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Research Article

ALLELOPATHIC POTENTIAL OF *PARTHENIUM HYSTEROPHORUS* AND *TRIDAX PROCUMBENS* AQUEOUS LEAF EXTRACTS ON WEED CONTROL AND GROWTH OF BLACKGRAM (*VIGNA MUNGO* L.)

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Abstract: The pot culture experiment was conducted during September 2018 at Agricultural College and Research Institute, Madurai, 625 104, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, to assess allelopathic potential of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on weeds and growth of blackgram. The experiment was laid out in completely randomized block design with 17 treatments replicated twice. The treatments consisted of pre and early post emergence application of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extract 0.5, 1.0, 2.0 and 3.0 per cent concentration. The results of the experiment revealed that the plant height, leaf area index and dry matter production was significantly influenced by aqueous leaf extract of *Parthenium hysterophorus* 3.0% as pre-emergence (PE) followed by *Tridax procumbens* 3.0% as PE. The data on weeds, total weed density and total dry weight of weeds were significantly reduced under pre-emergence (PE) application of aqueous leaf extract of *Parthenium hysterophorus* at 3.0% followed by *Tridax procumbens* at 3.0% as PE. Further, the weed density and dry weight of weeds were not significantly influenced by other concentrations tried.

Keywords: Allelopathy, Blackgram, Growth and weed control efficiency

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Introduction

Pulses are the important constituent of the Indian diet and supply a major part of the protein requirement. Among the pulse crops, black gram is an important legume crop cultivated worldwide in tropical and subtropical regions. Even though cultivated area is higher the productivity of pulses in India is low. Heavy infestation of weed is one of the predominant reasons among the various factors responsible for the lower yield of black gram. The crop is not a very good competitor against the weeds and therefore weed control initiatives are essential to ensure proper crop growth, particularly in the early growth period. Allelopathy is the direct or indirect effect of plants with one another through producing chemical compounds [1]. The concept that, some of the crop or weed plants may be allelopathic effect to common weeds of agricultural lands is receiving greater attention as an alternative weed control strategy. The allelopathic compounds can be used as natural herbicides and are less disruptive of the global ecosystem than synthetic agrochemicals. The phytotoxic compounds from plants are used in the production of new herbicides and represent a wide range of chemistries and mechanisms of action that have potential in the design and development of new herbicides. Photosensitizes (light-activated compounds) are potentially useful in agriculture as herbicides [2]. Allelopathic effects of weed on weed plays major role in alleleopathic weed management. Most of the weeds have potential natural allelochemicals in terms of terpenoids, monoterpenes, sesquiterpene lactones *etc*. Wide range of terpenoids and fatty acids will receive a great attention in years to come in development of natural products as herbicides [3, 4]. Among the several weeds, phytotoxicity of *Parthenium* has been more pronounced over weeds germination and its early growth stages [5, 6]. The synthetic action of water extract from *Tridax procumbens* on *Vigna radiata* is promoting with the optimum safest concentrations. *T. procumbens* has the allelopathic effect on native weeds therefore, it could be used as herbicide and cover plant for inhibit the growth of weeds. Work was undertaken to study the effect of *Parthenium* and *Tridax* on weed control and growth of blackgram for the eco-friendly weed management.

Materials and Methods

A pot culture experiment was conducted at Agricultural College and Research Institute, Madurai, 625 104, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India during September 2018. The soil used in this study was sandy loam in texture with low in available N (237 kg ha^{-1}), medium in available P (18 kg ha^{-1}) and medium in available K (240 kg ha^{-1}). The organic carbon content of the soil was 0.64 % with pH of 7.4 (Neutral in reaction). The blackgram var. VBN 6 was used for this study. The experiment was laid out in completely randomized block design with 17 treatments and two replications. Totally 34 pots were taken and filled with 7 kg of soil in each pot and three seeds per pot was sown. All pots were watered regularly so that the plants would not suffer from water stress. The treatments comprised of application of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts at 3 Days After Sowing DAS (pre-emergence), 10 DAS (Early post emergence) at four different concentrations of 0.5, 1.0, 2.0 and 3.0 per cent. The leaves of *Parthenium hysterophorus* and *Tridax procumbens* were collected and cut into small pieces, then the leaf pieces were soaked in suspension of alcohol and water (1:1) and kept for overnight. After 12 hours, soaked leaves were ground to paste and then leaf extracts of both weed species were prepared by filtration and kept as a stock solution [7]. From the stock solutions, four different concentrations 0.5, 1.0, 2.0 and 3.0 per cent was prepared and sprayed using hand sprayer as per the treatment schedule. In blackgram, the observation on plant height (15 and 30 DAS), leaf area index and dry matter production was recorded at 30 DAS. The observation on weeds viz., number of grasses and broadleaved weeds (no pot^{-1}), total weed density (10 and 20 DAS), and total dry weight of monocot and dicot weeds (g pot^{-1}) were recorded at 30 DAS. Weed control efficiency (WCE) was computed by adopting a formula suggested by [8] and expressed in percentage.

$$WCE\ \% = \frac{Wpc - Wpt}{Wpc} \times 100$$

Where,
Wpc = Weed population in the control plot.
Wpt = Weed population in the treated plot.

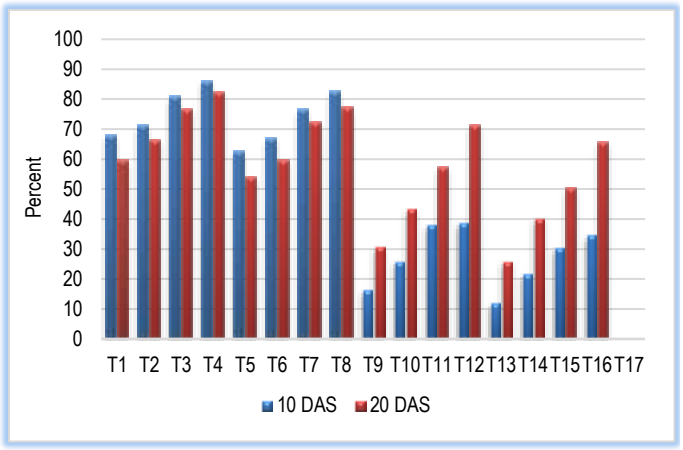

Fig-1 Effect of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on weed control efficiency (%) in Blackgram

Statistical analysis

The data on the weeds and blackgram recorded under different treatments were statistically analyzed as suggested by [9]. The data on weed density and weed dry weight were subjected to square root transformation $\sqrt{(x + 0.5)}$ before analysis. The treatment differences were worked out at five per cent probability level. The non-significant treatment differences were denoted as NS.

Results and Discussion

Effect of allelopathic aqueous extracts on weeds

Weed density

Application of the botanical reduced weed incidence and showed potential weed management efficiency. Various phenolics constituents of *Parthenium* may show herbicidal activity at various concentrations depending on species and other environmental conditions. The coumarins and phenolics compounds derived from cinnamic and benzoic acids interfere to some degree with many vital plant processes, including cell division, mineral uptake, stomatal function, water balance, respiration, photosynthesis, protein and chlorophyll synthesis, and phytohormone activity [10], and may exert oxidative stress [11]. The weed density of grasses, broad leaved weeds and total weed densities were recorded at 10 and 20 DAS of crop growth. *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts significantly reduce the weed density in the pot. At 10 and 20 DAS, the perusal of data revealed that application of *Parthenium hysterophorus* leaf extract at 3.0% as pre-emergence was found effective in limiting weed growth which recorded significantly lower density of grasses (0.97 and 0.97 no pot^{-1}), broad leved weeds (2.83 and 3.24 no pot^{-1}) and total weed density (2.92 and 3.32 no pot-1). Next to this treatment *Tridax procumbens* leaf extract at 3.0% as pre-emergence recorded lower density of grasses 1.22 and 1.41 no pot^{-1}, 3.08 and 3.54 no pot^{-1} broad leaved weeds and total weed density of 3.24 and 3.74 no pot^{-1}. Higher weed density values were recorded in control in which no weed control measures were taken.

Weed dry weight

There was significant influence on allelopathic leaf extracts on weed dry weight at 30 DAS. [12] opined that, weed dry weight is a better parameter to measure the competition than weed number since, it precisely measures the quantity of growth-related factors utilized by the weeds. At 30 DAS the data revealed that, the lowest weed dry weight of grasses, broad leaved weeds and total weed dry weight was observed with application of *Parthenium hysterophorus* leaf extract at 3.0% as pre-emergence (0.80, 1.63 and 1.67 g pot^{-1}, respectively). It was followed by application of *Tridax procumbens* leaf extract at 3.0% as pre-emergence recorded lower dry eight of grasses (0.96 g pot^{-1}), broad leaved weeds (1.88 g pot^{-1}) and total weed dry weight (1.99 g pot^{-1}). Significantly the higher dry matter of grasses, broad leaved weeds and total weed dry weight were noticed in control pot (1.89, 3.98 and 4.35 g pot^{-1}, respectively). This might be due to vegetative growth of the weeds was inhibited by the *Parthenium* extracts and ultimately the dry biomass was decreased whether applied as pre-emergence or post-emergence. *Parthenium* residues were found to be phytotoxic and also rich in phenolics [13]. The presence of phenolics in *Parthenium* residues and their interference with soil chemistry upon release may be responsible for a decrease in the growth of weeds.

Weed Control Efficiency

Weed control efficiency worked out at 10 and 20 DAS on the basis of total weed population. The highest weed control efficiency of 86.09 and 82.34% was recorded in pre-emergence application of *Parthenium hysterophorus* leaf extract at 3.0% at 10 and 20 DAS, respectively. It was followed by *Tridax procumbens* aqueous leaf extract at 3.0% as pre-emergence, in which 82.61 and 77.29% were recorded at 10 and 20 DAS, respectively. The lowest weed control efficiency of 12.61 and 26.03% was observed with *Tridax procumbens* leaf extract at 0.5% as early post emergence at 10 and 20 DAS, respectively. These results were attributed due to decreasing trend of weeds germination, density and biomass with the *Parthenium* leaf extract as foliar spray. When applied at optimum concentrations, these allelochemicals interfere with the cell division, hormone biosynthesis and mineral uptake and transport, membrane permeability, stomatal oscillations, photosynthesis, respiration, protein metabolism and plant water relations [3], which may cause substantial growth reduction. These similar results were also reported by [14].

Effect of allelopathic aqueous extracts on crop growth attributes

Plant height

In general, plant height was increased from 15 DAS to 30 DAS. All the stage of observation, there was significant differences in plant height due to allelopathic aqueous leaf extracts as foliar spray. Application of aqueous leaf extract as pre-emergence had significant influence on plant height compared to early post emergence. Among the different treatments, aqueous leaf extract of *Parthenium hysterophorus* at 3.0% as pre-emergence recorded taller plants of 35 and 57.15 cm at 15 and 30 days, respectively. Next to this treatment plant height of 32 and 54 cm was recorded on aqueous leaf extract of *Tridax procumbens* at 3.0% as pre-emergence and aqueous leaf extract of *Parthenium hysterophorus* at 2.0% as pre-emergence (29.5 and 51.5 cm) at 15 and 30 DAS, respectively. The lower plant height was recorded in control. These results were attributed due to the presence of auxin like substances and other growth promoting hormones in the leaf extracts had enhanced the plant height thus results increase in plant height. These results were in line with the [15]. Similarly, [16] reported that Pre-emergence application of *Parthenium* extracts was more effective in inhibiting the weed germination as compared to post-emergence, thus favours the germination of seed and grow without competition of resources.

Leaf area index (LAI)

Parthenium hysterophorus and *Tridax procumbens* aqueous leaf extracts had significant influence on the leaf area index. Among the different treatments, aqueous leaf extract of *Parthenium hysterophorus* at 3.0% as pre-emergence registered higher leaf area index 3.07 at 30 DAS. It was followed by *Tridax procumbens* at 3.0% as pre-emergence (2.86), *Parthenium hysterophorus* at 2.0% as pre-emergence (2.65) and *Tridax procumbens* at 2.0% as pre-emergence (2.49). This might be due to, application of *Parthenium* leaf extracts as pre-emergence increased the plant height and increased the number of leaves in the plant, hence the higher leaf is index was observed in this treatment. The minimum LAI of 0.91 were recorded under control, in this treatment no weed management practices were taken due to higher weed population reduction in plant height and number of leaves were noticed.

Dry matter production (DMP)

The data pertaining to plant DMP was recorded at 30 DAS.

Table-1 Effect of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on weed density (no pot^{-1}) of Blackgram

T.No.	Treatments	Grasses		Broad leaved weeds		Total weed density	
		10 DAS	20 DAS	10 DAS	20 DAS	10 DAS	20 DAS
T_1	PE *Parthenium hysterophorus* leaf extract at 0.5%	2.00(3.50)	2.24(4.50)	3.94(15.00)	4.47(19.50)	4.36(18.50)	4.95(24.00)
T_2	PE *Parthenium hysterophorus* leaf extract at 1.0%	1.73(2.50)	2.12(4.00)	3.81(14.00)	4.06(16.00)	4.12(16.50)	4.53(20.00)
T_3	PE *Parthenium hysterophorus* leaf extract at 2.0%	1.58(2.00)	1.58(2.00)	3.08(9.00)	3.54(12.00)	3.39(11.00)	3.81(14.00)
T_4	PE *Parthenium hysterophorus* leaf extract at 3.0%	0.97(0.50)	0.97(0.50)	2.83(7.50)	3.24(10.00)	2.92(8.00)	3.32(10.50)
T_5	PE *Tridax procumbens* leaf extract at 0.5%	2.00(3.50)	2.45(5.50)	4.30(18.00)	4.74(22.00)	4.69(21.50)	5.29(27.50)
T_6	PE *Tridax procumbens* leaf extract at 1.0%	1.87(3.00)	2.24(4.50)	4.06(16.00)	4.47(19.50)	4.42(19.00)	4.95(24.00)
T_7	PE *Tridax procumbens* leaf extract at 2.0%	1.73(2.49)	1.87(3.00)	3.39(11.00)	3.84(13.50)	3.74(13.50)	4.12(16.50)
T_8	PE *Tridax procumbens* leaf extract at 3.0%	1.22(1.00)	1.41(1.50)	3.08(9.00)	3.54(12.00)	3.24(10.00)	3.74(13.50)
T_9	EPOE *Parthenium hysterophorus* leaf extract at 0.5%	3.67(13.00)	3.39(11.00)	5.96(35.00)	5.52(30.00)	6.96(48.00)	6.44(41.00)
T_{10}	EPOE *Parthenium hysterophorus* leaf extract at 1.0%	3.24(10.00)	2.92(8.00)	5.74(32.50)	5.10(25.50)	6.56(42.50)	5.83(33.50)
T_{11}	EPOE *Parthenium hysterophorus* leaf extract at 2.0%	2.65(6.50)	2.35(5.00)	5.43(29.00)	4.58(20.50)	6.00(35.50)	5.10(25.50)
T_{12}	EPOE *Parthenium hysterophorus* leaf extract at 3.0%	2.74(7.00)	2.00(3.50)	5.34(28.00)	3.84(13.50)	5.96(35.00)	4.18(17.00)
T_{13}	EPOE *Tridax procumbens* leaf extract at 0.5%	3.87(14.50)	3.61(12.50)	6.04(36.00)	5.66(31.50)	7.14(50.50)	6.67(44.00)
T_{14}	EPOE *Tridax procumbens* leaf extract at 1.0%	3.39(11.00)	3.00(8.50)	5.87(34.00)	5.24(27.00)	6.75(45.00)	6.00(35.50)
T_{15}	EPOE *Tridax procumbens* leaf extract at 2.0%	3.08(9.00)	2.55(6.00)	5.61(31.00)	4.90(23.50)	6.36(40.00)	5.48(29.50)
T_{16}	EPOE *Tridax procumbens* leaf extract at 3.0%	2.92(8.00)	2.24(4.50)	5.48(29.50)	4.06(16.00)	6.16(37.50)	4.58(20.50)
T_{17}	ControlA	4.06(16.00)	4.06(16.00)	6.48(41.50)	6.63(43.50)	7.62(57.50)	7.75(59.50)
	SEd	0.16	0.17	0.09	0.11	0.08	0.14
	CD(P=0.05)	0.33	0.37	0.19	0.23	0.18	0.29

Data were subjected to √(X+0.5) transformation. Figures in parenthesis are original values

Table-2 Effect of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on dry weight of weeds (g pot^{-1}) in Blackgram

T.No.	Treatments	Grasses	Broad leaved weeds	Total weed dry weight
		30 DAS	30 DAS	30 DAS
T_1	PE *Parthenium hysterophorus* leaf extract at 0.5%	1.40(1.47)	2.74(7.02)	3.00(8.49)
T_2	PE *Parthenium hysterophorus* leaf extract at 1.0%	1.32(1.23)	2.60(6.25)	2.82(7.48)
T_3	PE *Parthenium hysterophorus* leaf extract at 2.0%	1.10(0.71)	2.02(3.60)	2.19(4.30)
T_4	PE *Parthenium hysterophorus* leaf extract at 3.0%	0.80(0.14)	1.63(2.15)	1.67(2.29)
T_5	PE *Tridax procumbens* leaf extract at 0.5%	1.39(1.44)	2.97(8.30)	3.20(9.74)
T_6	PE *Tridax procumbens* leaf extract at 1.0%	1.33(1.28)	2.69(6.72)	2.91(8.00)
T_7	PE *Tridax procumbens* leaf extract at 2.0%	1.21(0.97)	2.14(4.07)	2.35(5.04)
T_8	PE *Tridax procumbens* leaf extract at 3.0%	0.96(0.43)	1.88(3.04)	1.99(3.47)
T_9	EPOE *Parthenium hysterophorus* leaf extract at 0.5%	1.74(2.52)	3.19(9.70)	3.57(12.22)
T_{10}	EPOE *Parthenium hysterophorus* leaf extract at 1.0%	1.50(1.75)	3.08(8.97)	3.35(10.72)
T_{11}	EPOE *Parthenium hysterophorus* leaf extract at 2.0%	1.42(1.52)	2.79(7.27)	3.05(8.78)
T_{12}	EPOE *Parthenium hysterophorus* leaf extract at 3.0%	1.31(1.22)	2.21(4.39)	2.47(5.61)
T_{13}	EPOE *Tridax procumbens* leaf extract at 0.5%	1.81(2.78)	3.26(10.15)	3.66(12.93)
T_{14}	EPOE *Tridax procumbens* leaf extract at 1.0%	1.42(1.53)	3.16(9.51)	3.40(11.03)
T_{15}	EPOE *Tridax procumbens* leaf extract at 2.0%	1.40(1.46)	3.06(8.86)	3.29(10.31)
T_{16}	EPOE *Tridax procumbens* leaf extract at 3.0%	1.32(1.25)	2.60(6.29)	2.83(7.53)
T_{17}	Control	1.89(3.08)	3.98(15.36)	4.35(18.43)
	SEd	0.04	0.04	0.04
	CD(P=0.05)	0.09	0.08	0.08

Data were subjected to √(X+0.5) transformation. Figures in parenthesis are original values

Table-3 Effect of *Parthenium hysterophorus* and *Tridax procumbens* aqueous leaf extracts on plant height, leaf area index and dry matter production of blackgram

T.No.	Treatments	Plant height		LAI	DMP
		15 DAS	30 DAS	30 DAS	30 DAS
T_1	PE *Parthenium hysterophorus* leaf extract at 0.5%	19.5	42.8	1.43	0.70
T_2	PE *Parthenium hysterophorus* leaf extract at 1.0%	24.9	45.5	1.91	0.88
T_3	PE *Parthenium hysterophorus* leaf extract at 2.0%	29.5	51.5	2.65	1.43
T_4	PE *Parthenium hysterophorus* leaf extract at 3.0%	35.0	57.15	3.07	2.05
T_5	PE *Tridax procumbens* leaf extract at 0.5%	17.2	39.9	1.25	0.65
T_6	PE *Tridax procumbens* leaf extract at 1.0%	20.6	43.2	1.55	0.83
T_7	PE *Tridax procumbens* leaf extract at 2.0%	27.8	49.3	2.49	1.11
T_8	PE *Tridax procumbens* leaf extract at 3.0%	32.0	54.0	2.86	1.87
T_9	EPOE *Parthenium hysterophorus* leaf extract at 0.5%	15.2	37.75	1.01	0.58
T_{10}	EPOE *Parthenium hysterophorus* leaf extract at 1.0%	15.8	38.4	1.13	0.59
T_{11}	EPOE *Parthenium hysterophorus* leaf extract at 2.0%	18.0	41.5	1.39	0.68
T_{12}	EPOE *Parthenium hysterophorus* leaf extract at 3.0%	26.5	47.4	2.24	0.90
T_{13}	EPOE *Tridax procumbens* leaf extract at 0.5%	14.0	37.5	0.94	0.53
T_{14}	EPOE *Tridax procumbens* leaf extract at 1.0%	15.5	38.1	1.04	0.58
T_{15}	EPOE *Tridax procumbens* leaf extract at 2.0%	16.7	39.3	1.15	0.63
T_{16}	EPOE *Tridax procumbens* leaf extract at 3.0%	23.5	43.75	1.77	0.85
T_{17}	Control	12.0	35.6	0.91	0.51
	SEd	0.66	0.80	0.08	0.07
	CD(P=0.05)	1.38	1.69	0.17	0.14

**PE-Pre-Emergence; EPOE-Early Post Emergence*

The data on DMP revealed that, pre-emergence application of aqueous leaf extract had significant influence on plant dry matter production compared to early post emergence application. Among the different treatments, aqueous leaf extract of *Parthenium hysterophorus* at 3.0% as pre-emergence registered higher dry matter production (2.05 g plant^{-1} at 30 DAS). It was followed by *Tridax procumbens* at 3.0% as pre-emergence (1.87 g plant^{-1}), *Parthenium hysterophorus* at 2.0% as pre-emergence (1.43 g plant^{-1}) and *Tridax procumbens* at 2.0% as pre-emergence (1.11 g plant^{-1}). The minimum DMP of 0.51 g plant^{-1} were recorded under control. [17] Reported that, 3% leaf extract has no inhibitory effect on growth of pulses whereas more than this has negative effect on pulses. From the experiment it could be concluded that application of *Parthenium* and *Tridax* leaf extracts as pre-emergence had synergistic influence on the blackgram. With respect to weeds pre-emergence had negative influence on the total weed density, total weed dry weight and aqueous leaf extracts positively influence the weed control efficiency. Foliar spray of alleolopathic leaf extracts as early post emergence was not any influence on weeds and growth of blackgram.

Application of research: Study of application of *Parthenium* and *Tridax* leaf extracts as pre-emergence had synergistic influence on the blackgram

Research Category: Weed control efficiency

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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