3 mg dry wt. eq. extract/ ml). Khan *et al.* (2021); Kato-Noguchi *et al.*, (2017) and Khan and Kato-Noguchi (2016) found that the shoot length of barnyard grass was suppressed by different extract concentrations obtained from different plant.

Effect of Lebbeck extract on shoot length of barnyard grass

Like the root growth, the shoot growth of barnyard grass showed a decreasing response to the Lebbeck extracts (Fig. 2). Results indicated that the highest root length (7.2 mm) was recorded from control treatment T_0 (no extract), followed by T_1 (0.01 mg dry wt. eq. extract/ml) extract (4.13 mm). The lowest root length (2.067 mm) was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ml) and the root length at T_3 (0.1 mg dry wt. eq. extract/ml) was recorded at 2.7 which decreased gradually from T_0 (Control).

Effect of Devil's cotton extract on shoot length of barnyard grass

Results indicated that 8.967 mm was recorded from control treatment T_0 (no extract), which was the highest root length. The T_1 (0.01 mg dry wt. eq. extract/ ml) extract showed at 5.7 mm. The lowest root length (1.867 mm) was observed from seed treatment T_4 (0.3 mg dry wt. eq. extract/ ml) and the root length at T_3 (0.1 mg dry wt. eq. extract/ ml) was recorded 3.6 mm, which was gradually and significantly decreased from T_0 (Control). Naz and Bano (2014) reported that leaf extracts of *Ricinus communis* and *L. camara* inhibit the growth of maize seedlings, which is in resemblance with existing results that may be caused by the effect of volatile phenolic compounds or alkaloids.

Effect of Scarlet gourd extract on shoot length of barnyard grass

Significant variation was found on shoot length barnyard grass seeds affected by different levels of extract of Scarlet gourd (Fig. 2). Control treatment T_0 (no extract) showed the highest root length (10.667 mm), followed by T_1 (0.01 mg dry wt. eq. extract/ ml) extract and T_2 (0.03 mg dry wt. eq. extract/ ml) extract (7.33 mm). The lowest root length (2.867 mm) was observed from seed treatment T_4 (0.3 mg dry wt. eq. extract/ml), that was significantly and gradually decreasing from T_0 (Control). Scarlet gourd is a very common and available medicinal plant which may have a vast amount of secondary metabolites that can slow the growth of monocotyledonous plant. Kato-Noguchi *et al*. (2011) also claimed that *Cucumis sativus* which has some secondary metabolites that inhibit the growth of barnyard grass. So, these plants have a chance to claim economic source of weed suppression by natural means.

Effect of spreading hogweed extract on shoot length of barnyard grass

The variation was found in the shoot length of barnyard grass seeds and the result was significant (Figure 2). Results indicated that the highest shoot length (7.9667 mm) was recorded from control treatment T_0 (no extract), followed by T_1 (0.01 mg dry wt. eq. extract/ ml) extract (7.433 mm). The lowest shoot length of 1.9 mm was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ ml). At the result of highest concentration T_4 shoot length 1.9 mm was significantly decreased from T_0 (control). Thomford *et al*. (2018) found that spreading hogweed contains polyphenols such as caffeic acid, rutin, quercetin, citric acid, ferulic acid and gluconic acid, which may have the potential to suppress the vegetative growth of barnyard grass.

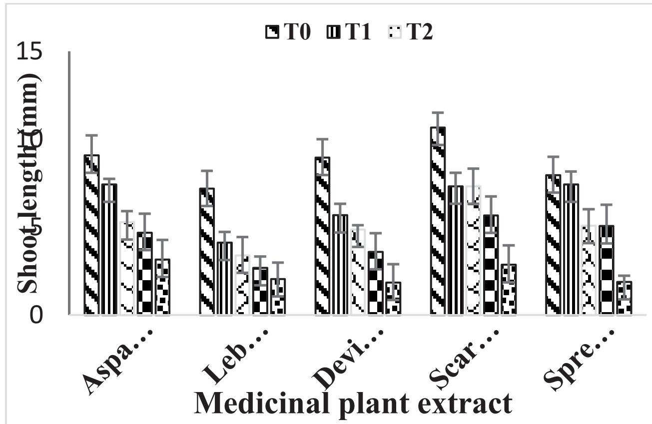

Fig. 2. Shoot length (mm) of barnyard grass at 96 hours affected by different medicinal plants.

T_0 = 0 (control without extract), T_1 = 0.01 mg dry wt. eq. extract/ml, T_2 = 0.03 mg dry wt. eq. extract/ml, T_3 = 0.1 mg dry wt. eq. extract/ml, T_4 = 0.3 mg dry wt. eq. extract/ml

Effect of Asparagus extract on root length of okra

Asparagus (*Asparagus racemosus* wild.) made variation on root length okra seeds in different levels of extract (Fig. 3). Highest root length (10.533 mm) was recorded from control treatment T_0 (no extract) followed by T_1 (0.01 mg dry wt. eq. extract/ml) extract (7.667 mm). The lowest root length (2 mm) was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ml) and the root length at T_3 (0.1 mg dry wt. eq. extract/ ml) was recorded at 3.767 mm, which was also significantly decreased from T_0 (Control). In Mishra *et al*. (2017) it was observed that Asparagus contains many secondary metabolites such as isoflavones, asparagamine, racemosol, and polysaccharides which may cause the result of shoot growth inhibition.

Effect of Lebbeck extract on root length of okra

Variation was found in the root length of okra seeds by different levels of extract concentration (Fig. 3). Results showed that the highest root length (7.533 mm) was recorded from control treatment T_0 (no extract), followed by T_1 (0.01 mg dry wt. eq. extract/ml) extract (4.367 mm). The lowest root length (2.7 mm) was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ml), which was at a decreasing rate from T_0 (Control). It was observed that root length decreased with an increase of concentration. Khan *et al.* (2021); Khan and Kato-Noguchi (2016) and Macdonald *et al*. (2010) reported that the root length of dicotyledonous test species was inhibited by the extract concentrations obtained from different plants.

Effect of Devils cotton) extract on root length of okra

Significant variation was found in the root length of okra seeds affected by different levels of extract of Devils cotton (*Abroma augusta*) (Fig. 3). The highest root length of 10.067 mm was recorded from control treatment T_0 (no extract), and the lowest root length was 2.167 mm observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ ml), which was significantly decreased from T_0 (Control). The effect of treatment T_1 (0.01 mg dry wt. eq. extract/ ml) extract showed the root length (5.767 mm) and was followed by T_2 (0.03 mg dry wt. eq. extract/ ml) extract (5.067 mm). Khan and Kato-Noguchi (2016) and Suwitchayanon *et al*. (2015) found that *Couroupita guianensis* and *Hibiscus sabdariffa* inhibit the growth of garden cress.

Effect of Scarlet gourd extract on root length of okra

The findings on scarlet gourd showed significant variation in the root length of okra seeds at different levels of extract (Fig. 3). The lowest root length (0.567 mm) was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ ml) and the highest root length (9.7 mm) was recorded from control treatment T_0 (no extract), which was significantly decreasing. The effect of treatment T_1 (0.01 mg dry wt. eq. extract/ mL) extract showed the root length (7.167 mm) and was followed by T_2 (0.03 mg dry wt. eq. extract/ ml) extract (4.133 mm).

Effect of Spreading hogweed extract on root length of okra

Significant variation was found in the root length of okra seeds by different treatment concentrations of spreading hogweed (Fig. 3). 10.167 mm was recorded from control treatment T_0 (no extract), which was the highest root length, and the lowest root length 0.533 mm was observed from seed treatment with T_4 (0.3 mg dry wt. eq. extract/ ml), which was significantly and gradually decreasing from T_0 (Control). The effect of treatment T_1 (0.01 mg dry wt. eq. extract/ ml) extract showed the root length (7.767 mm) and was sfollowed by T_2 (0.03 mg dry wt. eq. extract/ ml) extract (5.93mm). Similar results were found by Khan and Kato-Noguchi (2016) and Islam *et al.* (2017) where medicinal plants showed phytotoxic or allelopathic effects.

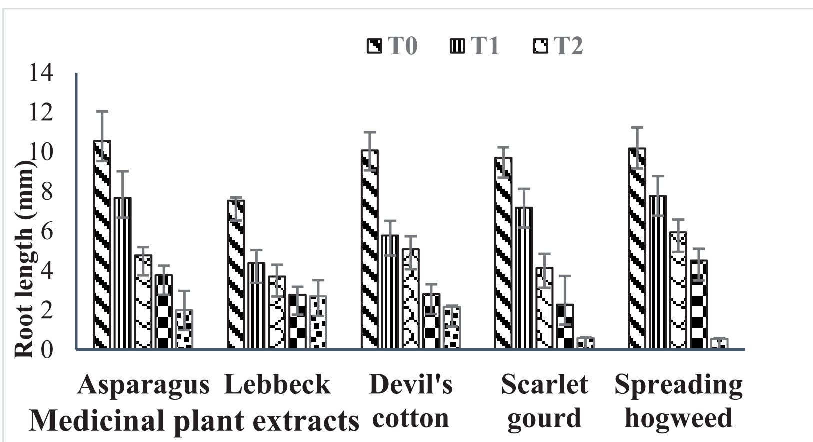

Fig. 3. Root length (mm) of okra at 96 hours affected by different medicinal plants

T_0 = 0 (control without extract), T_1 = 0.01 mg dry wt. eq. extract/ml, T_2 = 0.03 mg dry wt. eq. extract/ml, T_3 = 0.1 mg dry wt. eq. extract/ml, T_4 = 0.3 mg dry wt. eq. extract/ml.

CONCLUSION

Aqueous methanol extracts from five selected medicinal plants had inhibitory effects on the shoot and root lengths of two test species, including one weed. The results of our research indicated that those five medicinal plants probably have allelopathic potential and might have contained allelochemicals. The isolation, purification, and characterization of allelochemicals from those medicinal plants could have brought wider scope for weed management by replacing synthetic herbicides. This technique of weed control might be used to integrate sustainable farming systems. These medicinal plants could also be used by incorporating them with agricultural land as mulch or soil additives so that there is a huge possibility to add allelochemicals to soil in a significant amount, which might be an eco-friendly weed management strategy.

REFERENCES

Aliotta, G., Cafiero, G. and Otero, A.M. 2006. Weed germination, seedling growth and their lesson from allelopathy in agricultural. P. 285-299. *In:* M.J. Reigosa, N. Pedrol and L. González (ed.).

Allelopathy: A Physiological Process with Ecological Implications. Springer Publisher, the Netherlands.

Chowdhury, N.S., Farjana, F., Jamaly, S., Begum, M.N., and Zenat, M.E.A. 2019. Pharmacological values and phytochemical properties of Devil's cotton (Ulatkambal) - A review. *Bangladesh Pharm. J.*, 22(1): 109–116.

Chris Blok, Baumgarten, A., Baas, R., Wever, G. and Lohr, D. 2019. P. 11: 509-564. Analytical methods used with soilless substrates. Soilless Culture . 2nd edn. Elsevier.

Gilani, S.A., Fujii, Y., Shinwari, Z.K., Adnan, M., Kikuchi, A. and Watanabe, K.N. 2010. Phytotoxic studies of medicinal plant species of Pakistan. *Pak. J. Bot*., 42(2): 987-996.

Islam, A.K.M.M. and Kato-Noguchi, H. 2014. Phytotoxic activity of *Ocimum tenuiflorum* extracts on germination and seedling growth of different plant species. *The Sci. World J*., Article ID: 676242.

Islam, M.S., Iwasaki, A., Suenaga, K. and Kato-Noguchi, H. 2017. 2-Methoxystypandrone, a Potent Phytotoxic Substance in *Rumex maritimus* L. *Theo. and Exp. Pl. Phy*., 29: 195-202.

Karim, R. 1998. Relative yields of crops and crop losses due to weed competition in Bangladesh. 41: 318-324.

Kato-Noguchi, H., Le Thi, H., Teruya, T. and Suenaga, K. 2011. Two Potent Allelopathic Substances in Cucumber Plants. Scientia Horticulturae (Amsterdam), 129, 894-897.

Kato-Noguchi, H., Nakamura, K., Ohno, O., Suenaga, K. and Okuda, N. 2017. Asparagus Decline: Autotoxicity and Autotoxic Compounds in *Asparagus Rhizomes*. *J. Pl. Physio.*, 213: 23-29.

Khan, M.S.I., Kaium, M.A., Sarkar, B.K., Begum, R., Begum, N., Islam, M.A., Chowdhury, M.T.I., Habib, M., Hakim, M.A. 2021. Potencies of *Justicia adhatoda* L. For Its Possible Phytotoxic Activity. *Pl. Sci. Today*, (8)289-292.

Khan, M.S.I. and Kato-Noguchi, H., 2016. Assessment of allelopathic potential of *Couroupita guianensis* Aubl. *POJ,* 9(2):115-120.

Khan, M.S.I., Islam, A.K.M.M. and Kato-Noguchi, H. 2013. Evaluation of Allelopathic Activity of Three Mango (*Mangifera indica*) Cultivars. *Asian J. Pl. Sci.,* 12: 252-261.

Khan, A.M., Qureshi, R.A., Ullah, F. and Gilani, S.A. 2011. Phytotoxic effects of selected medicinal plants collected from Margalla Hills, Islamabad Pakistan. *J. Medi. Pl. Res*., 5(18): 4671-4675.

Macdonald, I.O., Oludare, A.S. and Olabiyi, A. 2010. Phytotoxic and antimicrobial activities of flavonoids in *Ocimum gratissimum*. *Life Sci. J.,* 7: 3.

Mishra, J. and Verma, N. 2017. Asparagus racemosus: Chemical constituents and pharmacological activities -A review. *Euro. J. Biomed. & Pharma. Sci.,* 4(6): 207-213.

Mutlu, S. and Atici, O. 2009. Allelopathic effect of *Nepeta meyeri Benth*. extracts on seed germination and seedling growth of some crop plants. *Acta Physio. Plantrum,* 31: 89-93.

Naz, R. and Bano, A. 2014. Effects of Allelochemical Extracts from Medicinal Plants on Physiological and Biochemical Mechanisms of Maize (*Zea mays* L.) Seedlings. *Int. J. Agro. Agri. Res.*, 5: 31-39.

Piyatida, P. and Kato-Noguchi, H. 2010. Screening of allelopathic activity of eleven Thai medicinal plants on seedling growth of five test plant species. *Asian J. Pl. Sci*., 9(8): 486-491.

Qusim, M., Fujii, Y., Ahmed, M.Z., Aziz, I., Kazuo N., Watanabe, M. and Ajmal, K. 2019. Phytotoxic analysis of coastal medicinal plants and quantification of phenolic compounds using HPLC, *Pl. Biosystems.,* 153**(**6): 767-774.

Shao-Lin, P., Jun, W. and Qin-Feng, G. 2004. Mechanism and active variety of allelochemicals. A review- *Acta Bota. Sinica*. 46 (7): 757-766.

Singh, H.P., Batish, D.R., Kaur, S. and Kohli, R.K. 2003. Phytotoxic interference of *Ageratum conyzoides* with wheat (*Triticum aestivum*). *J. Agro. Crop Sci*., 189(5): 341-346.

Suwitchayanon, P., Pukclai, P., Ohno, O., Suenaga, K. and Kato-Noguchi, H. 2015. Isolation and Identification of an Allelopathic Substance from *Hibiscus sabdariffa*. *Natur. Pro. Commu*., 10: 765-766.

Thomford, N.E., Kevin, D., Adu, F., Chirikure, S., Wonkam, A. and Dandara, C. 2018. Bush mint (*Hyptis suaveolens*) and spreading hogweed (*Boerhavia diffusa*) medicinal plant extracts differentially affect activities of CYP1A2, CYP2D6 and CYP3A4 enzymes. *J. Ethnophar*., 211: 58-69.

Varsha, S., Agrawal, R.C. and Pandey, S. 2013. Phytochemical screening and determination of anti-bacterial and anti-oxidant potential of *Glycyrrhiza glabra* root extracts. *J. Env. Res. Develop.*7:4.

Verma, S.C., Vashishth, S., Singh, R., Kumari, A., Meena, A.K., Pant, P., Bhuyan, G.C. and Padhi, M.M. 2013. A review on parts of *Albizia lebbeck* (L.) Benth. used as Ayurvedic drugs. *Res. J. Pharm. and Techno*. 6: 1307-1313.