INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 12, No. 5, p. 167-173, 2018

RESEARCH PAPER OPEN ACCESS

Allelopathic effect of various aqueous plant extracts on weeds and yield of maize (*Zea mays* L.)

Iqtidar Hussain[1], Ejaz Ahmed Khan[1], Ali Ahmed Sabir[1], Umer Khitab[1], Imam Bakhsh[1], Muhammad Shuaib Khan[2], Yasir Ihtesham[1*]

[1]*Department of Agronomy, Faculty of Agriculture, Gomal University, D.I.Khan (KPK) Pakistan*
[2]*Gomal College of Veterinary Sciences, Gomal University, D.I.Khan (KPK) Pakistan*

Key words: Allelopathic effect, plants extracts, maize yield, weeds.

http://dx.doi.org/10.12692/ijb/12.5.167-173 Article published on May 24, 2018

Abstract

A field study was performed at Research field of Faculty of Agriculture; Gomal University Dera Ismail Khan during summer 2016 to evaluate the Allelopathic impacts of different plants extracts on weeds biomass and yield of maize. The experiment was arranged in a Randomized Complete Block Design with four replicates. Mature leaves (1kg) of these plants were cut and slashed, then bubbled with hot water (10lit) and concentrate was sifted through a Muslin material and crushed by squeezing by hands. The treatments included, T_1= Control (No splash on weeds) , T_2= Chemical (Atrazine @ 400 g kg^{-1} (40% w/w) and Mesotrione @ 100 g kg^{-1} (10% w/w)), T_3= Kortuma (*Citrullus colocynthis* L.), T_4= Neem (*Azadirachta indica* L.), T_5= Sheesham (*Dalbergia sissoo* L.), T_6= Acacia (*Acacia arabica* L.), T_7= Draikh (*Meliaazadirach* L.), T_8= Sunflower (*Helianthus annuus* L.), T_9= (*Sorghum vulgaris* L.), T_{10}= (*Eucalyptus camaldulensis* L.), T_{11}= Congress grass (*Parthenium hysterophorus* L.), T_{12}= Tobacco (*Nicotiana tobacum* L.), T_{13}= Popular (*Populous deltoids* L.). The statistical analysis of gathered information depicted that utilization of various concentrations of plants diminished weeds and a few concentrates had phytotoxic impact on Maize crop likewise though a few plants stimulate vegetative maize development. Among all treatments, Sunflower extract application gave reliably better weed control and increment maize yield while Eucalyptus, Neem, Draikh and Congress grass separates diminished plant height, cob length, number of grains cob^{-1}, biological yield and grain yield. Leaf concentrate of *Eucalyptus*, Neem and Draikhsup pressively affect maize crop however it control weeds to some degree yet its utilization is not prudent in maize cultivates to control weeds because of its negative effects on development of maize crop. In the trial, chemical control stays best in weed concealment and getting the most extreme grain yield of maize. Tobacco and Kortuma remove splashed and fused soil altogether increment the root and shoot length yet these two concentrates having little weed concealment.

* **Corresponding Author:** Yasir Ihtesham ✉ yasir.ihtesham@yahoo.com

Introduction

Maize is third most important food after the wheat and rice. Maize is a demanded part of cropping system because most of the people use it as staple food. Maize crop is grown twice in a year because it has a short duration and is grown for dual purpose i.e. grain and fodder. Maize has the maximum productivity among cereals in the world, is of great importance in the developing country like Pakistan. Maize productivity was 4.920 billion tones of year 2015-2016. It is decreased to 0.03% previous year 2014-2015 production which was 4.937 million tons (Anonymous, 2016). Weed is one of the production constraints on maize crop. Weeds minimized the grain yield of maize to 30.15% when no weed controls practices ware adopted. The control of weeds is troublesome i.e. hand or manual weeding is difficult to adopt on a large maize field while chemical control is costly and have and dangerous for ecosystem. The trend of using high doses of herbicides can make weeds more tolerant of herbicides and pollute the ecosystem with hazardous chemicals (Stephenson *et al.,* 2000).

The term allelopathy was first coined by Austrian Scientist named Hans Molish in 1937 in his book entitled "Allelopathy" (The Effects of plants on each other). Herbicides posed serious threats to ecosystem as well as human being. Allelopathy is different from competition and negative interference and also eco-friendly. Secondary metabolites are released from donor plant and have inhibited effect on the germination, growth and development of other undesirable plants (Mengal *et al*., 2015). Allelopathy afforded eco-friendly environment in reducing weeds and minimizing the use of chemicals that cause environmental pollution and pesticides resistance problems. Now, the poisonous chemicals entering in the environment are continuously contaminating the air surface and ground water for live stock as well as human consumptions, while their decomposed residue and metabolites released from plant to soil more in food chain nutrition cycle (Judiat *et al.,* 2001). Arif *et al.* (2015) reported that metabolites and physiological processes of weeds were affected by allelochemicals because of their phytotoxic effects. It was noted that in an aqueous media, the compounds might substitute one another due to their high biological exchange resulting in the potency increment in each other (Greig and Blum, 1991). Therefore, the need of time is to control weeds for enhancing the grain yield of maize with costless and eco-friendly approaching like allelopathy. Allelopathy is totally reliable approach to environment to suppress weeds and boost crop yield in sustainable agriculture system (Youngqing, 2005). So, this experiment was conducted to evaluate the allelopathic impacts of different plant extracts on weeds biomass and yield of maize. The experiment was arranged in a Randomized Complete Block Design with four replicates.

Materials and methods

Site description

The experiment conducted in summer 2016 at the research area of Faculty of Agriculture, Gomal University Dera Ismail Khan, Pakistan.

Plant material

The plant material of maize variety "MMRI Yellow" was obtained from MMRI Yousawala-Sahiwal, which is an open pollinating variety of maize having a high yield potential and adoptability in the agro climatic conditions of Dera Ismail Khan. Plant leaves for making extracts were collected from the different fields of this area and from the road side of the University.

Experiment

The experiment was arranged in Randomized Complete Block Design with four replications. The plot size was 6 m^2 (1.5m X 4m). The experiment was practiced on the summer sowing with maize crop during the month of July, 2016. Thirteen treatments were applied which were as under:

T_1= Control (No splash on weeds) , T_2= Chemical (Atrazine 500 gL^{-1} (44% w/w) and Mesotrione 50 gL^{-1}(5% w/w)), T_3= Kortuma (*Citrullus colocynthis* L.), T_4= Neem (*Azadirachta indica* L.), T_5= Sheesham

(*Dalbergia sissoo* L.), T_6= Acacia (*Acacia arabica* L.), T_7= Draikh (*Melia azadirach* L.), T_8= Sunflower (*Helianthus annuus* L.), T_9= (*Sorghum vulgaras* L.), T_{10}= (*Eucalyptus camaldulensis* L.), T_{11}= Congress grass (*Parthinium hytrophorus* L.), T_{12}= Tobacco (*Nicotiana tobacum* L.), T_{13}= Popular (*Populous deltoids* L.).

Procedures

The plant extracts were prepared from collected newly matured leaves by taking 1 kg of leaves with 10 liters of water. The leaves were cut, slashed and placed in hot bubbled water after taking off the fire for 24 hrs. Then the concentrate was sifted through a Muslin material and crushed by squeezing with gloved hands for taking out extract. These extracts were stored in plastic container for using in future.

The maize seed was socked for 12 hrs in these extracts separately as a seed priming treatments for observing their impacts on germination percentage and root-shoot length in the field. The germination percentage was recorded after 15 days of sowing and root-shoot length was 21 days. These was planted an extra row for these two parameters and these plants were removed for taking data of root-shoot length and the empty ridge worked as boundary for separating the plots with each other. The seed of this row was only soaked. The extracts were sprayed twice i.e. after 21 days and 36 days of sowing. The data onto weed fresh weight before spray was registered after 20 days of sowing and data of weed density and weed fresh weight after spray was recorded after 15 days of 2nd application of treatments. All the rest of data was registered on the respecting growth stages of maize crop. The crop was harvested when the maize plants reached at physiological maturity after completing the days of maturity (110 days). All the cultural practices except weed control were done uniformly in all plots having different treatments.

Data Registering Parameters

There were total 10 parameters for registering data, which were Germination % of Maize, Root, Shoot length (cm), Cob length (cm), Weed density after spray (m^{-2}), Fresh weight of weed after spray (g m^{-2}), Dry weight of weeds after spray (gm^{-2}), Plant height (cm), Number of grains Cob^{-1}, Biological yield (Kg ha^{-1}) and, Grain yield (Kg ha^{-1}).

Data analysis

The registered data analyzed by statistical technique analysis of variance techniques (Steel and Torrie, 1997) and Least Significant Difference test was applied using MSTATC software (MSTATC, 1991).

Results and discussion

Germination % of Maize

The results of germination are presented in table 1. Germination % is very important character of any maize variety. It is handled genetically in any maize variety however climatic condition, soil characters and plant litter incorporated into soil responsible for enhancing or inhibiting it directly. The application of plant extracts scored significant influence on the germination % of maize. The prominent germination % was scored after control/water (89%) and Chemical (88%) i.e. by Tobacco, Kortuma and Popular extracts. The least germination was achieved by Neem extract (52%), Sunflower (54%) and Sorghum (54%). These three inhibited germination among all these plant extracts. These results are supported by Ejaz *et al.,* (2004) who suggested that Eucalyptus inhibited the germination of cotton with its allelochemicals. The Eucalyptus suppressed the germination of maize and enhanced the germination activity of wheat and chick pea reported by Blais *et al.*, (1997). The Beltran *et al.*, (1997) also reported that the low germination of maize occurred due to applying the extracts of sunflower plant.

Root-Shoot length (cm)

The results of root-shoot length can be seen in the table 1. The root-shoot length of maize influenced by different plant extracts observed significant at $p<0.05$. The seed and seedling of maize treated with Kortuma extract (26.01 cm) showed the maximum root shoot length after control plants and Tobacco extract (23.93 cm) followed it. The inhibiting plant extracts for root-shoot length were Neem extract (14.60 cm) and sunflower (17.70 cm).

Table 1. Allelopathic influence of different plant extracts on the Weeds and Maize growth and yield.

Treatments	Germ %	Root-Shoot length (cm)	Weed density (m^{-2})	Fresh weight (g m^{-2})	Plant height (cm)	Cob Length (cm)	No. of Grains Cob^{-1}	Biological Yield (kg ha^{-1})	Grain Yield (kg ha^{-1})
T_1	89 a	26.60 a	520.25 a	832.11 a	172.18 h	3.4 d	272.25 e	6723.78 e	2241.32 d
T_2	88 a	26.34 ab	210.50 e	103.69 f	220.21 a	8.2 a	392.12 a	10287.50 a	4152.28 a
T_3	80 ab	26.01 b	328.19 c	345.09 bc	200.24 cde	5.79 bc	315.19 c	8060.33 c	3112.32 ab
T_4	54 cd	14.6 j	278.12 d	245.95 cd	202.22 cd	4.82 bc	301.12 cd	7324.72 cd	2817.20 c
T_5	57 c	20.22 d	354.12 c	252.83 d	206.27 cd	6.80 b	351.25 b	9303.08 c	3378.11 b
T_6	74 b	19.18 f	381.75 c	272.13 c	207.42 c	5.21 bc	311.75 c	8608.19 d	3188.22 b
T_7	65 bc	18.20 g	297.00 d	212.22 e	194.55 ef	3.99 c	286.50 d	7091.33 b	2626.42 c
T_8	52 d	17.7 h	298.19 d	278.40 d	215.42 b	7.80 a	375.18 a	10014.40 b	3391.52 a
T_9	54 cd	15.6 i	459.25 b	380.33 b	205.32 cd	5.67 bc	346.25 b	8871.20 c	3051.90 ab
T_{10}	59 c	18.21 g	256.27 d	229.41 de	197.58 de	4.41 c	291.18 d	7103.28 cd	2732.91 c
T_{11}	89 a	19.43 f	263.19 d	198.11 b	193.62 ef	3.60 d	281.06 d	6908.70 d	2521.18 c
T_{12}	88 a	23.93 c	433.50 b	389.56 c	196.26 de	6.04 b	335.18 bc	8346.00 c	3210.39 b
T_{13}	80 ab	20.92 e	407.0 bc	301.14 d	203.12 d	6.42 b	328.36 bc	8351.20 c	3212.12 b

These results are supported by Zaheer *et al.,* (2014) who clarified that the sunflower extracts reduce the root shoot length of wheat.

Weed density after spray (m^{-2})

There was noticed a significant difference at $p<0.05$ among all treatments for weed density. The least number of weeds was recorded for Chemical control of weeds (210.50 m^{-2}). The high efficacy for weed density was brought under notice by plant extracts like Congress Grass (263.93 m^{-2}), Eucalyptus (256.25 m^{-2}), Neem (278.12 m^{-2}), Draikh (297.00 m^{-2}) and Sunflower (298.19 m^{-2}). The least reduction in the weed density was noticed by the application of plant extracts like Sorghum (459.25 m^{-2}), Tobacco (433.50 m^{-2}), Popular (407.00 m^{-2}).

The maximum weed density achieved by the weedy plots (520.25). These findings are similar to the finding of Mahmood *et al.,* (2015) who demonstrated that weed density of maize crop subjected to the reduction of 70% by applying Sunflower, Brassica and Sorghum water extract. The weed concealment can be done by application water extracts from different plants having allelopathic potential in the field of crops (Hong *et al*., 2004). Sunflower water extract (sunfaab) has been intensively reported to posses strong allelopathic potential and inhibit the growth process of other plants (Cheema *et at*., 2003).

Fresh weight of weed after spray (g m^{-2})

A significant difference was found at $p<0.05$ between all treatments for fresh weight of weeds after spray. Minimum weight was experienced for Chemical control of weeds (103.69 gm^{-2}). The maximum reduction for weed density were brought under notice by plant extracts like Congress Grass (198.11gm^{-2}), Eucalyptus (229.41gm^{-2}), Draikh (212.22 m^{-2}), Neem (245.95 gm^{-2}) and Sunflower (278.40 gm^{-2}). The minimum concealment in the weed fresh weight were observed by the application of plant extracts like Sorghum (380.33 gm^{-2}), Tobacco (389.56 gm^{-2}), Popular (301.14 gm^{-2}). The maximum weed fresh weight was achieved by the weedy plots (832.11gm^{-2}). These findings are similar to the finding of Mahmood *et al.*, (2015) who demonstrated that weed fresh weight in maize crop subjected to the reduction by applying Sunflower, Brasica and Sorghum water extracts. A similar type of research was conducted by Hussain *et al*., (2014) in which they researched the effect of allelopathic crop extracts on reduction of weeds in wheat and predicted that maximum reduction of weed fresh weight (62%) was obtained by sorghum water extracts.

Plant height (cm)

Plant height is greatly inclined by genotype as well as environmental factors including minerals, light, space and water stress. Moreover plant height shows

vegetative growth. The influence of plant extracts was observed significant at $p<0.05$. The plots treated with chemical scored (220.21 cm) maximum plant height and followed by Sunflower extract (215.42 cm). Taller plants were recorded in chemical control which may be due less competition of weeds with maize. The minimum plant height was observed in the plots treated with Congress grass extract (193.62 cm), Draikh extract (194.55 cm) and Tobacco extract (196.20 cm) after weedy control (172.18 cm). The consoling results were found by Abbas *et al.*, (2016) and Fuksa*et al.,* (2004) that plant height reduction was occurred due to enhancing of weed biomass.

Cob length (cm)

The statistical analysis proved that the plant extract has a significant influence on the cob length of maize. The cob height (8.2 cm) was found maximum in the plots where Chemical is applied for weed control. The plant extracts like Sunflower (7.80 cm) and Sheesham (6.80) influenced positively on the cob length after the chemical control (8.2 cm).

The reduction in the cob length was occurred in plots, which were treated with Congress grass (3.60 cm), Draikh (3.99 cm), Neem (4.82) and weedy plots (3.4 cm). This study is in agreement with the results of Catherine (2003) in which she stated that the growth indices were increased with allelopathic extracts of plants and increase in cob length was also occurred. In our experiment the growth indices were increased by weed suppression. Cobs of larger size (Table 1) were produced where chemical weed control is applied, while extract of Sheesham, Acacia, Tobacco and popular showed positive result in case of cob length. Smaller cobs were produced in control (weedy check).

Number of grains Cob^{-1}

The number of grains is one of yield contributing components of maize. The plant extracts proved significant at $p<0.05$. The Chemical application resulted in maximum number of grains cob^{-1} (392.12). The plots treated with sunflower extract (375.18), Sorghum (346.25) and Tobacco (335.28) and Popular (328.36) scored prominent number of grains after Chemical application. The inhibition in number of grains was occurred by Congress grass (281.06), Draikh (286.50) and Eucalyptus (291.18) and minimum number of grains was showed by Weedy plots (272.14) (Table 1). Mahmood *et al.* (2015) reported that the number of grains per cob was significantly different by application of extract from sunflower, sorghum, mulberry and Brassica on maize crop for weed control. Cheema *et al.*, (2003) also reported that sonfab (sunflower water extracts) and sorgab (sorghum water extract) in different concentration have positive effect on number of grains and grain yield and also suppress the weeds.

Biological yield (Kg ha^{-1})

The biological yield of maize in this experiment was proved significant by analyzed data at $p<0.05$. The most prominent biological yield was obtained in plots treated with Chemical for weed control. But some plant extracts like Sunflower (10014.40 Kg ha^{-1}), Acacia (8608.19 Kg ha^{-1}), Popular (8351.20 Kg ha^{-1}) and Tobacco (8346.00 Kg ha^{-1}) also contributed in accumulating dry matter partitioning of maize. Some plant extracts like Congress grass (6908.70 Kg ha^{-1}), Draikh (7091.33 Kg ha^{-1}) and Eucalyptus (7103.28 Kg ha^{-1}) proved inhibitory action on biological yield of maize when applied for weed control in maize (Table 1).The most reduction in biological yield was accounted for weedy plots (6723.78 Kg ha^{-1}). The supported results were found by Mahmood *et al.*, (2015) who stated that biological yield was shown a significant increase by the allelopathic impacts of plant extract like Sunflower, Sorghum and Brassica by suppressing the weeds.

Grain yield (Kg ha^{-1})

The grain yield of maize was experienced significant when analyzed the data at $p<0.05$. The Chemical application for weed concealment achieved maximum grain yield (4125.2 kg ha^{-1}) in maize under our experiment. The plant extracts like sunflower (3591.52 kg ha^{-1}), Sheesham (3378.11 kg ha^{-1}), Kortuma (3112.32 kg ha^{-1}), Popular (3212.32 kg ha^{-1}), and Tobacco (3210.39 kg ha^{-1}) have intermediate

results. The reduction in yield was noticed in plots where the extracts like Congress Grass (2521.18 kg ha^{-1}), Draikh (2626.42 kg ha^{-1}), Eucalyptus (2732.91 kg ha^{-1}) and Neem (2817.20 kg ha^{-1}). The poorest performance of grain yield (2241.32 kg ha^{-1}) was noticed in the weedy plots.

The similar results was found by Mahmood *et al.*, (2015) who exclaimed that the combinations of Brassica, Sorghum and Sunflower extracts enhanced grain yield and it had a inverse relationship with weed biomass. All herbal extracts have positive effect on grain yield to maize but chemical control is best. This might be due to effective weed control. So, maize plants got maximum nutrition from available resources of soil. Sunflower extract showed statistically. Similar result as chemical control-From their results, we can conclude that allelopathic plants water extracts can utilize as weedicides to keep our environment healthy and pollution free.

Conclusion

From this study, it is concluded that sunflower, sorghum, Neem, Draikh, Congress grass can effectively control weeds and having no pollution effect on environment and crop. It is suggested that studies of this nature might be continued using different plant extracts from different crops. This type of study could decrease the cost of production and strengthen efforts into protecting environment on sustainable basis.

Conflict of interest

The authors have no conflict of interest to disclose.

Acknowledgement

This study was financially supported by Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan.

References

Abbas A, Muhammad AK, Ashiq S, Marwat KB, Abass UJ, Dawood J, Shahid S. 2016. Performance and economics of growing maize under organic and inorganic fertilization and weed management.Pakistan Journal of Botany**48,** 311-318.

Arif M, Cheema ZA, Khaliq M, Hassan A. 2015. Organic weed management in wheat through allelopathy. International Journal of Agriculture Biology**17,** 127-134.

Baltran L, Lyva A, Caparicon L.1997. A preliminary study of allelopathic effects of sunflower (*Helianthus annuus* L.) on several economic crops. Cultivos Tropicales**18(1),** 40-42.

Blaise D, Tyagi PC, Khola OPS, Ahlawat SP. 1997. Effects of eucalyptus on wheat, maize and cowpeas.Allelopathy **4,** 341-394.

Catherine MC. 2003. Validation of a hyperspectral curve fitting model for the estimation of plant water content of agricultural canopies.Remote Sense Environment**87(2),** 148-160.

Cheema ZA, Khaliq A, Hussain R. 2003. Reducing herbicide rate in combination with allelopathics orgaab for weed control in cotton. International Journal of Agriculture Biology**5,** 4-6.

Ejaz AK, Khan MA, Ahmad HK, Khan FU. 2004. Allelopatic effects of eucalyptus leaf extracts on germination and growth of cotton (*Gossypium hirsutum* L.). Pakistan Weed Science Research **10(34-),** 145-150.

Fuksa P, Hakl J, Kocourkova D, Vesela M. 2004. Influence of weed infestation on morphological parameters of maize (*Zea mays* L.). Plant Science & Environment**50(8),** 371-378.

Gerig TM, Blum U. 1991. Effects of mixtures of four phenolic acids on leaf area expansion of cucumber seedling grown in portsmouth B_1 soil materials. Chemical Ecology **17,** 29-39.

Hong NH. 2004. Paddy weed control by higher plants from south East Asia. Crop Protection **23(4),** 255-261.

Hussain S, Hassan F, Rasheed M, Ali S, Ahmed M. 2014. Effects of allelopathic crop water extracts and their combinations on weeds and yield of rain fed wheat. Food Agriculture & Environment **12,** 161-167.

Judith CS, Lemley AT, Hogan S1, Weismiller RA, Horsby AG. 2001. Health effects of drinking water contamination. Florida Co-operative Extension service.Institute of Food and Agricultural Sciences, University of Florida, USA.

Mahmood A, Khaliq A, Ihsan MZ, Naeem M, Matloob A, El-Nakhlawy FS. 2015. Estimation of weed dry biomass and grain yield as a function of growth and yield traits under allelopathic weed management in maize.Planta Daninha **33(1),** 23-31.

Mengal BS, Baloch SU, Sun Y, Bashir W, Wu KR, Shahwani AR, Baloch HN, Baloch SK, Baloch RA, Sabiel SA1, Badini SA, Baber S. 2015. The influence of Allelopathic weeds extracts on weeds and yield of wheat. Biology, Agriculture and Healthcare **5(1),** 218-227.

Steel RGD, Torrie JH, Dickey DA. 1997. Multiple comparisons. Principles and Procedures of Statistics. McGraw Hill Book Co., New York, USA; **3,** 178-198.

Youngqing MA. 2005. Allelopathic studies of common wheat (*Triticum aestivum* L.). Weed Biology Management**5,** 93-104.

Zaheer M, Abdul M. 2014. Allelopathic effects of aqueous extract of sunflower on wheat. Pakistan Journal of Botany **46(5),** 1715-1718.