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Original Research Article

Evaluation of Parthenium (*Parthenium hysterophorus L.*) water extract alone and with low doses of herbicide for weed control in wheat

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A B S T R A C T

Keywords

Herbicide dose, Parthenium water extracts, wheat, allelopathy

Allelopathy being an environmentally friendly, sustainable and economical approach is attaining interest of the researchers globally and can help to reduce the problems raised by synthetic chemicals. In order to overcome the harmful effect of herbicide usage, allelopathic water extract of platinum with reduced herbicide doses were tested for weed management in wheat during the year 2011-12 at Koont research farm PMAS, Arid Agriculture University, Rawalpindi. The treatment combinations were the parthenium water extract @ 24 L ha^{-1} combined with reduced doses of Buctril Super 60 EC @ 300, 225, 150 and 75 ml ha^{-1}, respectively. Individual herbicide (Buctril Super 60 EC) treatments @ 750 ml ha-1 full dose and a weedy check were included for comparison. The data recorded at 45 and 75 DAS (days after sowing) showed that water extract @ 24 L ha^{-1} combined with Buctril Super 60 EC@ 150 ml ha^{-1} inhibited total weed density by 38 and 84%, total weeds, fresh weight by 67 and 87% and total weeds dry biomass by 69 and 86% respectively and it increased grain yield by 91% as compared to control. The findings revealed that, alleophathy can be the best option in order to reduce herbicide dose and enhance the wheat yield.

Introduction

Allelopathy is natural, environmentally safe and inexpensive approach (Inderjit and Duke, 2003). Allelopathic interference has been exploited as a weed control strategy and a substitute to the synthetic chemical herbicide (Narwal, 2000; Jabran *et al*., 2008). Parthenium is an allelopathic weed and it may inhibit the germination and growth of several other crop plants and trees. The plant contains parthenin a sesquiterpene lactones, phenolics and fumaric acid (Kanchan and Jayachandra, 1980).

Tefera (2002) reported that parthenium allelochemicals can be used as alternatives for achieving sustainable weed management. Parthenium extract significantly inhibited the seed germination of *Eragrostistef* L. Due to released phytotoxins from leaves (Stephen and Sowerby, 1996). The release of phytotoxic chemicals of platinum might be involved in the decline of plant biodiversity (Adkins and Sowerby, 1996). Its allelopathic effects might be happen through leaching, volatilization, root exudations and by its decomposition (Adkins and Sowerby, 1996; Khan et al., 2012). Inhibition of seed germination and seedling growth of many crops have been reported by parthenium extracts viz, barley (*Hordeumvolgare* L.) and maize (*Zea mays* L.) (Rashid *et al*., 2008). Sesquiterpene lactones, phenolics and in particular parthenin are found to be inhibitory for seed germination and growth in many plants (Swaminathan *et al*., 1990).

Reduction in weed population due to parthenium water extract was reported by (Batish *et al*. 2002a). It is concluded that *Parthenium hysterophorus* L. can be used as a tool for weed management, but still needs comprehensive study to completely explore its potential effects against different types of weeds. Cheema *et al*. (2003) suggested the possibility of combination of allelopathic water extracts with lower herbicide rates for effective weed management. The use of water extract of allelopathic crops alone and with low doses of herbicide is an inexpensive, environmentally safe and effective weed control option (Kim and Shin, 2008).

All over the world, what is the most widely used as staple food grain and in human food is the leading source of vegetable protein (Fahad et al. 2013). It is also an important grain and a staple food crop of Pakistan and accounts for nearly 36% of the total cropped area, 30% of the value added by the major crops and 76% of the total production of food grains (Fahad et al. 2013). Although wheat production has increased in our country, but average yield does not go beyond 30-35% of its optimum potential and this rate is very low as compared to other advanced wheat producing countries of the world (Hussain *et al.*, 2007). To meet the rising demand, wheat production should be 18.86 million tons against present 16.8 million, a shortfall of 2.36 million tons (Hassan, 2007). Among the yield limiting factors, weeds intervention is one of the most important, but less recognized constraints in Pakistan (Fahad et al. 2013). The present research was initiated with the objective to explore the effect of parthenium water extract alone and with low doses of a commercial herbicide for weed management and higher yield of wheat.

Materials and Methods

To investigate the effect of the parthenium water extract alone and with reduced rates of herbicide for weed control in wheat, an experiment was conducted on University Research Farm Chakwal Road, PMAS Arid Agriculture University Rawalpindi during rabbi season, 2011-2012. Wheat variety Chakwal-50 was sown as a test variety at a seed rate of 110 kg ha^{-1}. Individual plot size for each treatment was 6m x 8m with row space of 25 cm. A field experiment was laid out using a RCBD design with four replications and eight treatments. A recommended fertilizer dose (150-120-90 kg NPK ha-1) was applied in the form of Urea, di-Ammonium phosphate and potassium sulphate, respectively in all treatments. Half dose of nitrogen and all the P_2O_5 and K_2O were applied at the time of sowing while remaining half nitrogen was applied with first irrigation.

Procedure to prepare Water Extract

Parthenium plant herbage harvested from the university field area was sundried and chaffed into 2 cm pieces with fodder cutter. To prepare parthenium water extract (W.E) chaffed parthenium parts was soaked in distilled water in 2:10 (2 kg parthenium herbage in 10 L of water) for 24 hours at room temperature (Marwat *et al.*, 2008). The extract was attained by the filtration of the mixture (water and herbage) via screen.The herbicide used was buctril super 60 EC at low (300, 225, 150. 75 ml ha^{-1}) and recommended dose (750ml ha^{-1}). Standard procedures were adopted for recording the data on various growth and yield parameters.

Statistical Analysis

The collected data were subjected to analysis of variance procedure and the means were compared by using LSD at the 5 percent level of probability (Montgomery, 2001).

Results and Discussion

Weed Density (Weeds m-2)

Species such as Convolvulus arvensis L., Fumaria indica L., and Asphodelus tenuifoliuscav. were dominated weeds in the experimental area. Data pertaining to the total weed density recorded at 45 and DAS is demonstrated in Table 1. Weed density was inhibited by all the treatments of aqueous extract of Parthenium hysterophorus L. along with reduced doses of Buctril Super 60 EC as compared to weedy check. Application of parthenium water extract alone had also shown significant effect on the suppression of weed population but the effect was slow. Weed density was reduced by 38 and 84 percent in the plots where parthenium water extract @ 24 L ha-1 + Buctril Super 60 EC @ 150 ml ha-1 was sprayed at 30 and 60 DAS recorded at 45 and 75 DAS, compared to control. Weeds were suppressed by 39 and 77 percent in the plots where parthenium water extract @ 24 Lha-1 + Buctril Super 60 EC @ 75 ml ha-1was applied at 30 and 60 DAS recorded at 45 and 75 DAS, relative to control. Whereas, the application of Buctril Super 60 EC @ 750 ml ha-1 (recommended dose) at 30 DAS reduced weed density by 16 and 75 percent recorded at 45 and 75 DAS, compared to control.

These results were nearly equal to the results presented by Iqbal and Cheema, (2007) who suggested that the synthetic herbicide dose can decrease by 70% in cotton when used in combination with allelopathic crop water extract.

Weeds fresh weight (g m-2)

Data in Table1 showed that parthenium water extract along with reduced doses of Buctril Super60 EC significantly reduced fresh weight of weeds in all treatments as compared to control both at 45 and 75 days after sowing. Foliar application of combined Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 150 ml ha-1 at 30 and 60 DAS decreased weeds fresh weight by 67 and 86 percent recorded at 45 and 75 DAS respectively, compared to control.

Weeds fresh weight was decreased by 58

and 86 percent where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 75 ml ha-1wasapplied at 30 and 60 DAS recorded at 45 and 75 DAS, relative to controls. Hand weeding at 30 and 60 DAS reduced weeds fresh weight over control by 85 and 94 percent recorded at 45 and 75 DAS, respectively. In the plots where alone Parthenium W.E. @ 24 L ha-1 at 30 and 60 DAS was applied had reduced overall weeds fresh weight by 46 and 74 percent compared to control recorded at 45 and 75 DAS, respectively. Whereas Buctril application @ 750 ml ha-1at 30 DAS reduced weed fresh weight by 29 and 80 percent relative to control.

These results are in the line with the findings of Shahid et al. (2007) who studied the influence of aqueous extract of various plants individually and in combination with low rates of herbicides against weeds of wheat. They observed that aqueous allelopathic crop extract alone and in combination with low rates of herbicides significantly reduced weed density and weed biomass relative to control.

Weed dry weight (g m^{-2})

The perusal of the data given in Table 1 recorded at 45 and 75 DAS showed that foliar spray of all the treatments either solely or in combination suppressed weeds dry matter effectively relative to control. Foliar application of parthenium water extract combined with reduced doses of herbicide suppressed weeds dry weight by 69 and 86 percent when Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml ha^{-1} was applied recorded at 45 and 75 DAS, compared to control. Weeds dry weight was reduced by 49 and 84 percent in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 75 ml ha^{-1} was sprayed at 30 and 60 DAS recorded at 45 and 75 DAS, compared to control. In hand weeding plots weeds dry weight was reduced by 77 and 92 percent as compared to control recorded at 45 and 75 DAS, respectively.

Data pertaining to dry weight of weeds indicated that recommended dose of Buctril super 60 EC @ 750 ml ha^{-1}applied at 30 DAS reduced the weeds dry weight by 46 and 84 percent recorded at 45 and 75 DAS, respectively relative to control while the application of sole Parthenium W.E. @ 24 L ha^{-1} at 30 and 60 DAS decreased the weeds dry weight by 46 and 70 percent. Minimum reduction of 41 and 55 percent in dry weight of weeds was recorded in treatment where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 225 ml ha^{-1}applied at 30 and 60 DAS was applied.

The results of a current study supported earlier findings of Sharif *et al*. (2005) and Bhatti*et al*. (2000) who testified that allelopathic plant water extract in combination with low doses of herbicide suppressed total dry weight of weeds significantly over control in wheat.

Wheat growth and Yield

Data about plant height presented in Table 2 showed that Maximum plant height of 73.72 and 72.47cm was recorded in plots sprayed with Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 150 ml ha-1and Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 225 ml ha-1respectively compared to control. Blum (1996) reported that the taller plants were found probably due to better weed control in these treatments favoring plant height.

Table.1 Effect of parthenium (*parthenium hysterophorus* l.) water extract alone and with low doses of herbicide for weed control in wheat on weeds density, weeds fresh weight and weeds day weight all at 45 and 75 DAS

Treatments	Weed density (Weeds m^{-2})		Weed fresh weight ($g\ m^{-2}$)		Weed dry weight ($g\ m^{-2}$)	
	45 DAS	75 DAS	45 DAS	75 DAS	45 DAS	75 DAS
Weedy check (control)	79.25 a (----)	156.25 a (----)	60.945 a (----)	233.03 a (----)	9.75 a (----)	45.10 a (----)
Hand weeding at 30 and 60 DAS	12.25 e (84.54)	14.75 g (90.56)	9.125 e (85.02)	13.6 f (94.16)	2.25 d (76.92)	3.55 f (92.12)
Parthenium W.E. @ 24 L ha^{-1} at 30 and 60 DAS	62.75 bcd (20.82)	52 d (66.72)	33.17 c (45.57)	61.75 cd (73.50)	5.25 b (46.15)	13.43 c (70.22)
Buctril Super 60 EC @ 750 ml ha^{-1} at 30 DAS (recommended dose)	66.5 ab (16.08)	38.5 e (75.36)	43.325 b (28.91)	46.35 de (80.10)	5.25 b (46.15)	7.23 d (83.96)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 300 ml ha^{-1} at 30 and 60 DAS	58.5 bcd (26.18)	69.25 b (55.68)	22.82 d (62.55)	66.75 c (71.35)	3.75 c (61.53)	13.28 c (70.55)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 225 ml ha^{-1} at 30 and 60 DAS	63.75 bc (19.55)	62.25 c (60.16)	43.795 b (28.14)	106.23 b (54.41)	5.75 b (41.02)	20.45 b (54.65)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml ha^{-1} at 30 and 60 DAS	49 cd (38.17)	25.25 f (83.84)	20.375 d (66.56)	31.5 e (86.48)	3 cd (69.23)	6.33 de (85.96)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 75 ml ha^{-1} at 30 and 60 DAS	48 d (39.43)	36.5 e (76.64)	25.7 cd (57.83)	32.2 e (86.18)	5 b (48.71)	7 e (84.47)
LSD (0.05)	14.97	6.01	7.74	16.32	0.87	1.32

Wheat growth and Yield

Table.2 Effect of parthenium (parthenium hysterophorus l.) water extract alone and with low doses of herbicide for weed control in wheat on plant height, fertile tiller, spike length, spikelets per spike, aerial biological yield, grain yield, straw yield and harvest index

Treatments	Plant height (cm)	Fertile tiller (m^{-2})	Spike length (cm)	Spikelets per spike	Grains per spike	Aerial biological yield	Grain yield	Straw yield (kg ha^{-1})	Harvest Index (%)
Weedy check (control)	68.85 b	212.25 c	8.38 b	16.64 c	44.88 c	4010.4 f (-----)	797.8 e (----)	3212.6 d (-----)	19.89 d (-----)
Hand weeding at 30 and 60 DAS	71.22 ab	260 a	9.37ab	17.02bc	53.14 a	5513 b (37.46)	1534.1 a (92.29)	3978.9 ab (23.85)	27.83 a (39.87)
Parthenium W.E. @ 24 L ha^{-1} at 30 and 60 DAS	71.15ab	246.25 b	9.69ab	18.04 a	48.75 b	5158.9 c (28.63)	1303.5 bcd (63.38)	3855.3 b (20.00)	25.26 bc (26.99)
Buctril Super 60 EC @ 750 ml ha^{-1} at 30 DAS (recommended dose)	69.27 b	243.5 b	10.47ab	17.97 a	51.88ab	4737 d (18.11)	1267.9 cd (58.92)	3469.1 c (7.98)	26.76abc (34.52)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 300 ml ha^{-1} at 30 and 60 DAS	70.37 ab	239.5 b	9.48ab	17.22abc	50.28ab	4541.7 e (13.24)	1204.8 d (51.01)	3336.9 cd (3.86)	26.52abc (33.31)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 225 ml ha^{-1} at 30 and 60 DAS	72.47 ab	259.5 a	10.17 ab	18.1 a	51.96ab	5429.7 b (35.39)	1340.9 bc (68.07)	4088.8 a (27.27)	24.70 c (24.15)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml ha^{-1} at 30 and 60 DAS	73.72 a	264.75 a	11.31 a	17.7 ab	52.73 a	5625 a (40.26)	1523.2 a (90.92)	4101.8 a (27.67)	27.09ab (36.15)
Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 75 ml ha^{-1}at 30 and 60 DAS	72.25ab	257.5 a	9.61ab	17.47abc	52.4 a	5416.7 b (35.06)	1402.5 b (75.79)	4014.1 ab (24.94)	25.90abc (30.17)
LSD (0.05)	4.38	9.61	2.39	0.92	3.23	102.64	107.03	160.95	2.23

Maximum number of productive tillers 265 and 260 were recorded in plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 150 ml ha-1 and Parthenium W.E. + Buctril Super 60 EC @ 24 L ha-1 + 225 ml ha-1was applied at 30 and 60 DAS, respectively. Numbers of fertile tillers per m-2 in the plots where sole Parthenium W.E. @ 24 L ha-1was applied at 30 and 60 DAS were 246. These findings are similar to the results of Naseem et al. (2009) who stated that number of fertile tillers increased with the integration of allelopathic extract to the wheat crop.

Data about spike length presented in Table 2 showed that maximum spike length, i.e. 11.31 cm was recorded in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml $ha^{-1}$was applied at 30 and 60 DAS. These results showed that different weed control treatments increased spike length over control. The increase in spike length may be due to the suppression of vegetative growth of weeds (Majeed *et al*., 2012). Data presented in Table 2 demonstrated that the spikelets per spike were significantly influenced by different weed control treatments. The highest numbers of spikelets 18.1 were recorded in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1}+ 225 ml ha^{-1} was applied at 30 and 60 DAS. The effective weed control eventually facilitated healthy crop stand and resulted in the maximum number of spikelets per spike. Effect of allelopathic W.E. along with reduced doses of synthetic herbicide on spikelets per spike in wheat was also reported by Sharif *et al*. (2005).

Data regarding grain per spike indicated that all treatments had caused an increase in grains per spike as compared to control. The highest number of grains per spike, i.e. 52.73 was recorded in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml $ha^{-1}$was applied at 30 and 60 DAS (Table. 2). The difference in the number of grains per spike might be due to weed suppression. These results agreed with Cheema *et al*. (2003) who reported that grains per spike were significantly increased with the application of the allelopathic water extract. Iqbal *et al*. (2010) also reported that increased in grain number per spike in wheat was due to the weed suppression by the application of allelopathic water extracts along with reduced doses of herbicide.

The data documented in Table 2 indicated that hand weeding and foliar application of parthenium water extract along with reduced doses of herbicide significantly affected the biological yield of wheat relative to control. The maximum increase in biological yield with 40 percent over control was recorded in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml $ha^{-1}$was applied at 30 and 60 DAS. In the plots where hand weeding was done increased biological yield was 37 percent over the control. Results are similar to the finding of Mahrajan *et al*. (2007) who concluded that increasing concentration of parthenium water extract exhibited inhibitory impacts on seedling growth and seed germination of cereal crops.

Grain yield of the crop is the function of the interaction of various genetic and environmental factors including the yield components. Any variation in these factors may be variation in grain yield. All the treatments had significant differences between wheat grain yield (Table. 2) . The maximum increase in grain yield, i.e. 91 percent over control was recorded in the plots where Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml ha^{-1} was applied at 30 and 60 DAS. The results confirmed the finding of Cheema *et al*. (2003) who concluded that wheat yield significantly increased due to the application of allelopathic water extracts along with reduced doses of herbicides. These results also supported the finding of Iqbal *et al*. (2010). Straw yield of wheat was also enhanced by all the weed control treatments as compared to control (Table.2). Parthenium W.E. + Buctril Super 60 EC @ 24 L ha^{-1} + 150 ml ha^{-1} applied at 30 and 60 DAS produced maximum straw yield i.e. 4101 kg ha^{-1}. This increased in straw yield due to the combined application of allelopathic crop water extracts and herbicide may be the result of better weed control. Our results are in agreement with the findings of Reeves (2006) who reported that weed control increased dry matter production in wheat.

Results showed that harvest index increased with better weed control, which might be possible because of more nutrient availability in the plots where there is less weed with wheat competition. The results agreed to the work of Jamil *et al*. (2005) who stated that increased in harvest index was due to better weed control in wheat.

Herbicide exposure is at high risk in developing countries like Pakistan, where there is no awareness about the safe use of agro-chemicals. Allopathic research seems to be environment friendly, cost-effective, easy and acceptable to the farming community. 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 weeds.

To demonstrate allelopathy, plant origin, production, and identification of allelochemicals must be established as well as persistence in the environment over time in concentrations sufficient to affect plant species. On the basis of this it may be concluded that the use of parthenium water extract combined with low doses of herbicide was found very useful, economical and environmentally safe approach which may confirm to be a useful initiative for weed management and enhancing crop yield. However, such studies may be continued to further validate the findings of this study.

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