▼ Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan.
Vol. 24-25, Nos. 1-4 January-October 2013-14, pp. 01-23 ISSN 1021-1012

SCREENING FAISALABAD FLORA FOR ALLELOPATHIC POTENTIAL

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Abstract

Indiscriminate pesticidal usage has fabricated harsh effects on environment, human and animal health. None chemical pest control is therefore gaining attraction now a days; allelopathy has emerged as natural technique of pest management in recent years in this regard. Various plants were sampled from different parts of Faisalabad and their extracts were prepared in Weed science and Allelopathy Laboratory, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan. The extracts were then applied to the maize seeds to check their allelopathic activity. Total phenolic, EC and pH of the extracts were determined to find out the relation between allelopathic activity and their biochemical properties. Results showed that 62 plants had significant inhibitory effect (>20% inhibition) where as 35 plants had significant promotory effect (>20%). Plant water extracts of *Heliotropium europoeum, Rumex dentatus, Tribulus terestris, Sesbania sesban* and *Trianthema portulacastrum* showed highest inhibitory effect where as *Gossypium arboreum, Cassia fistula, Conyza ambigua and Quercus Virginia* had highest promotory effect. Positive correlation was found between inhibition percentage, and phenolic contents. From preliminary screening about 32 plants were selected and further checked against lettuce and these selected plant were used as natural bio-herbicide on three noxious weeds of wheat (*Cronopus didymus, chenopodium murala* and *Avena futua*). Resulted aqueous extracts should be used as potent plants on their allelopathic behavior for natural integrated crop management.

Keywords: Allelopathy, Flora, Maize, Pesticide, Pest management.

INTRODUCTION

Pest management is a key factor in successful crop production. Allelopathy is one of the basic phenomena in which growth of the one plant influenced positively or negatively by the action of the release of substance by another plant. A plant having potential to produce

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allelochemicals is called the "donor plant," while the plant which is found in the nearby environment of donor plant and is affected by allelochemicals produced by donor plant is called affected "receiver plant." Both receiver and donor plants can affect each other through competition and allelopathy. The combined effect of these two interactions has been termed "interference" [Muller 1969]. Naturally, allelopathy is a vital environmental friendly science because it can decrease the use of synthetic pesticides and herbicides by the action of allelochemicals [Honga 2003]. Main affect of allelopathy is that it improves the quality and quantity of crop and also suppresses the weeds to prevent the environment from hazardous effects [Fujii 2001]. Though, we cannot stop the usage of pesticides, it is possible to reduce its dose by exploiting allelopathy [Rejila and Vijayakumar 2011].

The rising concentration in allelopathy has been motivated by the appreciation that application of allelopathy may offer alternative to synthetic herbicides for weed management [Romeo and Wu 1999] and it is fit standard that allelopathy has prospective for weed control [Rice 1984, An *et al*. 1998]. Laboratory bioassay improved the maximum association of allelopathy [Foy 1999]. Several bioassays have been developed to discover the function of allelopathy in plants interaction [Pederson 1986]. Many of works have been made to improve laboratory bioassays about crops with strong allelopathic potential for weed management. Scientists have been working on the screening bioassays for the determination of allelopathic potential plants for weed reduction. These bioassays can be divided into different aspects as chemical screening, seedling screening, field screening etc. The objective of screening bioassays is to argue the basic methodology for the estimation of strong allelopathic potential plants. Many studies have reported allelopathic activity of different plants. Seventy plant species native of Japan have been identified for allelopathy by applying water extraction method and it has been documented that plants showed strong allelopathic activity [Fujii *et al.* 1991 a]. About 78 medicinal plants showing allelopathic activity have been screened using the solvent (water and methanol) extraction method [Fujii *et al.* 1991 b].

Suitable use of allelopathic plants in agriculture could reduce the pesticide application and thereby reduce the environmental and food pollution, decrease costs in agriculture, improve food security in poor regions and soil productivity, and increase biodiversity and sustainability in the agro-ecosystems [Duke *et al.* 1993]. The need for finding various allelopathic plants for weed control is indispensable [Xuan *et al.* 2003]. Observation of new plants having strong allelopathic potential, which may result in greater weed control and provide soil enrichment which is very important to reduce dependence on synthetic herbicide in the present agricultural production [Dayan *et al.* 2003].

Many of the plants that have been already determined to have strong allelopathic potential for weed management are Mungbean, Maize, Brassica, Sunflower, Mulberry, Rice, and sorghum. Allelopathic plants have strong inhibitory effect due to the presence of phenols which plays an important role in allelopathy aspect as in sorghum (2-hydoxy 5-methyl-3-p-benzoquinone), rice (Ergosterol peroxide, P-coumaric acid and 7-oxo-stigmasterol), brassica (Nitriles, Isothiocyanates and Oxazolidinethione) and in sunflower (Isochlorogenic acid, Chlorogenic acid, Scopolin and á-naphthol) [Siddiqui *et al.* 2009].

The purpose of this study was to evaluate of allelopathic activity/potential of various new plants in Faisalabad district. Plants across the Faisalabad had been collected and their extracts evaluated in terms of their inhibitive and promotive effect on the test species (*Zea mays* L.). Phenolic contents, pH and electric conductivity were determined to find out the relationship between phenolic contents and inhibitory effect. Moreover, water extracts having higher inhibitory potential were checked against different noxious weeds of wheat to explore new bioherbiscides.

MATERIALS AND METHODS

Laboratory experiments were conducted to screen Faisalabad flora for allelopathic potential against the test specie maize (*Zea mays* L.). These experiments were carried out on different trials consisting of 10-15 plant species. The proposed study was carried out in weed science and allelopathy laboratory, Department of Agronomy, University of Agriculture, Faisalabad. Experiments were laid out in completely randomized design. Experiments were comprised of following aspects. Plants were collected across Faisalabad on the basis of following characteristics:

1. The plant having stronger growth and invasion than the others in plant population.
2. The plant having less natural weed density in its canopy and surroundings than other plants in their ecosystem.
3. The common fruit and crop plants.
4. The plants already known having allelopathic potential.

Plant species were taken in the weed science and allelopathy laboratory of Department of Agronomy, University of Agriculture, Faisalabad and fresh leaves, stem and roots of these plants were separated, cleaned several times by tap water in order to remove dirt and dust, chopped into 1 cm length, dried at 70 ºC and then were ground into powder. One gram of this dried material was taken and mixed with 20 ml of distilled water. These solutions were filtered by filter papers. After that, the extracts were kept at 4 °C until use. Maize and lettuce seeds were used as the test plant in this experiment because it is strongly sensitive to allelochemicals at low concentration. Commercial seeds of maize were provided by Ayub Agriculture Research Institute (AARI), Faisalabad. The seeds were randomly selected and germination test was conducted. Nine seeds of maize sowed in a 9 cm Petri dish, on filter paper, and 3 ml aliquot of the extracts sprayed. Control treatment received only distilled water. All treatments were placed in a growth chamber at 25 ºC.

The number of seeds germinated was counted daily up to 10 days after which germination ceased. Seeds were considered germinated, when the radical was of 2 mm. Fifteen days after sowing, total germinated seeds were counted and germination %age was calculated by using the following formula for each replication of treatment.

$$\text{Germination \%age} = (\text{Germinated Seeds/Total Seeds}) \times 100$$

It was calculated from 2nd day of experiment to check when first seed of the each treatment was germinated upto 2 mm. The germination index (GI) was calculated as described by the Association of official Seeds Analysts (1983) by using the following formula:

$$GI = \frac{\text{No. of germinated seeds}}{\text{Days of first count}} + - - - - - - - + \frac{\text{No. of germinated seeds}}{\text{Days of final count}}$$

Time taken to 50% germination of seedlings (T_{50}) was calculated according to the following formulae modified by Farooq *et al.* [2005]. Where N is the final number of germinated seeds and ***ni*** and ***nj*** cumulative number of seeds germinated by adjacent counts at times ***ti*** and ***tj*** when *ni<N/2< nj*.

$$T50 = ti + \frac{(N/2) - ni)(tj - ti)}{nj - ni}$$

At the time of harvesting after 15 days of trials, root length was measured by using scale. Out of nine plants, three plants were selected for measuring the root length in centimeters (cm). Similarly shoot length was also measured at the time of harvest of trials. Three, out of nine plants were selected which showed vigorous growth. Measuring scale was used to get data of shoot length in centimeters (cm). Electrical balance was used to measure the total plant weight. Before measuring, each plant was washed with distilled water gently. Three plants with healthy growth were selected for measuring the weight in gram (g).

Selected three healthy growing plants were separated from each of replication and put in the separate envelope. Then it was placed in oven at 70 ºC for 48 hours. After this, each of plant weight was measured by electrical balance in grams (g). Water extract of these different plants species were also measured with EC meter to determine the EC and pH. For this, Electrode was neutralized with their respective magnesium chloride and hydrogen chloride solution and got the standard reading. After this, reading of each water extracts was measured carefully.

1. The procedure to determine the phenolic contents in the water extract
2. Put 0.1 ml or 100 ul sample, a gallic acid calibration standard, or blank (deionized or distilled water) into a 1-cm, 2-ml plastic or glass cuvette.
3. Add 7 ml distilled water, followed by 0.5 or 500 ul folin reagent µl FC reagent.
4. Mix thoroughly by pipetting or inverting and incubate 1 to 8 min.
5. Add 1.5 ml sodium carbonate solution, mixed, and incubated 2 hr at room temperature.
6. Measure sample absorbance at 765 nm.

The selected plant water extracts which had strong allelopathic potential were tested against different wheat weeds as wild oat(*avena futua*), Kurand (*Chenopodium murale*), Jangli halon (*Cronopus didymus*); in Weed science and Allelopathic laboratory (Ahmad and Shaikh, 2003). The data collected was analyzed using the Fisher's analysis of variance function of statistics computer package and LSD at 5% probability was used to compare the treatment's means [Steel *et al.* 1997].

RESULTS AND DISCUSSION

EFFECT OF DIFFERENT PLANT WATER EXTRACTS ON GERMINATION OF MAIZE (*Zea Mays* L.)

Germination Percentage

Germination percentage expresses the proportion of total number of seeds that are alive. All the plant aqueous extracts showed allelopathic activity either positive or negative towards germination of maize seeds. The results revealed that water extracts of *Heliotropium europoeum, Rumex dentatus, Sesbania sesban, Chenopodium album, Dactyloctenium aeguptium, Capris deciduas* and *False amaranth* showed highest inhibition (more than 50 %) on the seed germination of test plant. Dandelot *et al.* [2008] worked on the two aquatic species to determine the allelopathic effect against cress and lettuce growth, germination, mortality, yield percentage and seedling growth. He reported the inhibitory effect of selected plants on the germination due to higher allelopathic potential.

Time to Start Germination

Data presented in Table 1 showed that time to start germination of maize was affected by the application of selected plant water extracts over control. Data showed that plant water extracts of Trianthema portula-castrum, Heliotropium europoeum, Rumex dentatus, Chenopodium spp, Tribulus terestris, Portulaca oleracea Raya grass, Jacaranda mimosifolia, Sesbania sesban and Kochia scoparia negatively affected the maize germination and got maximum time to start germination (4.00 days) as compared to control (2.00 days) at 25 ºC. Amoo *et al.* [2008] revealed that reason beyond the decrease in time to start germination may be due to the allelopathic activity of plants which affect the vigor of seeds.

Table 1: Screening Faisalabad flora for allelopathic potential against maize.

Trial 1

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	1.control	2.00	7.83±0.29	5.72±2.39	2.2±0.17	100
1	*Oryza sativa*	2.00	5.25±0.35	1.95±0.56	3.1±0.58	100
2	*Capsicum annuum*	2.00	3.65±0.76	1.20±0.26	3.1±0.59	55.6
3	*Sesamum indicum*	2.00	2.92±0.55	0.80±0.09	2.8±0.55	92.6
4	*Phoenix dactylifera*	2.00	4.00±0.49	0.75±0.06	2.0±0.24	66.7
5	*False amaranth*	2.00	3.54±0.30	0.64±0.07	2.0±0.17	40.7
6	*Trianthema portulacastrum*	4.00	5.34±0.86	0.38±0.18	2.1±0.08	57.0
7	*Hibiscus esculentus linn*	2.00	2.38±0.16	0.47±0.17	3.1±0.59	77.8
8	*Sorghum bicolor*	2.00	4.53±0.44	0.68±0.13	3.1±0.63	85.2
9	*Phyllanthus emblica*	3.00	2.28±0.37	0.39±0.19	2.6±0.61	70.7
10	*Psidium guajava*	2.00	1.75±0.32	0.82±0.39	2.3±0.60	88.9

Trial 2

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	2.control	2.00	5.82±0.24	5.82±0.24	2.6±0.22	100
1	*Chlorophytum comson*	2.00	4.58±0.54	2.29±0.27	2.8±0.23	92
2	*Heliotropium europoeum*	4.00	6.25±0.36	0.60±0.05	2.3±0.45	46
3	*Cassia fistula*	2.00	6.08±0.27	1.56±0.09	2.4±0.35	100
4	*Ficus religiosa*	2.00	5.46±0.18	1.09±0.04	2.8±0.52	88
5	*Pseudosasa japonica*	2.00	5.13±0.33	0.86±0.05	2.7±0.25	88
6	*Gossypium arboreum*	2.00	5.87±0.44	0.84±0.06	3.0±0.37	84
7	*Acacia karoo*	3.00	5.69±0.71	0.71±0.09	2.8±0.22	60
8	*Ficus bengalensis*	2.00	5.37±0.48	1.88±0.17	2.9±0.22	92
9	*Eucalyptus camaldulensis*	2.00	5.64±0.50	0.61±0.03	3.1±0.28	96

Trial 3

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	3.control	2.00	6.63±0.33	3.65±0.22	2.33±0.17	100
1	*Broussanetia papyrifera*	3.00	5.30±0.89	3.51±0.22	2.56±0.24	53
2	*Rumex dentatus*	4.00	7.31±0.36	3.19±0.34	1.78±0.59	48
3	*Scripus maritimus*	2.00	5.87±0.29	3.75±0.23	2.66±0.20	62
4	*Ricinus communis*	2.00	5.56±0.62	3.22±0.01	2.00±0.00	68
5	*Dalbergia sissoo*	2.00	5.64±0.54	3.68±0.26	2.54±0.40	65
6	*Datura stramonium*	2.00	4.87±0.86	3.60±0.43	2.15±0.30	66
7	*Chenopodium album*	2.00	5.53±0.34	3.32±0.04	2.38±0.07	50
8	*Sorghum halepense*	3.00	6.06±0.73	3.80±0.51	1.90±0.10	58
9	*Dactyloctenium aeguptium*	3.00	7.27±0.46	3.41±0.19	2.08±0.09	50
10	*Berberis lyceum*	2.00	6.55±0.70	3.38±0.13	2.76±0.46	69

Trial 4

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	4.control	2.00	6.04±1.19	6.04±1.19	1.3±0.25	100
1	*Zea mays*	2.00	5.03±0.27	2.51±0.14	2.4±0.83	72
2	*Chenopodium spp*	4.00	5.03±0.27	0.41±0.12	1.6±0.13	66
3	*Demostchya bypinata*	3.00	6.83±0.34	0.88±0.17	1.6±0.04	61
4	*Chenopodium album*	2.00	4.50±0.24	0.90±0.05	2.4±0.80	69
5	*Bracharia fotlis*	2.00	4.69±0.76	0.78±0.13	3.1±1.05	72
6	*Capris deciduas*	2.00	2.86±0.82	1.44±0.37	2.6±0.73	49
7	*Kekavacacia nilotica*	2.00	3.50±0.69	0.85±0.04	3.2±0.85	92
8	*Abelmoschus esculentus*	3.00	4.47±0.61	0.50±0.07	2.4±0.85	61
9	*Mangifera indica*	3.00	4.72±0.10	0.47±0.01	3.5±0.71	69

Trial 5

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	5.control	2.00	2.8±0.38	3.04±0.22	2.2±0.17	100
1	*Parthenium hysterophorus*	2.00	2.4±0.49	3.28±0.38	2.1±0.22	63
2	*Catharanthus roseus*	3.00	2.4±0.29	3.40±0.24	2.6±0.51	74
3	*Terminalia catappa*	3.00	3.4±0.77	2.97±0.19	2.1±0.24	77
4	*Citrulus colocynthis*	2.00	3.1±0.20	2.96±0.20	1.8±0.10	91
5	*Ficus bengalensis*	2.00	3.1±0.20	2.96±0.20	1.8±0.11	78
6	*Syzyginum cumini Jaman*	3.00	3.7±0.37	3.45±0.25	1.8±0.11	51
7	*Acanth famly*	2.00	3.9±1.18	3.23±0.35	2.4±0.39	88
8	*Caradinea spp*	2.00	2.5±0.50	2.77±0.17	2.1±0.17	91
9	*Achyranthus aspara*	2.00	2.7±0.33	3.01±0.21	1.7±0.03	91

10	*Nerium oleandra*	2.00	3.7±0.47	3.13±0.05	1.9±0.08	100
11	*Saccharum spp*	3.00	2.9±0.51	3.00±0.20	1.9±0.07	77
12	*Tribulus terestris*	4.00	4.2±0.38	2.78±0.16	1.8±0.12	51
13	*Oxalis cornoculata*	2.00	2.9±0.46	3.03±0.22	1.9±0.08	78
14	*Rhapidophyllum hystrix*	2.00	2.9±0.45	2.83±0.20	2.1±0.22	64

Trial 6

No.	PLANTS	aTSG	bGI	cMGT	dT50%G	eGP
	6.control	2.00	2.58±0.21	2.07±0.66	1.9±0.08	100
1	*Euphorbia hirta*	2.00	3.84±1.24	1.10±0.60	2.8±0.74	69
2	*Alternathra chiloxeriods*	3.00	6.78±0.95	1.80±0.28	1.9±0.08	88
3	*Ficus spp*	3.00	6.54±0.32	1.33±0.41	1.9±0.31	81
4	*Morus alba*	2.00	5.35±0.76	1.08±0.16	2.1±0.44	77
5	*Echinochloa colonum*	2.00	5.86±1.40	0.81±0.30	2.5±0.76	77
6	*Conyza ambigua*	3.00	6.11±0.43	1.15±0.18	1.8±0.04	92
7	*Sphenoclea zeylanica*	2.00	7.10±0.75	0.93±0.13	3.3±0.83	81
8	*Alstonia actinophylla*	2.00	4.40±1.78	0.71±0.06	1.8±0.11	77
9	*Casia fistula*	2.00	3.74±0.91	1.00±0.60	3.4±0.82	65
10	*Parthenium hysterophorus*	2.00	4.03±0.86	0.60±0.16	3.4±0.69	73
11	*Carthamus oxyacantha*	2.00	5.09±0.22	0.63±0.19	3.3±0.83	81
12	*Quercus Virginia*	2.00	4.55±0.57	0.50±0.12	2.6±0.75	85
13	*Saraca asoca*	2.00	5.37±0.85	0.44±0.09	2.0±0.27	69
14	*Portulaca oleracea*	4.00	7.12±0.95	0.34±0.17	1.8±0.16	52
15	*Achyranthus aspara*	2.00	4.71±0.53	0.64±0.32	2.3±0.36	73

Trial 7

No.	PLANTS	aTSG	bGI	cMGT	dT50%G	eGP
	7.control	2.00	5.17±0.29	2.62±0.03	1.8±0.10	100
1	*Raya grass*	4.00	1.98±0.56	3.77±0.57	3.1±0.41	66
2	*Pothos scandens*	3.00	3.90±0.62	3.83±0.29	1.9±0.07	79
3	*Eribotrya japania*	3.00	5.17±1.91	4.24±0.21	3.2±1.03	75
4	*Hibiscus rosa-sinensis*	2.00	5.11±0.62	4.41±0.12	3.0±1.06	83
5	*Bombay ceibalium*	2.00	4.99±0.72	4.39±0.10	3.6±0.97	96
6	*Dalbergia sissoo*	2.00	4.44±0.69	4.75±0.18	4.8±0.39	100
7	*Ruscus aculeatus*	3.00	5.17±0.49	4.36±0.11	3.0±1.09	60
8	*Panicum granatum*	2.00	4.93±1.45	4.36±0.21	3.0±0.61	83
9	*Duranta erecta*	2.00	6.13±1.11	3.75±0.60	2.9±1.17	55
10	*Certculia*	2.00	5.76±0.46	4.26±0.04	1.8±0.11	79
11	*Alstonia scholaris*	2.00	4.11±0.76	4.59±0.07	3.7±0.36	71

12	*Euonymus fortunei*	2.00	4.69±1.10	4.63±0.15	3.3±0.80	78
13	*Rosa arvensis*	2.00	5.29±0.36	4.47±0.20	4.0±1.18	92
14	*Pseudois nayaur*	2.00	4.26±0.46	4.55±0.11	3.3±0.66	75
15	*Amelanchier alnifolia*	2.00	4.68±0.82	4.52±0.14	3.3±0.71	79

Trial 8

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	8.control	2.00	8.54±0.74	3.70±0.07	2.0±0.26	100
1	*Cedrela tona*	2.00	5.20±1.15	3.69±0.05	3.0±0.29	88
2	*Jacaranda mimosifolia*	4.00	7.44±0.84	3.88±0.07	1.8±0.12	68
3	*Syzyginum cumini*	2.00	4.00±0.74	4.10±0.06	2.3±0.44	96
4	*Oxallis corniculata*	2.00	6.03±0.87	3.90±0.03	2.8±0.17	88
5	*Callistemon brashyandrus*	2.00	5.71±0.63	3.77±0.13	2.3±0.47	73
6	*Thevetia peruviana*	2.00	4.04±0.48	4.10±0.17	3.1±0.29	73
7	*Nerium oleandra*	3.00	6.44±0.71	3.80±0.05	2.3±0.23	85
8	*Blepharis ciliaris*	2.00	7.42±0.44	3.70±0.08	2.5±0.29	88
9	*Saccharum officinarum l.*	2.00	6.29±1.62	3.82±0.15	2.6±0.51	81
10	*Grewia asiatica*	2.00	6.72±1.36	3.77±0.05	3.3±0.07	85
11	*Ricinus communis l.*	2.00	5.31±1.35	3.96±0.24	2.6±0.52	77
13	*Thevetia nerifolia*	2.00	4.90±0.22	4.00±0.13	2.9±0.43	81
14	*Ficus bengalensis*	3.00	7.27±1.02	3.78±0.09	1.7±0.12	72

Trial 9

No.	PLANTS	[a]TSG	[b]GI	[c]MGT	[d]T50%G	[e]GP
	9.control	2.00	5.84±0.66	3.87±0.16	2.2±0.93	100
1	*Carosendra eranthinumum*	2.00	2.97±1.04	3.52±0.41	4.2±1.42	59
2	*Erythrina suberosa*	2.00	2.68±0.62	3.66±0.51	4.8±0.71	67
3	*Catharanthus rosea*	2.00	3.44±0.31	3.44±0.34	3.8±1.50	70
4	*Tabebuia rosea*	2.00	3.25±0.27	3.32±0.22	5.7±1.70	74
5	*Sesbania sesban*	4.00	4.33±0.70	2.79±0.04	3.2±0.87	41
6	*Zinnia elagans*	2.00	2.90±0.32	3.75±0.20	3.5±1.23	79
7	*Monstira deliciosa*	3.00	3.22±0.49	3.32±0.26	4.8±0.71	74
8	*Bambusa vulgaris*	2.00	3.61±1.15	3.36±0.36	3.2±1.09	69
9	*Ficus benmenica*	2.00	2.94±0.36	3.42±0.35	6.4±0.95	70
10	*Alopecurus agrestis*	2.00	2.83±0.75	3.51±0.37	4.2±1.66	59
11	*Eurema hecabe*	2.00	2.51±0.55	3.80±0.23	3.2±0.88	76
12	*Jasminum officinate*	2.00	2.25±0.17	3.63±0.06	4.5±0.42	87
13	*Cordyline terminalis*	2.00	3.58±0.30	3.17±0.28	3.4±0.76	57

Trial 10

No.	PLANTS	aTSG	bGI	cMGT	dT50%G	eGP
	10.control	2.00	5.78±0.52	3.26±0.07	2.3±0.47	100
1	*Lagistomia indica*	2.00	3.75±0.57	3.19±0.07	1.8±0.17	56
2	*Aloe barbadensis*	2.00	4.00±0.57	3.26±0.07	2.3±0.47	58
3	*Nycthanthes arbor-tristis*	2.00	3.92±0.17	3.24±0.01	2.0±0.03	69
4	*Terminalia arjuna*	2.00	4.08±0.55	3.28±0.06	2.4±0.44	81
5	*Portulaca oleracea*	2.00	5.08±0.57	3.21±0.05	2.2±0.45	73
6	*Cassia fistula*	2.00	5.00±0.55	3.26±0.04	2.3±0.41	81
7	*Euphorbia helioscopia*	2.00	4.81±0.81	3.22±0.04	2.3±0.43	77
8	*Kochia scoparia*	4.00	4.44±0.77	3.19±0.04	1.9±0.09	75
9	*Moringa oleifera*	2.00	7.56±0.53	3.14±0.05	2.2±0.49	77

a**TSG,** Time to start germination, b**GI,** Germination index, c**MGT,** Mean germination time, d**T50%G,** Time to 50% germination, e**GP,** Germination percentage

Germination Index

The increase in germination index of maize may be due to decrease in vigor of seeds and negative allelopathic activity of different groups of plant species also plays an important role in this regard. Among the different groups of plant water extracts which reduced the maize germination percentage by 40-79% the following plant species as *Heliotropium europoeum, Dactyloctenium aeguptium*, *Duranta erecta, Berberis lyceum, Jacaranda mimosifolia* and *Ficus bengalensis* have maximum GI. These findings are in line with the work reported by Fatunbi *et al.* [2009] who observed the allelopathic potential of *Acacia mearnsii* L.

Mean Germination Time

Among the groups of allelopathic plants water extracts, some of the plant species showed least values of mean germination as compared to treatments follows as *Heliotropium europoeum, Tribulus terestris*, *Rumex dentatus,Sesbania sesban* and *Trianthema portulacastrum.*The findings results are also obtained by Mubeen *et al.* [2011] who worked on rice by two different experiments in Petri dishes and sand on germination and seedling aspects.

Time to 50% Germination

Among the different (40-79% maize seeds germination percentage) of allelopathic plants water extracts; some plant species showed lowest values of time to 50% germination given as *Heliotropium europoeum, Tribulus terestris*, *Rumex dentatus,Sesbania sesban* and *Trianthema portulacastrum.* Reason beyond the decrease in T50%G of maize may be due to the allelopathic activity of plant aqueous extracts. It is also observed that reduction in time to 50% germination may be decreased in vigor of maize.

Similar results are also obtained by Mubeen *et al.* [2011] who worked on rice by two different experiments in Petri dishes and sand on germination and seedling aspects.

So, it is concluded that all of the treatments affected on the maize germination through different aspects as time to start germination, mean germination time, germination index and time to 50% germination. But among the parameters time to 50% germination showed irregular values it's because of irregular germination of maize seeds during the trials. It is suggested from the findings that maize germination varied affected due to the allelopathic potential of different plants water extracts. Decrease in vigor of seeds also an important factor in the increase/decrease values of germination of seeds.

EFFECT OF DIFFERENT PLANT WATER EXTRACTS ON GROWTH OF MAIZE (*ZEA MAYS* L.)

All the plant aqueous extracts showed allelopathic activity either improved or decreased the germination of maize seeds. The results revealed that water extracts of *Heliotropium europoeum, Rumex dentatus, Sesbania sesban, Chenopodium album, Dactyloctenium aeguptium, Capris deciduas* and *False amaranth* showed highest inhibition (>50 %) on the seed germination of test plant.Similar results are also obtained by Mubeen *et al.* [2011] who worked on rice by two different experiments in petri dishes and sand on germination and seedling aspects. Different allelopathic water extracts *Trianthema portulacastrum* L., *Dactyloctenium aegyptium* L. and *Eleusine indica* L. were obtained by soaking in water at (1:20 w/v) for 24 h at room temperature. He concluded that *Trianthema portulacastrum* L. has strongly allelopathic effect which was determined by significantly results from mean germination time and time taken to 50% germination.

Effect of different selected plant water extracts on the root length of maize and inhibition percentage based on root length is presented in Table 2. The results showed that 60 plants water extracts had inhibitory effect whereas 30 plants had promotory effect. Rest of the 55 plants did not showed significant inhibitory or promotory effect compared to control. *Heliotropium europoeum,Rumex dentatus*, *Tribulus terestris* and *Sesbania sesban* had highest inhibitory effect (>70%). The data showed that reduction in shoot length varied among the allelopathic plant extracts based on the inhibition percentage. Plant water extracts showed highest inhibitory potential and decreased shoot length of maize as *Heliotropium europoeum* (0.96±0.15), *Rumex dentatus* (2.19±0.06), *Tribulus terestris* (4.09±0.06) and *Sesbania sesban* (6.76±0.39) as compared to control. Four of the treatments which had strong inhibition percentage >70%

dominantly decreased the biomass of maize as *Heliotropium europoeum* (0.96±0.02, 0.58±0.03), *Rumex dentatus* (0.83±0.00, 0.32±0.00), *Tribulus terestris* (1.47±0.02, 0.47±0.02) and *Sesbania sesban* (2.21±0.11, 0.59±0.04). Same results were also in lined with Verma and Rao [2006] who worked on some water extract of weeds *Ageratum conyzoides* L., *Cynodon dactylon* L., *Parthenium hysterophorus* L., and *Solanum nigrum* L. (10% w/v) against PS – 1042,PK – 416 and Shilajeet varieties of soybean (*Glycine max* L.). He concluded that water extracts of weeds had both inhibitory and promotry effect on germination and growth of the test species.

So, it may be considered that allelopathic plant water extracts decreased the biomass of maize plants due to the presence of strong allelopathic potential. Reduction in biomass depended on the inhibition percentage among the treatment compared to control. Among the different selected plant water extracts; some of the plants species minimized the fresh weight of maize as compared to other treatments given as *Heliotropium europoeum, Rumex dentatus*, *Tribulus terestris* and *Trianthema portulacastrum* and *Sesbania sesban.* Inhibition percentage of these said allelopathic water extracts observed more than 70% which dominantly decreased the biomass of maize.

Table 2: Effect of different plant water extracts on growth of maize (Zea mays L.)

Trial 1

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	1.control	16.97±0.81 bc	5.32±0.34 bc	2.19±0.08 abc	0.65±0.04abc	0
1	*Oryza sativa*	18.79±1.44 ab	3.29±0.18 ef	2.27±0.02 d	0.77±0.03 ab	-11
2	*Capsicum annuum*	14.02±0.34 cd	4.71±0.24 c	2.03±0.13 bcd	0.76±0.03 a	17
3	*Sesamum indicum*	19.59±1.15 ab	6.98±0.58 a	1.95±0.06 cd	0.66±0.04abc	-15
4	*Phoenix dactylifera*	19.03±1.60 ab	6.38±0.34 ab	2.29±0.05 ab	0.57±0.06 c	-12
5	*False amaranth*	15.26±0.08 c	5.17±0.55 def	2.22±0.06 abc	0.56±0.04 bc	10
6	*Trianthema portulacastrum*	6.17±1.60 f	1.56±0.28 g	1.75±0.13 a	0.51±0.04 bc	64
7	*Hibiscus esculentus linn*	21.17±1.07 a	4.40±0.31 cd	2.00±0.08 cd	0.57±0.04 bc	-25
8	*Sorghum bicolor*	11.03±1.41 de	2.22±0.31 c	2.24±0.09 abc	0.68±0.06abc	35
9	*Phyllanthus emblica*	8.63±0.27 ef	3.16±0.12 f	2.32±0.08 d	0.59±0.04abc	49
10	*Psidium guajava*	20.65±1.40 a	3.72±0.12cde	2.20±0.03 abc	0.71±0.02 ab	-22

Trial 2

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	2.control	6.10±0.07 cd	2.78±0.24 cd	1.08±0.04 c	0.63±0.02 cd	0
1	*Chlorophytum comson*	4.27±0.63 f	1.24±0.12 f	1.04±0.03 cd	0.64±0.03 cd	30
2	*Heliotropium europoeum*	0.99±0.13 g	0.96±0.15 f	0.96±0.02 d	0.58±0.03 d	84
3	*Cassia fistula*	9.08±0.30 b	2.47±0.17 de	1.09±0.01 c	0.81±0.00 a	-49

4	*Ficus religiosa*	6.99±0.60 ef	1.20±0.12 de	1.20 ±0.04 c	0.75±0.01 ab	-15
5	*Pseudosasa japonica*	5.770.46 cd	2.63±0.29 f	1.27±0.02 ab	0.75±0.03 ab	5
6	*Gossypium arboreum*	11.33±0.72 def	5.40±0.30 de	1.12±0.01 a	0.64±0.01 ab	-86
7	*Acacia karoo*	2.52±0.49 a	2.02±0.20 a	1.01±0.03 cd	0.60±0.01 cd	59
8	*Ficus bengalensis*	7.87±0.53 g	3.48±0.08 e	1.23±0.04 bc	0.71±0.02 d	-29
9	*Eucalyptus camaldulensis*	7.02±0.31 bc	3.88±0.26 bc	1.09±0.03 a	0.75±0.00 bc	-15

Trial 3

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	3.control	16.68±0.64 a	6.66±0.25 a	1.21±0.02 cde	0.47±0.02 a	0
1	*Broussanetia papyrifera*	6.48±0.24 cd	2.47±0.03 d	0.98±0. 02 ef	0.41±0.01 ab	61
2	*Rumex dentatus*	4.42±0.28 d	2.19±0.06 d	0.83±0.00 f	0.32±0.00 c	73
3	*Scripus maritimus*	10.17±0.61 b	5.29±0.17 bc	1.13±0.04 cde	0.36±0.00 bc	39
4	*Ricinus communis l.*	7.06±0.37 cd	5.17±0.25 c	1.03±0.05 def	0.40±0.01 abc	58
5	*Dalbergia sissoo*	10.21±0.33 b	6.43±0.34 ab	1.35±0.01 abc	0.38±0.00 bc	39
6	*Datura stramonium*	8.21±0.20 bc	4.98±0.13 c	1.58±0.02 a	0.40±0.00 abc	51
7	*Chenopodium album*	11.03±0.67 b	6.80±0.09 a	1.280.01 bcd	0.36±0.01 bc	34
8	*Sorghum halepense*	10.49±0.62 b	4.78±0.17 c	1.22±0.07 cde	0.48±0.02 a	37
9	*Dactyloctenium aeguptium*	6.49±0.52 cd	5.40±0.26 bc	1.16±0.06 cde	0.36±0.00 bc	61
10	*Berberis lyceum*	6.82±0.41 cd	5.99±0. 17 abc	1.50±0.06 ab	0.40±0.00 abc	59

Trial 4

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	4.control	11.76±0.85 a	8.03±0.56 bc	1.90±0.12 abc	0.04±0.01 efg	0
1	*Zea mays*	12.44±0.55 a	6.88±0.29 cd	1.92±0.14 abc	0.04±0.01 def	-6
2	*Chenopodium spp*	7.09±0.99 c	3.93±0.60 e	1.82±0.21 c	0.04±0.01 abcd	40
3	*Demostchya bypinata*	10.41±0.64 b	6.44±0.47 e	1.95±0.24 c	0.05±0.02 g	11
4	*Chenopodium album*	11.88±0.38 a	8.09±0.27 d	2.07±0.01 abc	0.06±0.02 fg	-1
5	*Bracharia fotlis*	13.14±1.16 a	7.15±0.55 bc	1.84±0.04 abc	0.04±0.01 bcde	-12
6	*Capris deciduas*	13.18±0.95 a	8.83±0.16 cd	2.49±0.22 bc	0.06±0.02 cde	-12
7	*Kekavacacia nilotica*	12.87±0.79 a	9.69±0.29 ab	2.47±0.25 a	0.06±0.02 ab	-9
8	*Abelmoschus esculentus*	13.12±1.15 a	8.21±0.24 a	2.46±0.14 a	0.06±0.02 a	-12
9	*Mangifera indica*	13.03±0.78 a	8.20±0.36 bc	2.13±0.14 ab	0.04±0.01 abc	-11

Trial 5

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	5.control	15.76±0.78 a	8.03±0.33 abcd	1.90±0.12abcd	0.56±0.04abc	-0
1	*Parthenium hysterophorus*	10.70±0.58cd	9.33±0.15 a	1.92±0.2 abcd	0.53±0.04bcd	32
2	*Catharanthus roseus*	8.29±0.73 de	6.13±0.39 e	1.67±0.22 cd	0.60±0.03 ab	47
3	*Terminalia catappa*	8.11±0.58 de	7.86±0.40 abcde	1.84±0.15abcd	0.43±0.02 d	49
4	*Citrulus colocynthis*	12.74±0.65abc	9.07±0.37 ab	2.40±0.21 a	0.51±0.03bcd	19

5	*Ficus bengalensis*	11.08±0.30bcd	7.82±0.09 abcde	1.76±0.24 bcd	0.59±0.01 ab	30
6	*Syzyginum cumini Jaman*	6.29±0.30 ef	6.57±0.31 de	1.58±0.22 d	0.56±0.03abc	60
7	*Acanth famly*	12.56±0.33abc	7.30±0.42 bcde	1.85±0.24abcd	0.60±0.03 ab	20
8	*Caradinea spp*	10.59±0.40 cd	8.84±0.40 abc	2.27±0.14 ab	0.64±0.02 a	33
9	*Achyranthus aspara*	12.12±0.77abc	8.82±0.30 abc	2.24±0.09 abc	0.58±0.02 ab	23
10	*Nerium oleandra*	10.52±0.16 cd	7.84±0.18abcde	1.91±0.06abcd	0.57±0.02 ab	33
11	*Saccharum spp*	8.16±0.62 de	6.67±0.33 de	1.93±0.17abcd	0.60±0.03 ab	48
12	*Tribulus terestris*	3.59±0.01 f	4.09±0.06 f	1.47±0.02 d	0.47±0.02 cd	77
13	*Oxalis cornoculata*	10.80±0.82 cd	7.13±0.29 cde	2.01±0.05abcd	0.55±0.04abc	31
14	*Rhapidophyllum hystrix*	7.66±0.87 de	4.01±0.08 f	1.52±0.06 d	0.54±0.02 bc	51

Trial 6

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	6.control	13.28±0.90 de	7.59±0.40 de	2.35±0.34 bcd	0.42±0.04 ab	0
1	*Euphorbia hirta*	10.44±0.88 ef	7.16±0.25 de	1.91±0.16 defg	0.41±0.03 ab	24
2	*Alternathra chiloxeriods*	8.67±0.63 f	8.34±0.39 cd	2.38±0. 17bcde	0.37±0.02 ab	37
3	*Ficus spp*	14.44±0.61 bcd	8.46±0.36 cd	2.55±0.16 gh	0.49±0.03 ab	-4
4	*Morus alba*	14.92±0.95 bcd	6.01±0.13 ef	2.43±0.07 gh	0.49±0.02 ab	-8
5	*Echinochloa colonum*	13.51±0.56 de	8.38±0.17 cd	1.83±0.03 efgh	0.42±0.05 ab	1
6	*Conyza ambigua*	18.68±0.38 a	10.32±0.1 ab	3.02±0.01 a	0.39±0.01 ab	-36
7	*Sphenoclea zeylanica*	12.79±0. 22 de	7.97±0.30 cd	2.07±0.18 cdef	0.44±0.05 ab	7
8	*Alstonia actinophylla*	14.61±0.30 bcd	7.78±0.33 cd	2.28±0.13 bcde	0.45±0.04 ab	-6
9	*Casia fistula*	14.18±0.51 cd	8.73±0.28 bcd	2.75±0.19 ab	0.46±0.04 ab	-3
10	*Parthenium hysterophorus*	15.50±0.15abcd	9.44±0.27 abc	2.59±0.09 ab	0.49±0.02 a	-13
11	*Carthamus oxyacantha*	15.51±0.41abcd	9.31±0.28 abc	2.94±0.10 a	0.44±0.05 ab	-13
12	*Quercus Virginia*	17.74±0.24 ab	8.80±0.29 bcd	2.64±0.05 ab	0.42±0.05 ab	-29
13	*Saraca asoca*	16.05±0.96abcd	10.55±0.1 a	1.75±0.04 fgh	0.47±0.03 a	-17
14	*Portulaca oleracea*	4.79±0.13 g	5.12±0.31 f	1.41±0.07 h	0.32±0.05 b	65
15	*Achyranthus aspara*	17.54±0.22 abc	8.40±0.24 cd	2.42±0.12 bc	0.41±0.05 ab	-27

Trial 7

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	7.control	15.53±1.51 ab	12.22±0.66 ab	2.87±0.19 bcd	0.60±0.02 bcde	0
1	*Raya grass*	6.74±1.21 fg	9.18±0.57 cde	2.51±0.25 cde	0.66±0.02 bcd	57
2	*Pothos scandens*	12.13±0.95bcde	9.50±0.58 cde	2.45±0.18 cde	0.57±0.03 def	22
3	*Eribotrya japania*	10.03±0.31 cdef	11.24±1.06 abc	3.05±0.17 abc	0.67 ±0.02 ab	35
4	*Hibiscus rosa-sinensis*	14.62±1.35 ab	13.10±0.83 a	3.94±0.17 a	0.64±0.02 bcd	6
5	*Bombay ceibalium*	18.31±1.04 a	12.32±0.53 a	3.41±0.16 ab	0.58±0.01 de	-18
6	*Dalbergia sissoo*	13.69±1.10 bc	12.23±0.71 ab	2.84±0.16 bcd	0.56±0.02 ef	12
7	*Ruscus aculeatus*	6.88±0.18 fg	9.73±0.87 bcde	2.15±0.23 e	0.59±0.01 cde	58

8	*Panicum granatum*	10.33±1.02 cdef	9.74±0.73 bcde	2.09±0.24 e	0.60±0.02 bcde	33
9	*Duranta erecta*	5.44±1.07 g	7.43±1.19 e	1.87±0.21 e	0.50±0.00 f	65
10	*Certculia*	17.61±1.39 a	13.23±0.69 a	2.97±0.24 de	0.59±0.03 cde	-13
11	*Alstonia scholaris*	8.50±1.08 efg	8.56±0.45 de	1.92±0.17 e	0.66±0.02 abc	45
12	*Euonymus fortunei*	8.99±1.16 defg	8.58±0.82 de	2.14±0.12 e	0.64±0.03 bcd	42
13	*Rosa arvensis*	14.70±0.82 ab	12.73±0.25 a	2.98±0.15 bcd	0.73±0.02 a	5
14	*Pseudois nayaur*	12.49±1.10 bcd	11.060.77 abcd	2.85±0.12 bcd	0.65±0.01 bcd	20
15	*Amelanchier alnifolia*	12.67±1.30 bcd	12.69±0.34 a	2.94±0.12 bcd	0.67±0.02 ab	18

Trial 8

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	8.control	19.18±0.60 ab	9.10±0.27 defg	2.85±0.22 bcde	0.65±0.02 cde	0
1	*Cedrela tona*	13.53±0.59 de	9.52±0.16 cdef	3.06±0.08 bc	0.70±0.03 abc	29
2	*Jacaranda mimosifolia*	9.46±0.50 f	7.92±0.15 g	2.52±0.02 cde	0.59±0.01 e	51
3	*Syzyginum cumini*	13.91±0.50 de	8.60±0.68 efg	2.59±0.07 cde	0.64±0.02 cde	27
4	*Oxallis corniculata*	13.56±0. 49 de	8.56±0.31 fg	2.69±0.15 bcde	0.66±0.02 bcd	29
5	*Callistemon brashyandrus*	14.27±0.71 d	9.39±0.39 cdef	2.98±0.24 bcde	0.72±0.03 ab	26
6	*Thevetia peruviana*	21.13±1.02 a	8.98±0.47 defg	3.31±0.08 ab	0.59±0.03 e	-10
7	*Nerium oleandra*	15.39±0.54 cd	9.56±0.72 cdef	2.46±0.16 de	0.64±0.02 cde	20
8	*Blepharis ciliaris*	13.87±0.99 de	9.64±0.08 cdef	2.77±0.13 bcde	0.64±0.02 cde	28
9	*Saccharum officinarum*	15.25±0.80 cd	10.02±0.31bcde	2.87±0.22 bcde	0.72±0.01 ab	20
10	*Grewia asiatica*	17.02±1.07 bc	10.72±0.39 abc	3.00±0.17 bcd	0.62±0.02 de	11
11	*Ricinus communis l.*	20.49±1.03 a	11.39±0.48 ab	3.19±0.21 ab	0.67±0.02 bcd	-7
13	*Thevetia nerifolia*	15.52±0.55 cd	9.72±0.62 cdef	2.77±0.15 bcde	0.69±0.02 abc	19
14	*Ficus bengalensis*	11.51±0.54 ef	10.14±0.25abcd	3.64±0.14 a	0.74±0.02 a	40

Trial 9

No.	Plants	RL (cm)	SL (cm)	FW (g)	DW (G)	IP (%)
	9.control	24.40±0.38 a	11.16±0.18 bc	3.18±0.21bcde	0.67±0.03abcd	0
1	*Carosendra eranthinumum*	15.42±1.05 c	12.70±0.14 ab	3.44±0.26 bcd	0.71±0.03 ab	38
2	*Erythrina suberosa*	24.41±0.52 a	12.99±0.41 ab	3.84±0.38 bc	0.72±0.04 ab	1
3	*Catharanthus rosea*	25.51±0.95 a	15.22±0.66 a	4.89±0.34 a	0.61±0.01 cd	-3
4	*Tabebuia rosea*	22.58±0.68 ab	12.96±0.47 ab	3.87±0.14 b	0.62±0.03 cd	9
5	*Sesbania sesban*	3.57±0.24 f	6.76±0.39 d	2.21±0.11 f	0.59±0.04 d	86
6	*Zinnia elagans*	14.62±0.66 c	10.07±0.71 bc	3.13±0.39 cde	0.64±0.02abcd	41
7	*Monstira deliciosa*	14.73±0.46 c	9.32±0.18 cd	2.60±0.16 ef	0.66±0.04 bcd	40
8	*Bambusa vulgaris*	26.63±0.84 a	15.00±0.69 a	3.40±0.19 bcd	0.68±0.04abcd	-8
9	*Ficus benmenica*	18.59±0.98 bc	15.26±0.10 a	3.81±0.31 bc	0.62±0.02 cd	25
10	*Alopecurus agrestis*	23.20±0.74 ab	14.80±0.19 a	3.86±0.11 b	0.67±0.03abcd	6
11	*Eurema hecabe*	9.60±0.98 de	9.64±0.48 cd	2.90±0.24 def	0.68±0.03 abc	62

12	*Jasminum officinate*	17.72±1.20 c	14.40±0.49 a	3.61±0.04 bcd	0.72±0.01 ab	28
13	*Cordyline terminalis*	7.64±0.74 ef	9.07±0.69 cd	2.55±0.34 ef	0.69±0.03 abc	70

Trial 10

No.	**Plants**	**RL (cm)**	**SL (cm)**	**FW (g)**	**DW (G)**	**IP (%)**
	10.control	17.07±0.92 b	10.41±0.47 b	2.41±0.00 bc	0.67±0.02 ab	0
1	*Lagistomia indica*	8.56±0.41 c	5.77±0.47 f	1.38±0.15 d	0.53±0.01 c	50
2	*Aloe barbadensis*	12.02±1.57 c	9.52±0.30 bcd	1.80±0.51 cd	0.73±0.02 a	30
3	*Nycthanthes arbor-tristis*	8.86±0.94 c	8.63±0.45 cd	2.89±0.54 b	0.65±0.01 b	48
4	*Terminalia arjuna*	11.07±1.52 c	8.49±0.68 cd	2.07±0.36 cd	0.66±0.02 ab	35
5	*Portulaca oleracea*	10.53±1.31 c	6.44±0.35 ef	1.89±0.21 cd	0.64±0.02 b	38
6	*Cassia fistula*	12.31±1.96 c	9.67±0.59 bc	1.68±0.42 cd	0.65±0.01 b	28
7	*Euphorbia helioscopia*	12.16±1.76 c	10.03±0.17 bc	1.61±0.58 d	0.71±0.02 ab	29
8	*Kochia scoparia*	9.48±0.58 c	7.91±0.09 de	1.52±0.31 d	0.65±0.01 b	44
9	*Moringa oleifera*	22.58±1.17 a	12.96±0.81 a	3.87±0.20 a	0.73±0.01 a	-32

Means are not sharing the same letters within the column and differ significantly @ 5% Probability Level, [a]**RL**, Root Length, [b]**SL**, Shoot Length, [c]**FW**, Fresh Weight, [d]**DW**, Dry Weight, [e]**IP,** Inhibition Percentage

MAIZE GROWTH AS INFLUENCED BY BIOCHEMICAL PARAMETERS WITH NATURAL-ALLELOPATHIC WATER EXTRACTS

The results show that different plants had different contents of phenolic in their leaves. Highest phenolic contents were observed in 286.96 ug/g in *chenopodium* spp, whereas lowest Phenolic contents were noted in the *Achyranthus aspara* i.e. 13.60 µg/g. However, it was observed that the plants having higher amount of phenolic compounds had higher allelopathic activity, in terms of promotory or inhibitory effect. Plant water extracts which strongly inhibited the maize growth showed the highest values of phenolic contents given as *Heliotropium europoeum* (264.63 µg/g), *Rumex dentatus* (249.39 µg/g), *Tribulus terestris* (245.33 µg/g), and *Sesbania sesban,* (277.82 µg/g) compared with the other treatments.The findings was also in lined with Sánchez–Moreiras *et al.* [1999] who reported the allelopathic activity in the Poaceae family due to the presence of phenolic compounds specially hydroxamic acids, flavonoids etc. He resulted that inhibition or stimulatory aspect was directly related to the donor plant. He suggested that naturally, total soluble phenolic contents in plant water extracts exerted their effect during antioxidant activity.

The results of pH and EC are presented in Table 3. Data showed that maximum aqueous extracts which had allelopathic potential were acidic in nature and having maximum EC values. Among all the treatments strongest inhibitory plants (20-70% inhibition in maize growth) observed the acidic pH and increasing EC values given as *Heliotropium europoeum* (6.5, 6421 dS/m), *Rumex dentatus* (6.9, 6852 dS/m), *Tribulus terestris* (6.7, 4191 dS/m) and *Sesbania sesban,* (6.8, 6171 dS/m), *Trianthema portulacastrum* (6.8, 6498 dS/m), *Broussanetia papyrifera* (5.6, 4331 dS/m), *Dactyloctenium aeguptium* (5.5, 6021 dS/m), *Syzyginum cumini* (5.9, 1131 dS/m), *Portulaca oleracea* (6.8, 4051 dS/m), *Duranta erecta* (6.8, 6671 dS/m), *Eurema hecabe* (5.4, 6711 dS/m), *Cordyline terminalis* (5.8, 741 dS/m), *Acacia karoo* (5.5, 1351 dS/m), *Ricinus communis*(5.9, 6421 dS/m), *Datura stramonium* (6.7, 6741 dS/m), *Berberis lyceum* (6.4, 5851 dS/m), *Rhapidophyllum hystrix* (6.5, 1821 dS/m), *Raya grass* (5.5, 4601 dS/m), *Ruscus aculeatus* (5.2, 2571 dS/m), *Jacaranda mimosifolia* (4.6, 1911 dS/m), *Lagistomia indica* (6.3, 3151 dS/m), *Nycthanthes arbor-tristis* (5.9, 3751 dS/m), *Phyllanthus emblica* (5.4, 2872 dS/m), *Catharanthus roseus* (6.5, 1341 dS/m), *Terminalia catappa* (5.3, 2491 dS/m), *Saccharum spp* (5.8, 2671 dS/m), *Alstonia scholaris* (5.7, 3281 dS/m), *Euonymus fortunei* (6.5, 2221 dS/m), *Ficus bengalensis* (5.5, 3771 dS/m), *Zinnia elagans* (6.8, 6771 dS/m), *Monstira deliciosa* (5.6, 4181 dS/m) and *Kochia scoparia* (6.4, 2761).

All of the extracts which have allelopathic potential must be acidic in nature. The pH and electrical conductivity was determined to find out their relationship with the allelopathic activity.

Table 3: Maize (*Zea mays* L.) growth influenced by bio-chemical parameters with natural-allelopathic water extracts.

PLANTS	**Total soluble phenolic contents** (µg Galic acid/g)	pH	EC
Oryza sativa	195.22	6	5511
Capsicum annuum	108.54	5.5	4731
Sesamum indicum	195.38	5.8	5251
Phoenix dactylifera	154.56	6.2	3141
False amaranth	64.290	6.5	6391
Trianthema portulacastrum	271.71	6.8	6498
Hibiscus esculentus linn	180.98	5.6	6491
Sorghum bicolor	140.27	6.8	6375
Phyllanthus emblica	224.20	5.4	2872
Psidium guajava	171.82	5.8	1861
Chlorophytum comson	76.653	5.8	4583
Heliotropium europoeum	264.63	6.5	6421
Cassia fistula	105.70	5.9	2521
Ficus religiosa	146.51	5.6	3761
Pseudosasa japonica	135.82	5.6	4471
Gossypium arboretum	146.57	5.7	4251
Acacia karoo	203.50	5.5	1351
Ficus bengalensis	139.04	6.4	4158
Eucalyptus camaldulensis	158.85	5.5	2371
Broussanetia papyrifera	218.00	5.6	4331
Rumex dentatus	249.39	6.9	6852
Scripus maritimus	124.82	6.1	4211
Ricinus communis	84.4033	5.9	6421
Dalbergia sissoo	118.60	6.5	3871
Datura stramonium	204.45	6.7	6741
Chenopodium album	85.227	5.6	6271

Sorghum halepense	58.397	6.6	3241
Dactyloctenium aeguptium	82.767	5.5	6021
Berberis lyceum	142.87	6.4	5851
Zea mays	37.62	6.7	1591
Chenopodium spp	286.94	6.3	6491
Demostchya bypinata	41.72	7.4	2091
Chenopodium album	16.76	7.6	1361
Bracharia fotlis	17.48	7.2	2781
Capris deciduas	39.32	7.7	3181
Kekavacacia nilotica	14.98	7.7	1341
Abelmoschus esculentus	15.78	5.6	1431
Mangifera indica	18.10	6.2	6491
Parthenium hysterophorus	37.320	6.5	2011
Catharanthus roseus	65.233	6.5	1341
Terminalia catappa	66.800	5.3	2491
Citrulus colocynthis	33.453	7.7	1371
Ficus bengalensis	38.410	6.4	1641
Syzyginum cumini Jaman	173.77	5.9	1131
Acanth famly	17.567	7.1	931
Caradinea spp	45.950	6.4	1451
Achyranthus aspara	36.163	6.3	3421
Nerium oleandra	39.880	6.5	2251
Saccharum spp2.3	91.867	5.8	2671
Tribulus terestris	245.33	6.7	4191
Oxalis cornoculata	36.943	6.7	3321
Rhapidophyllum hystrix	56.460	6.5	1821
Euphorbia hirta	145.12	6.5	1081
Alternathra chiloxeriods	12.06	6.7	1781
Ficus spp	71.61	6.5	1161
Morus alba	8.930	7.5	1124
Echinochloa colonum	54.92	7.2	1331
Conyza ambigua	66.37	6.7	1441
Sphenoclea zeylanica	34.95	7.8	1611
Alstonia actinophylla	91.20	7.1	1551
Casia fistula	48.28	7.3	2161
Parthenium hysterophorus	16.12	6.3	2011
Carthamus oxyacantha	25.95	6.5	1841
Quercus Virginia	25.15	7.5	3421
Saraca asoca	48.93	6.5	1421
Portulaca oleracea	264.22	6.8	4051
Achyranthus aspara	13.60	6.5	2341
Raya grass	232.99	5.5	4601
Pothos scandens	107.80	5.8	4121
Eribotrya japania	137.32	6.1	2761
Hibiscus rosa-sinensis	138.51	6.4	3421
Bombay ceibalium	126.50	6.7	2921
Dalbergia sissoo	160.31	6.5	6121
Ruscus aculeatus	208.94	5.2	2571
Panicum granatum	145.79	4.7	1921
Duranta erecta	251.82	6.8	6671
Certculia	42.447	6.7	1781
Alstonia scholaris	203.83	5.7	3281
Euonymus fortunei	108.56	6.5	2221
Rosa arvensis	104.50	5.4	651
Pseudois nayaur	126.77	6.7	3981
Amelanchier alnifolia	43.327	7.2	6430
Cedrela tona	86.05	4.4	2251
Jacaranda mimosifolia	223.62	4.6	1911
Syzyginum cumini	154.26	4.5	2171
Oxallis corniculata	111.84	5.9	2741
Callistemon brashyandrus	127.32	6	1031

Thevetia peruviana	115.06	5.7	4461
Nerium oleandra	258.18	5.1	1771
Blepharis ciliaris	112.49	6.2	2461
Saccharum officinarum	93.313	6.3	3491
Grewia asiatica	75.460	6.7	1411
Ricinus communis	125.57	6.8	5940
Thevetia nerifolia	90.923	6.6	5091
Ficus bengalensis	162.92	5.5	3771
Carosendra eranthinumum	137.26	6.7	2581
Erythrina suberosa	89.127	4.4	3671
Catharanthus rosea	80.433	5.3	3251
Tabebuia rosea	93.133	6.2	4291
Sesbania sesban	277.82	6.8	6171
Zinnia elagans	143.17	6.8	6771
Monstira deliciosa	144.21	5.6	4181
Bambusa vulgaris	39.270	4.8	2281
Ficus benmenica	95.647	5.3	2741
Alopecurus agrestis	76.907	5.9	4141
Eurema hecabe	152.35	5.4	6711
Jasminum officinate	134.92	5.8	5431
Cordyline terminalis	164.26	5.8	2741
Lagistomia indica	243.94	6.3	3151
Aloe barbadensis	97.597	6.7	6591
Nycthanthes arbor-tristis	183.31	5.9	3751
Terminalia arjuna	64.170	5.7	2681
Portulaca oleracea	95.873	5.7	1821
Cassia fistula	109.71	4.8	4241
Euphorbia helioscopia	26.107	6.5	3471
Kochia scoparia	143.95	6.4	2761
Moringa oleifera	137.62	5.2	6445

*Total soluble phenolic contents (µg Galic acid/g), **pH acidic in nature, ***EC (dS/m)

CORRELATION BETWEEN INHIBITION, EC, PHENOLIC COMPOUNDS AND pH OF ALLELOPATHIC PLANT SPECIES

Correlation between inhibition percentage, EC and pH of the allelopathic plant water extracts presented in Table 4. Data showed that EC correlated significantly with inhibition and pH while non significant with phenolic contents. Similarly, inhibition showed negatively correlated with pH and positive correlated with phenolic contents. On the other hand, data also revealed that pH was non-significant with phenolic compounds. Same results were obtained by Whitehead *et al*. [2002] who worked on the phenolic compounds collected from different sources of plant parts and soil. He determined the pH and phenolic compounds of the aqueous extracts. He found that all the water extracts which showed acidic in pH was due to the presence of phenolic compounds i.e. p-hydroxybenzoic, vanillic, p-coumaric and ferulic acids, p-hydroxybenzaldehyde and vanillin in the plant and plant soil.

So, it is concluded from the data that plants which have allelopathic potential showed maximum inhibition percentage, highest phenolic compounds, acidic in nature and highest EC value.

Table 4: Correlations (Pearson)

	EC	Inhibition	pH
Inhibition	0.4197		
P-VALUE	0.0168		
pH	0.4200	0.3384	
	0.0167	0.0581	
Phenolic	0.3139	0.5432	0.2161
	0.0802	0.0013	0.2350

Cases Included 32 Missing Cases 0 Significance at $P<0.05$

Table 5: Allelopathic potential of selected plant species against lettuce (*Lactuca sativa* L.)

Plants	Inhibition	Plants	Inhibition
Control	9.00	*Berberis lyceum*	6.33±0.67 (29.63)
Heliotropium europoeum	4.00[a]±0.58[b] (55.56[c])	*Rhapidophyllum hystrix*	5.67±0.88 (37.04)
Rumex dentatus	2.67±0.67 (70.37)	*Raya grass*	8.00±0.58 (11.11)
Tribulus terestris	3.33±0.88 (62.96)	*Ruscus aculeatus*	6.00±0.58 (33.33)
Sesbania sesban	4.67±0.33 (48.15)	*Jacaranda mimosifolia*	6.00±0.58 (33.33)
Trianthema portulacastrum	4.00±0.58 (55.56)	*Lagistomia indica*	5.67±1.20 (37.04)
Broussanetia papyrifera	5.67±0.67 (37.04)	*Nycthanthes arbor-tristis*	7.00±0.00 (22.22)
Syzyginum cumini	5.67±0.33 (37.04)	*Phyllanthus emblica*	6.67±0.67 (25.93)
Portulaca oleracea	6.00±1.15 (33.33)	*Catharanthus roseus*	6.67±0.67 (25.93)
Dactyloctenium aeguptium	6.33±0.88 (29.63)	*Terminalia catappa*	8.00±0.58 (11.11)
Duranta erecta	5.67±0.88 (37.04)	*Saccharum spp*	7.00±1.00 (22.22)
Eurema hecabe	7.00±0.58 (22.22)	*Alstonia scholaris*	6.67±0.88 (25.93)
Cordyline terminalis	5.67±0.67 (37.04)	*Euonymus fortunei*	5.67±0.33 (37.04)
Acacia karoo	6.67±0.88 (25.93)	*Ficus bengalensis*	6.33±1.20 (29.63)
Ricinus communis	6.67±1.45 (25.93)	*Zinnia elagans*	7.00±1.15 (22.22)
Datura stramonium	6.00±0.58 (33.33)	*Monstira deliciosa*	7.33±0.33 (18.52)
Kochia scoparia	6.00±0.58 (33.33)		

[a]Mean value [b]Standard error [c]Inhibition percentage

ALLELOPATHIC POTENTIAL OF SCREENED PLANT SPECIES AGAINST LETTUCE (*Lactuca sativa* L.)

Thirty one plant water extracts which showed more than 40 % inhibition in the preliminary bioassay were selected from 144 selected plants for second study. The effect of the screened plants was further verified by evaluating their effect on lettuce root. Data regarding germination of lettuce root was shown in Table 5. Almost similar trend of inhibition was observed in case of maize and lettuce. Highest inhibitory effect was observed by water extracts of Rumex *dentatus* (70.37%), *Tribulus terestris* (62.96%). *Heliotropium europoeum* (55.56%) and *Trianthema portulacastrum*(55.56%). *Sesbania sesban* showed highest inhibition which decreased the germination of lettuce by < 40 %. The higher inhibitory effect of plant water extracts might be correlated with the higher amount of allelochemicals in their plant parts. It is verified by the positive correlation between inhibitory effect of plants and total phenolic contents.

ALLELOPATHIC POTENTIAL OF SCREENED PLANT SPECIES AGAINST THREE NOXIOUS WEEDS OF WHEAT

Five plants having highest inhibition percentage (*Heliotropium europoeum, Rumex dentatus, Tribulus terestris, Sesbania sesban* and *Trianthema portulacastrum*)(more than 70 %) on the lettuce root was further tested against three noxious weeds of wheat(*Cronopus didymus, chenopodium murala* and *Avena futua*) to find out some organic control of said weeds. The results are presented in Table 6. All the extracts significantly reduced the germination of weeds, *Cronopus didymus* and *chenopodium murala* but *Avena futua* (48.55 B)showed maximum reduction by the application of all plants water extracts. On the other hand, *Chenopodium murala* germination was inhibited (65.667 A) as compare to *Cronopus didymus* (77.27 A). It was revealed that germination of the weeds delayed from two to three days due to the application of strong allelopathic water extracts. Similarly, all the water extracts showed significantly reduced the weeds germination compared to control. But *Trianthema portulacastrum* water extract showed dominant reduction in weeds among the other extracts as *Heliotropium europoeum, Rumex dentatus, Tribulus terestris* and *Sesbania sesban*. The findings were in lined with Naseem *et al*. (2009) who worked on the sunflower water extract (1:10 w/v) which was applied on pre-emergence 25+35 DAS of wheat variety Inqlab-91 in the lab. and field. He resulted that after application of extracts, growth of *Phalaris minor* L., *Chenopodium album* L., *Coronopus didymus* L. and *Avena fatua* L. in the wheat were significantly decreased and also increased in the yield except pre-emergence stages.

Table 6. Allelopathic potential of screened plant species against three noxious weeds of wheat

Treatments	***Cronopus didymus***	***chenopodium murala***	***Avena Futua***	**Total Means**
Control	100.00 a	100.00 a	100.00 a	100.00 A
Heliotropium europoeum	70.67 bcde	38.67 fg	38.33 fg	49.22 CD
Rumex dentatus	81.67 abc	83.33 abc	52.33 defg	72.44 B
Tribulus terestris	74.33 abcd	55.33 cdefg	28.67 g	52.89 CD
Sesbania sesban	92.67 ab	61.00 cdef	43.00 efg	65.56 BC
Trianthema portulacastrum	44.33 efg	55.67 cdefg	29.00 g	42.89 CD**
Total Means	77.27 A	65.667 A	48.55 B*	

Significant P<0.05, * Highly significant inhibited weed,

** Highly significant plant inhibitory water extract

CONCLUSIONS

It was concluded that water extracts of *Heliotropium europoeum, Rumex dentatus, Tribulus terestris, Sesbania sesban* and *Trianthema portulacastrum* can be used as natural bioherbiscides to control the weeds of wheat.

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