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AN INVESTIGATION OF ALLELOPATHIC POTENTIAL OF *DURANTA PLUMIERI* (JACQ) ON *SORGHUM VULGARE* (PEARS) VARIETIES

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Abstract:

Laboratory bioassay and field experiments were conducted to evaluate the allelopathic effects of aqueous and alcoholic extracts of Duranta plumieri (Jacq) on the seed germination, seedling growth and growth characteristics of two varieties of Sorghum vulgare (Pears). The results showed that all the concentrations of alcoholic extract inhibited the process of seed germination in both CSH-7 and M35-1 varieties. Similarly, the germination percentage, seedling length were also affected in both varieties form lower to higher concentrations of aqueous extract. Fresh weight per seedling was decreased as compared to control but without any definite pattern. However, dry weight per seedling was increased in both CSH-7 and M35-1 variety except at 0.25% where it was slightly decreased (6.67%). All the growth characteristics including root length, shoot length and total height of plant were significantly reduced when the plants were foliar sprayed with increasing concentrations of aqueous and alcoholic extracts. The inhibitory effects were concentration dependent and more reduction was recorded at 1.00% concentration of both the types of extract. The increased root to shoot ratio in both varieties also indicated that the shoot growth was more affected than the root growth. The alcoholic extract has more inhibitory effect than aqueous extract and out of the two varieties more growth inhibition was observed in M35-1 variety as compared to CSH-7.

Keywords: *Allelopathic Effects, Alcoholic Extract, Aqueous Extract, Growth Characteristics.*

Introduction

Allelopathy is a biological phenomenon by which a plant produces one or more biochemical that influence the growth, survival and reproduction of other plants. These biochemicals are known as allelochemicals and which are released by leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems. The allelochemicals can have beneficial or detrimental effects on the target plants (1).

The basic approach used in allelopathic research for agricultural crops has been to screen both crop plants and natural vegetation for their capacity to suppress the weeds. Most allelopathic studies cover only simple petridish bioassays to determine the effect of allelochemicals on germination and seedling growth of plant species. However,

it is also important to study the effects of allelochemicals on physiological processes which may clear the root causes of decreased germination percentage and seedling growth. With the help of such type of studies, one can identify the beneficial allelochemicals which are helpful to promote the physiological processes and increase the yield of crop plants. Such research furthers the possibility of using the allelochemicals as growth regulators or natural herbicides to promote sustainable agriculture.

Sorghum, the common and genus name for various species of grasses, is used for various purposes. The main commercial species *Sorghum vulgare* (Pears) is used for food, fodder, production of alcoholic beverages, biodiesel, etc. It is a staple food of very large population and mainly concentrated in the Peninsular and Central India.

Duranta plumieri (Jacq) (Syn. *D. repens* Linn., *D. erecta* Linn. and English Golden dewdrop), a member of family Verbenaceae, is a smooth shrub with struggling and drooping branches. This is a popular ornamental shrub upto 4 meters tall and usually trimmed as a hedge. The flowers are blue or pale purple often with two darker stripes, trumpet shaped and borne on spikes 4–9 cm long arising from the leaf axils. Even though the leaves, stem and fruits of *D. plumieri* are poisonous, these are used as febrifuge, for malaria, intestinal worms, diuretic and for treatment of abscesses. It is highly effective against larvae of mosquito, reduces viral titer of Hepatitis A. Although *D. plumieri* has been studied by number of workers for their potential medicinal value, its allelopathic effects on plant physiological processes are still unknown.

Hence the present study was designed not only to evaluate the allelochemical effects of aqueous and alcoholic extract of *Duranta plumieri* leaves on seed germination, seedling growth by petridish method but also on growth characteristics of *Sorghum vulgare* variety CSH-7 and M 35-1 in the field experiments.

Materials and Methods

To study the allelopathic effects of aqueous and alcoholic extracts of *Duranta plumieri* on seed germination, seedling growth and various growth characteristics of *Sorghum vulgare*, experiments were carried out in the laboratory and botanical garden of the Ajara Mahavidyalaya, Ajara.

A) Preparation of plant extract: One gram fresh and healthy leaves of *D. plumieri* were crushed in a mortar with pestle by adding small quantity of distilled water and filtered it through four layered muslin cloth. The final volume was made 100 ml with distilled water (1.00%). In the same manner, 1.0 % alcoholic extract was prepared. These 1.00 % aqueous and alcoholic extracts act as stock solutions, from where various concentrations were prepared by using distilled water or absolute alcohol. These were used for treatments during seed germination in petridish method and foliar spray in field experiments.

B) Germination tests: Germination tests of *Sorghum vulgare*varieties CSH-7 and M35-1 were performed in the petridish in the laboratory for seven days at room temperature. Nine hundred healthy seeds of each variety were surface sterilized with 0.1% Mercury chloride and then rinsed thoroughly with distilled water. Out of these, hundred seeds were put in each petridish and various concentrations (0.25%, 0.50%, 0.75% and 1.00%) of aqueous and alcoholic extracts of *D. plumieri*were applied to each individual petridish whereas the distilled water was used as control treatment. The germination percentage, root, shoot and seedling length were measured after the day seven. For biomass production the fresh weight, dry weight and moisture content were recorded. The experiment was repeated thrice and the data were statistically analyzed.

C) Field experiments*:* The seedlings of both the varieties of *S. vulgare*were raised in the fertile soil in the earthen pots. After one month of their normal growth the seedlings were foliar sprayed with the increasing concentrations

(0.25%, 0.50%, 0.75% and 1.00%) of the aqueous and alcoholic extracts of *D. plumieri* twice a weak. After one month treatment, the plants were uprooted and used for growth analysis.

Result and Discussion

The findings of present investigation indicate that under the laboratory bioassay, the process of seed germination in bothCSH-7 and M35-1 varieties of *Sorghum vulgare* was inhibited byall the concentrations of alcoholic extract of *D. plumieri*. Further to clarify the lowest concentrations of alcoholic extract such as 0.05%, 0.10%, 0.15% and 0.20% were used for treatments and which were also inhibited the seed germination. The allelopathic effect of aqueous extract of *D. plumieri* leaves on seed germination and seedling growth of *Sorghum vulgare* var. CSH-7 and M35-1 was further studied in detail and recorded in Table 1. It is found that the germination percentage was reduced in both the varieties of *S. vulgare* with the increasing concentrations and more reduction was observed in M35-1 variety as compare to CSH-7. The reduction in root length in both the varieties was directly proportional tothe increasing concentrations of aqueous extract with the exception of 1.00% concentration in M35-1 variety where it was slightly increased but less than the control. The same trend was observed with respect to total height of seedling. The shoot length in CSH-7 and M35-1 varieties was also decreased with the increasing concentrations of aqueous extract of *D. plumieri*. The fresh weight per seedling in both the varieties was decreased due to allelochemicals present in the aqueous extract but it did not show a definite pattern. The seedling dry weightin M35-1 variety was decreased at lower concentration, increased at moderate concentrations and remained more or less same as that of control at 1.00% concentration. On the contrary, it was increased in CSH-7 variety. The moisture content per seedling in both the varieties was also decreased due to aqueous extract of *D. plumieri*.

Seed germination and initial seedling growth are energy depending process. The root and shoot length indicate the productive efficiency of a crop. However, allelopathy is mostly studied in germination bioassays to know the physiological processes and structural characteristics involved in seed germination, which is important for establishment of plant species in their natural environment (2).

According to El-Shora and Abd El-Gawad (3), the influence of allelochemicals usually occurs in the early stage of plants causing inhibition of seed germination and/or seedling growth. The influence of leaf extract on seed germination seems to be mediated through a disruption of normal cellular metabolism rather than through damaging of organelles. The process of reserve mobilization usually takes place rapidly during early stage of seed germination seems to be delayed or decreased under allelopathy stress conditions (4,5). Allelopathic phytochemicals act by inhibiting the germination of plants thereby disrupting the cell division, interfering with the mechanism of energy transfer and limiting water and nutrient uptake (6).

The inhibitory effects of different allelochemicals on seed germination, seedling growth, root and shoot length, fresh and dry weight of the seedlings, etc. has been recorded by Singh and Hazarika (7) in soybean and groundnut, Ashrafi *et al.* (8) in *Sinapis arvensis* and *Setaria viridis*, Cai and Mu (9) in *Glycine max*, Singh and Sunaina (10) in *Lycopersicon esculentum*.

On the contrary, Baeshen (11) observed that the aqueous extract of *C. sativa*, *M. peperina* and *E. sativa* at different concentration levels enhanced the germination percentage, radical length, plumule length, fresh and dry weights of *Lens culinaris* seedlings.

Joshi *et al.* (12) studied the allelopathic effects of root and bark extracts of *Prunus jacquemontii* on *Raphanus sativa* and observed that as compare to aqueous extract all solvent extracts shown more inhibition of germination and

growth parameters. Magalhaes *et al.* (13) used different organic solvents for preparation of plant extracts of *Butia capitata* pyrenes and studied the allelopathic effects on germination of lettuce seeds (*Lactuca sativa* cv. Capitata). The radical growth was more inhibited by pure organic solvents than distilled water and the hexane extract wasmore inhibitory, followed by methanol and ethyl acetate extracts. This indicates that most of allelochemicals become more soluble in organic solvent and hence shows more inhibitory actions.

In both the varieties of *Sorghum vulgare*, roots were appeared to be more sensitive to allelopathic effects than shoot and which is in agreement with the results of Tefera (14) and Wakjira *et al.* (15).

Table 1: Allelopathic effect of aqueous extract of *Duranta plumieri*leaves (Petri dishes method) on Seed germination and Growth parameters of *Sorghumvulgare* varieties.

Variety	Parameter	Control	0.25%	0.50%	0.75%	1.00%
CSH-7	Root length	6.73	4.20	2.45	1.56	1.16
	Shoot length	6.41	4.28	4.82	4.60	4.47
	Total height	13.14	08.48	07.27	06.16	05.63
	Fresh weight	0.093	0.092	0.080	0.092	0.078
	Dry weight	0.022	0.032	0.028	0.034	0.025
	Moisture content	0.071	0.060	0.052	0.058	0.053
	Germination %	98	96	96	94	94
M 35-1	Root length	1.09	0.77	0.68	0.43	063
	Shoot length	4.17	3.15	2.95	2.49	2.43
	Total height	05.26	03.92	03.63	02.92	03.06
	Fresh weight	0.073	0.068	0.069	0.072	0.064
	Dry weight	0.030	0.028	0.032	0.035	0.030
	Moisture content	0.043	0.040	0.037	0.037	0.034
	Germination %	90	88	82	84	84

* Each value is mean of three determinations.

Values are expressed as g of fresh weight, dry weight and moisture content per seedling.

Values are expressed as cm of root length, shoot length and total height per seedling.

The results of the field experiment (Foliar sprayed) represented in Table 2 and 3 showed that all the growth parameters including root length, shoot length and total height of the plants in both CSH-7 and M35-1 varieties of *S. Vulgare* were decreased with increasing concentrations of both aqueous and alcoholic extracts of *D. plumieri*. The root length in both the varieties was significantly influenced as the concentration of both aqueous and alcoholic extract increased. The most effective reduction among all the treatments was observed at 1.00% alcoholic extract as compare to aqueous extract.

The reduction in shoot length in both the varieties was also directly proportional to the increasing concentrations of both the extracts. The maximum reduction was recorded at higher concentrations in M35-1 variety and especially due to alcoholic extracts. As both the root and shoot length were reduced it resulted into reduction of total height of plant in both the varieties of *S. vulgare*. However, the root to shoot ratio in CSH-7 variety was increased when plants were foliar sprayed with increasing concentrations of aqueous extract with the exception

of 0.25% concentration where it was slightly decreased (5.41%) as compare to control. Similarly, it was also increased due to lower concentration of alcoholic extract and finally decreased by 2.70% as compare to control at 1.00% concentration. The root to shoot ratio in M35-1 variety was also increased with the increasing concentrations of aqueous extract and only at higher concentration of alcoholic extracts. On the contrary, it was decreased by 12.5% and 8.33% as compare to the control at 0.25% and 0.50% alcoholic extracts, respectively.

Table 2: Allelopathic effect of aqueous and alcoholic extracts of *Duranta plumieri* leaves (Foliar spray) on Growth parameters of *Sorghum vulgare* var. CSH-7

Treatment	Control	Aqueous Extract				Alcoholic Extract			
Growth Parameters		0.25%	0.50%	0.75%	1.00%	0.25%	0.50%	0.75%	1.00%
Root Length	22.07 ± 2.77	20.38 ± 1.86	20.04 ± 1.32	17.07 ± 2.09	15.19 ± 1.53	19.92 ± 1.54	18.86 ± 1.34	16.23 ± 2.02	13.84 ± 1.70
Shoot length	59.18 ± 9.44	57.63 ± 7.29	50.55 ± 5.27	45.40 ± 11.7	39.88 ± 6.14	50.28 ± 7.36	46.38 ± 7.26	42.02 ± 7.27	39.20 ± 6.28
Total height of the plant	81.25 ± 9.89	78.01 ± 8.29	70.59 ± 4.82	62.47 ± 13.4	55.07 ± 6.54	70.20 ± 7.58	65.24 ± 7.71	58.25 ± 8.68	53.04 ± 6.16
Root/Shoot ratio	00.37	00.35	00.40	00.38	00.38	00.40	00.41	00.39	00.36

Table 3: Allelopathic effect of aqueous and alcoholic extracts of *Duranta plumieri* leaves (Foliar spray) on Growth parameters of *Sorghum vulgare* var. M 35-1

Treatment	Control	Aqueous Extract				Alcoholic Extract			
Growth Parameters		0.25%	0.50%	0.75%	1.00%	0.25%	0.50%	0.75%	1.00%
Root Length	25.95 ± 1.66	24.33 ± 1.76	24.14 ± 1.28	21.59 ± 1.41	19.36 ± 1.04	22.03 ± 1.60	18.24 ± 1.28	16.05 ± 1.36	14.34 ± 1.06
Shoot length	106.62 ± 14.77	97.74 ± 8.34	97.22 ± 8.60	75.83 ± 17.66	63.82 ± 12.26	89.31 ± 15.64	82.37 ± 15.46	63.41 ± 12.50	50.05 ± 13.67
Total height of the plant	132.57 ± 14.07	122.07 ± 7.98	121.36 ± 8.85	97.42 ± 18.57	83.18 ± 12.51	112.34 ± 16.89	100.61 ± 15.46	79.46 ± 13.03	64.39 ± 14.48
Root/Shoot ratio	00.24	00.25	00.25	00.29	00.30	00.21	00.22	00.25	00.29

Each value is a mean of ten observations.

Values are expressed as cm of root length, shoot length and total height per seedling. ± S. D.

The increased root to shoot ratio due to both aqueous and alcoholic extracts in CSH-7 and except at lower concentrations of alcoholic extracts in M35-1 variety indicated that shoot growth was more affected than the root growth.

Photo 1: Allelopathic effect of aqueous extract of *Duranta plumieri* leaves (Petriplate method) on Seed germination of *Sorghum vulgare* variety-CSH-7.

Photo 2: Allelopathic effect of aqueous extract of *Duranta plumieri* leaves (Petriplate method) on Seed germination of *Sorghum vulgare* variety-M35-1.

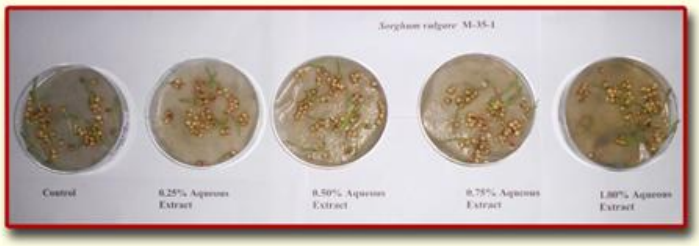

Photo 3: Allelopathic effect of alcoholic extract of *Duranta plumieri* leaves (Petriplate method) on Seed germination of *Sorghum vulgare* variety-CSH-7.

Photo 4: Allelopathic effect of alcoholic extract of *Duranta plumieri* leaves (Petriplate method) on Seed germination of *Sorghum vulgare* variety-M35-1.

Thobayet *et al.* (16) reported that leaf extract of *Zizyphus spina-christi* when used for irrigation caused decrease in the total root length, root surface area, number of tips and root volume of *Prosopis juliflora* and on the contrary leaf extracts of *Prosopis juliflora* stimulated all the parameters of *Zizyphus spina-christi* roots. Various reasons such as presence of phenolic compounds or reduced cell division, synthesis of carbohydrates, proteins, nucleic acids have been proposed for inhibition of shoot growth under the allelochemicals stress. According to Siddiqui and Zaman (17), the allelochemicals reduce the chlorophyll and porphyrin contents in the targeted plants which in turn effects the photosynthesis and ultimately the plant growth. According to Elisanate *et al.* (18), the

allelochemicals action on plants is known to be a diverse action and it includes a large number of biochemical reactions resulting into their modifications and affecting the growth of the plants.

From the present results it is clear that the reduced chlorophyll contents, mobilization of metabolites or reduced cell division might be responsible for reduction in growth of *Sorghum vulgare* varieties due to allelochemicals present in the leaves of *Duranta plumieri*.

Conclusion

From the present investigation, it can be concluded that under laboratory bioassay alcoholic extract of *Duranta plumieri* has more potential of inhibiting seed germination and seedling growth of *Sorghum vulgare* varieties CSH-7 and M35-1 as compare to aqueous extract. The findings of this study also demonstrated that in the field experiments all the growth parameters including root length, shoot length, total height of the plants were significantly reduced when the plants were sprayed with the increasing concentrations of both the aqueous and alcoholic extracts. The allelochemicals present in *Duranta plumieri* leaves are more soluble in organic solvents such as alcohol and its inhibitory effects seemed to be more severe during seed germination rather than during further growth of *Sorghum vulgare*.

References

1. Stamp, N. (2003). Out of the quagmire of plant defense hypotheses. *Quarterly Review of Biology, 78*(1), 23–55.
2. Matilla, A. (2004). Ecofisiologia de la germination de semillas. In M. J. Reigosa, N. Pedrol, & A. Sanchez (Eds.), *La ecofisiologia vegetal*. Thompson.
3. El-Shora, H. M., & Abd El-Gawad. (2014). Evaluation of allelopathic potential of *Rumex dentatus*. *Journal of Stress Physiology and Biochemistry, 10*, 167–180.
4. Gniazowska, A., & Bogatek, R. (2005). Allelopathic interaction between plants: Multi-site action of allelochemicals. *Acta Physiologiae Plantarum, 27*, 395–407.
5. Mishra, A. (2015). Allelopathic properties of *Lantana camara*. *International Research Journal of Basic and Clinical Studies, 3*, 13–28.
6. Abu-Romman, S., Shatnani, M., & Shibli, R. S. (2010). Allelopathic effects of spurge (*Euphorbia hieroslymitana*) on wheat (*Triticum durum*). *American-Eurasian Journal of Agricultural and Environmental Science, 7*(3), 298–302.
7. Singh, R., & Hazarika, U. K. (1996). Allelopathic effects of *Galinsoga parviflora* and *Bidens pilosa* on germination and seedling growth of soybean and groundnut. *Allelopathy Journal, 3*(1), 89–92.
8. Ashrafi, Y., Rahnavard, A., & Sadeghi, S. (2010). Allelopathic potential of sunflower (*Helianthus annuus*) against seed germination in *Sinapis arvensis* and *Setaria viridis*. *Indian Journal of Weed Science, 42*, 82–87.
9. Cai, S. L., & Mu, X. Q. (2012). Allelopathic potential of aqueous leaf extracts of *Datura stramonium* on *Glycine max*. *Allelopathy Journal, 30*(2), 235–246.
10. Singh, N. B., & Sunaina. (2014). Allelopathic stress produced by bitter gourd (*Momordica charantia*). *Journal of Stress Physiology and Biochemistry, 10*(2), 5–14.
11. Baeshen, A. A. (2014). Assessment of the effect of some medicinal plant extracts on germination and growth of lentil (*Lens culinaris*). *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5*(3), 1846–1853.

12. Joshi, R. K., Prasad, D., Pande, C. B., Rawat, M. S. M., & Pant, G. (1997). Allelopathic effect of root and bark extracts of *Prunus jacquemontii* on *Raphanus sativa*. *Allelopathy Journal, 4*(2), 329–334.
13. Magalhaes, H. M., Lopes, P. S. N., Silverio, F. O., *et al.* (2012). Effects of *Butia capitata* pyrenes extracts on germination of lettuce seeds. *Allelopathy Journal, 30*(1), 49–61.
14. Tefera, T. (2002). Allelopathic effects of *Parthenium hysterophorus* on seed germination and seedling growth. *Journal of Agronomy and Crop Science, 188*, 306–310.
15. Wakjira, M., Berecha, G., & Bulti, B. (2005). Allelopathic effects of *Parthenium hysterophorus* extracts on lettuce. *Tropical Science, 45*, 159–162.
16. Thobayet, S., *et al.* (2009). Effects of leaf extracts of *Zizyphus spina-christi* and *Prosopis juliflora* on each other seedlings roots. *Allelopathy Journal, 23*(1), 111–118.
17. Siddiqui, Z. S., & Zaman, A. U. (2005). Effects of *Capsicum* leachates on germination, seedling growth and chlorophyll accumulation in *Vigna radiata*. *Pakistan Journal of Botany, 37*, 941–947.
18. Elisanate, F., Tarimo, M. T., & Ndakidemi, A. (2013). Allelopathic effects on plant growth and chlorophyll content. *American Journal of Plant Sciences, 4*, 2332–2339.