PARTHENIUM DERIVED EXTRACT: A SUSTAINABLE WEED MANAGEMENT APPROACH IN MAIZE CROP

Muhammad Haroon[1], Atif shaheen[1], Fazli wahid[1], Mukhtar Alam[1], Hidayat ullah[1], Muhammad Saeed[1], Abdul Basir[1], Yousaf Jamal[1], Rafiullah[1], Muhammad Adnan[1] , Muhammad Saeed[2] and Muhammad Zeeshan Majeed[3]

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Abstract

The aim of study was to find the bio-potential of parthenium (*Parthenium hysterophorus* L.) derived extract effect on weed density and early growth response of maize crop. The experiment was laid out in randomized complete block design (CRD) with three replications. For experiment, soil was collected from weed infested field. The present results showed that parthenium derived extract at higher concentration (100%) greatly reduced weed density as well as also affect the maize growth i.e. chlorophyll content, leaf area, plant height, shoot biomass, root biomass. In addition, at lower concentration (25% and 50%) enhance maize chlorophyll content, leaf area, plant height, shoot biomass and effectively control weed density. The present study explained the bio potential of parthenium derived extract and play a key role in sustainable weed management.

Keywords: Allelopathy, bio stimulants, germination, maize andweed density.

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[1] Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa-Pakistan

2. Department of Weed Science and botany, University of Agriculture, Peshawar-Pakistan
Corresponding author email: haroonws@gmail.com

3. College of Agriculture University of Sargodha

Introduction

Maize is an important cereal crop and is widely grown in different parts of the Pakistan. It has great economic importance and is used as food, fodder and industrial raw materials (Bibi et al. 2010). The average yield in Pakistan is lower due to weeds competition and poor weed management approaches (Chikoye & Ekeleme 2003; Khan et al., 2012). If weeds are not properly managed it may cause a yield reduction up to 83% (Usman *et al*., 2001)

Parthenium is an invasive weed and has been reported across many countries of the world i.e. Asia, Africa and Pacific Island. It causes a severe health problems and agriculture losses as well (Dhilepan, 2009). Despite these problems, parthenium have also a potential in agriculture to improve the soil health and nourish the crop to enhance productivity. Plants offer a wide source of bioactive chemicals with the potential as bioherbicide, bio stimulants and comparatively safer to environment (Kishor et al. 2010). Allelopathy is currently a new approach to weed control and has been reported to controls weeds in agriculture system (Uludag*et al*., 2006; Chon and Nelson, 2010). It have a potential to delay or greatly inhibit weeds seed germination and growth (De Albuquerque *et al*., 2011; Soltys*et al*., 2013). Biostimulants is also now commonly practice for sustainable agriculture, reduce the use synthetic fertilizer, reduce the effect of stress, enhance plant growth and yield performance(Halpern et al., 2015; Le Mire et al., 2016; Van Oosten et al., 2017). To develop an effective control technique of parthenium is cost effective. Therefore, it is necessary to explore the bio potential of parthenium in agriculture. Parthenium derived extract can play a key role in a sustainable weed management as well as crop productivity.

MATERIALS AND METHODS

Pot experiment entitled "Parthenium derived Extract: A sustainable weed management approach in maize crop" were carried out at the Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa during summer 2021. The experiment was laid out in complete randomized design (CRD) having three replications. Four seeds of maize hybrid (FS-151) were sown in free draining pots (Height 21cm and width 18 cm) with similar volume of soil and humus (2:1).All pots were water with aqueous extract of parthenium at 100% field capacity. The experiment was completed in three weeks and data were recorded.

PREPARATION OF PARTHENIUM EXTRACTS AND APPLICATION

Parthenium from naturally growing area of Swabi were collected at vegetative stage and carried into laboratory of Agriculture, University of Swabi. The plants were shade dried, grinded and were weighed. Different concentration of parthenium derived extract were made i.e. 0, 25, 50, 75 and 100% (125g/L) accordingly. The ground sample of parthenium were mixed in water and kept for 24 hours at room temperature. Parthenium derived extract (PDE)with different concentration was obtained by filtration method and were applied at every three days interval with 100% field capacity

DATA COLLECTION

The data were recorded on weed density pot^{-1}, germination (%), plant height (cm), Chlorophyll content (CCI), leaf area plant (m^2), plant biomass (g), root biomass (g).

Statistical Analyses

Recorded data for weed density, germination, plant biomass, root biomass, root length, chlorophyll content was subjected to ANOVA using Statistix-8.0 and means were subjected to least significant difference (LSD) test. Plant height of maize hybrid were taken at 3 days intervals and were regressed using 3

sigmoid model (Chauhan, 2013; Haroon *et al*., 2019)

$$Y = a/\{1 + e\,[x - \frac{x50}{b}]\}$$

As Y is the estimated parameters at time x; a is the maximum plant height; *x*50 is the time (*x*) needed to reach 50 % plant height, while b shows the slop at the time days after transplanting. The fitness of each model was determined by r^2.

RESULTS AND DISCUSSION

Weed density pot^{-1}

The effect of Parthenium derived extract on weed density are shown in figure-1.The results showed that final weed density pot^{-1} were significantly reduced with application of 100% parthenium derived extract followed by PDE-75%as the maximum weed seed germination were recorded in control pots (18.33).Among treatments PDE-100% proved to complete control over weed density. Weed extract have the ability to effect germination of other weeds (Khan *et al*., 2004; Anjum *et al*., 2005). Post application of parthenium extract were found more effective against weed germination (Marwat *et al*., 2008). Parthenium water extract found more effective against different weeds of wheat crop (Afridi and Khan, 2015). The above results revealed that parthenium water extract have a potential to control weed seed germination and can be used as weed management practice in maize crop.

Germination (%)

Germination of maize hybrid were significantly affected by Parthenium derived extract, a declined trend was observed with increasing parthenium concentration. It inhibited maize seed germination and recorded minimum emergence in PDE-100% followed by PDE-75%. In control and PDE-25% no inhibition of maize seedling emergence was recorded, as PDE-50% were least affected. Parthenium water extract concentration significantly affects maize germination. Weed extract also have negative effect on crop seed germination and growth (Batish *et al*., 2007). Inhibitory effect of aqueous extract of parthenium on crop and weeds seed germination were reported by (Afridi and Khan. 2015; Motmainna *et al*., 2021). Similarly, Amare, (2018) reported minimum germination of maize under parthenium water extract.

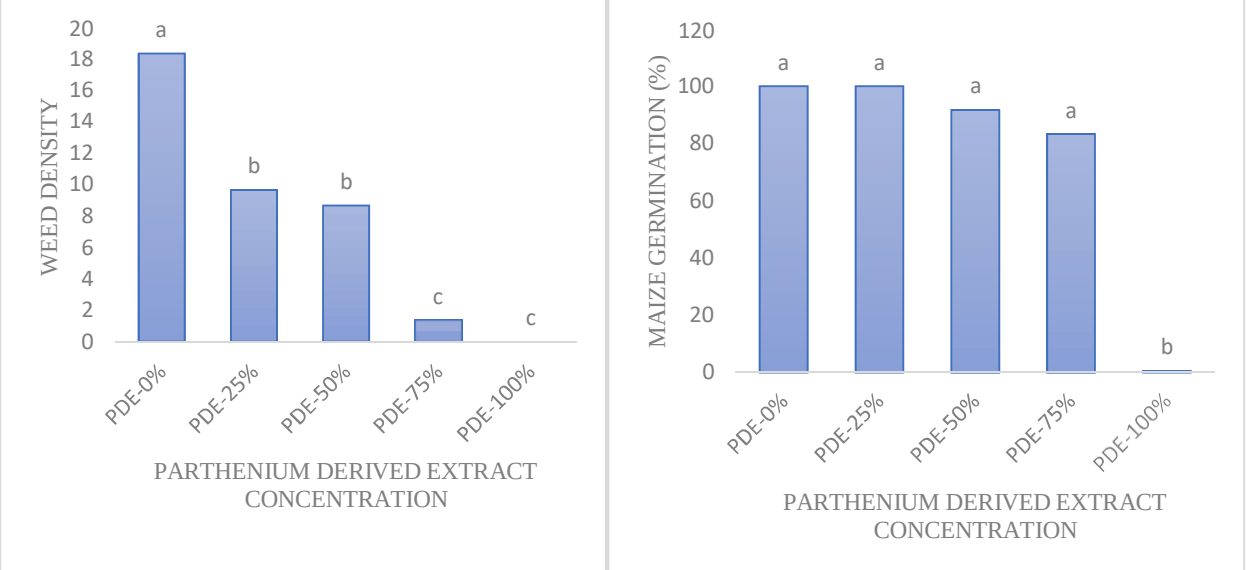

Fig-1. Weed density and germination of maize as affected by parthenium derived extract at different concentration. Different letters in the graph represent significant differences between treatments (P<0.05).

Plant height (cm)

The results showed a significant difference in plant height by using different concentration of Parthenium derived extract. Maize growth were stimulated when treated with PDE-25% and PDE-50% as compared to control pots. As inhibition were observed in PDE-75% and PDE-100% recorded minimum plant height. Parthenium water extract significantly affected plant height of maize hybrid. Plant height of maize decreased at different concentration during experiment. According to sigmoidal growth model maximum plant height (43.38 cm) were predicted at PDE-25% and 33.68 cm at PDE-50% compared with control. As maize height was reported minimum 5.07 cm at PDE-100%. At PDE-25%, maize hybrid took greater than 6.38 and 5.94 days (x0) to reach 50% of the maximum height. As in PDE-100% and PDE-75% it took only 4.48 and 5.33 days to reach 50% of the maximum height. Likewise, the slope was also greater at PDE-25% than control and PDE-100% (Table 1). Similar finding was also reported by Srivastava *et al*., (2010) reported that Parthenium derived extract at low concentration increased shoot length of cowpea as higher concentration reduced shoot length.

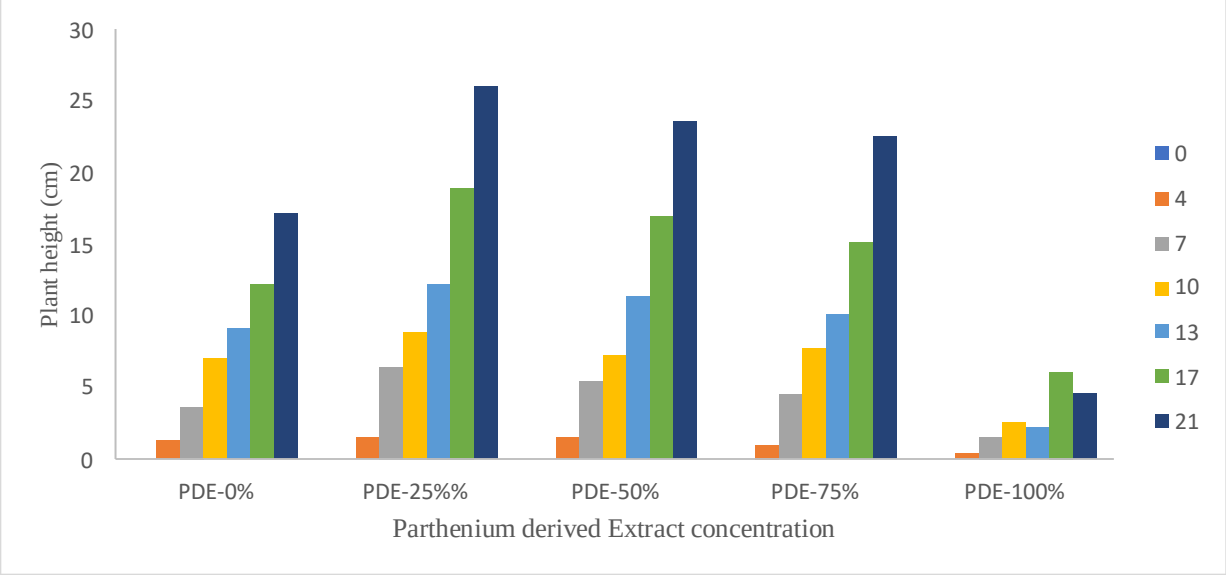

Fig-2. Response of maize plant height (cm) to Parthenium derived extract grown over 21 days.

Table-2 Three parameter sigmoid model was fitted to plant height (cm) of maize hybrid [Y = a/{1 + e {−(x-x50)/b}], a is the maximum parameter x50 is the time (x) needed to reach 50% of the parameter and b represents the slop]

Parthenium Extract concentration (%)	Plant height (cm)			
	a	b	x0	r^2
PDE- 0%	23.70	1.51	5.69	0.91
PDE-25%	43.38	1.61	6.38	0.83
PDE-50%	33.68	1.48	5.94	0.91
PDE-75%	31.39	1.19	5.33	0.91
PDE-100%	5.07	1.09	4.48	0.23

Chlorophyll Content (CCI)

Chlorophyll content for maize crop was increased significantly when grown with PDE-25% and PDE-50% (30.24 and 26.52 CCI) as compared to control pots. However, a decline trend was found when grown in PDE-75% and PDE-100% (2.94 CCI). Chlorophyll is the important source for photosynthesis and was found minimum in 100% extract concentration of Parthenium. The leaf area of maize was recorded minimum which led to decrease chlorophyll content. Srivasta et al. (2010) reported that parthenium extract 20-40% increased the plant growth and chlorophyll content of cowpea. Reduction in chlorophyll content in plants by application of allelopathic plant extract are also reported by (Siyar*et al*., 2019; Abdel-Farid, 2021; Motmainna *et al*., 2021).

Leaf area (m^2)

Parthenium derived extract significantly affected leaf area of maize crop at growth stage. The maximum increase in leaf area ($63.33m^2$) were found when extract was applied at PDE-25% followed by PDE-50% as compared to control ($26.43m^2$). As minimum leaf area ($3.92m^2$) was found in PDE-100%. The results showed a change in leaf area of maize with application of parthenium derived extract concentration. The results finding suggest that application of PDE-100% and 75% treatment have negative effect on leaf area of maize hybrid. Srivasta *et al*., (2010) revealed a reduction in leaf area with higher concentration. Some have revealed adverse effect of phytotoxin at different concentration on plant growth (Ladhari *et al*., 2011; Imatomi *et al*., 2013). Reduction in leaf area were also reported in several studies due to application of plant extract (Jibran *et al*.,2015; Algandaby *et al*., 2018).

Plant biomass (g)

The results showed that Parthenium derived extract significantly affected the plant biomass of maize crop. The magnitude of biomass decreased with increasing parthenium concentration. No survival or minimum plant survival were recorded when grown under PDE-100%. As maximum plant biomass (43.81 g) was recorded in PDE-25% followed by PDE-50% as minimum biomass (1.23 g) was recorded in PDE-100% statistically followed by PDE-75%. Demissie *et al*., (2013) reported a reduction in biomass of bean and onion with increasing Parthenium derived extract concentration. Similar results reported by Shikha and Ja, (2016) that Parthenium with higher concentration reduce biomass of *Cajanuscajan*. Likewise, Al-Wakeel *et al*., (2007) reported toxic effect of *Acacia nilotica* water extract at higher concentration as at lower concentration it stimulates peas growth.

Root biomass (g)

Data regarding the effect of Parthenium derived extract on root biomass are presented in table-(2). The results showed a remarkable reduction in root biomass (3.33 g) when maize crop was treated with PDE-100% followed by PDE-75%. However, maximum root biomass (16.70 g) was recorded in PDE-25% followed by PDE-50% as compared to control. Hussain *et al*., (2020) reported that lettuce root biomass was decreased when exposed to aqueous effect of Acacia foliage, flowers and phyllodes.

Table-2. Effect of Parthenium derived extract on weed density, chlorophyll content, leaf area, plant biomass and root biomass of maize hybrid (FS-151)

Treatment	Weed density pot^{-1}	Chlorophyll content (CCI)	Leaf area (m^2)	Plant biomass (g)	Root biomass (g)
PDE-0%	18.33 a	16.69 b	26.43 b	15.860 abc	6.80 bc
PDE-25%	9.66 b	30.24 a	63.33 a	43.817 a	16.707 a
PDE-50%	8.66 b	26.52a	30.09 b	40.370 ab	12.83 ab
PDE-75%	1.33 c	12.36 b	20.35 bc	12.627 bc	5.91 bc
PDE-100%	0 c	2.94 .c	3.92 c	1.23 c	3.33 c

Conclusion

This trail provides conclusive result about weed management through bioherbicide and offer new insight. One insight is that Parthenium derived extract at minimum concentration (25%) work as bio-stimulant for maize crop and also reduce weed density. The second insight is Parthenium derived extract at higher concentration (100%) inhibit the crop growth and the successfully control the weeds. The promising result of Parthenium derived extract (25%) could be used asbio stimulants for maize crop and as bio-herbicide for sustainable weed management.

Photo showed the effect of parthenium derived extract on weed density and growth performance of maize crop.

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