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ALLELOPATHIC EFFECT OF CONGRESS GRASS ON WEEDS AND YIELD OF WHEAT

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ABSTRACT

A research trial was conducted at the Agricultural Research Institute, Dera Ismail Khan to investigate the allelopathic effect of congress grass applied alone or in combination with half and full recommended doses of commercial herbicides (Puma Super and Buctril Super) during the year 2010-11. The results revealed that weed control strategies including hand weeding (30 and 60 days after sowing), application of herbicides and use of congress grass water extract significantly controlled weeds over the weedy check. Among the treatments, herbicide Puma Super full recommended dose (625 mL ha^{-1}) significantly increased leaf area index, leaf area duration, crop growth rate, number of tillers, number of grains $spike^{-1}$, 1000-grain weight and grain yield. While, weed density and dry weed biomass were minimum in hand weeding. The findings revealed that, in order to obtain maximum yield of wheat, the plots should be kept weed free by hand weeding throughout the growing season or weeds should be suppressed by application of herbicide like Puma super with recommended dose. It is therefore concluded that herbicides can be used to control weeds in wheat field where labor is expensive.

Key words: Allelopathy, congress grass, *Parthenium hysterophorus,* weeds, wheat, yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important staple food crop for more than one third of the world population. It is also an important grain and 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. 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 compare 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

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shortfall of 2.36 million tons (Hassan, 2007). The area under wheat has been increased by 2% in Punjab, 9.4% in Khyber Pakhtunkhwa (KPK), and decreased by as much as 30% in Sindh and 60% in Balochistan.

Among the yield limiting factors, weeds intervention is one of the most important but less recognized constraints in Pakistan (Qureshi and Bhatti, 2001). Weeds compete with the crop plants for nutrients, moisture, light, CO_2 and space, whereas many weeds also possess allelopathic effects against crops. Marwat *et al*. (2006) stated that with the advent of short duration varieties, weeds infestation has become even more severe and the annual losses to wheat crop in Pakistan on monetary basis are more than Rs. 28 billions.

As many as 37 species of harmful weeds grow in wheat field in different cropping systems, the most troublesome being *Phalaris minor*, *Chenopodium album*, *Convolvulus arvensis*, *Avena fatua* etc. For the control of these weeds species, farmers usually use commercial herbicides, which are causing resistance in organisms, environmental pollution, toxicity related health hazards in humans and livestock.

Studies have shown a great potential of allelopathy for weeds control in wheat. It is the best alternatives to the synthetic herbicides to control weeds (Bhowmik and Inderjit, 2003; Jabran *et al.,* 2008). Besides, allelopathy has many other applications in agro-eco systems and thus provides basis to sustainable agriculture. In Pakistan, many plant species species has shown allelopathic effects that could be successfully used for weed control in agricultural crops (Khan *et al.,* 2011).

Commonly cited effects of allelopathy include reduced seed germination and seedling growth. Like synthetic herbicides, there is no common mode of action or physiological target site for all allelochemicals. However, known sites of action for some allelochemicals include cell division, pollen germination, nutrient uptake, photosynthesis, and specific enzyme function.

Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids, with mixtures of different compounds sometimes having greater allelopathic effect than individual compound alone. Different plant parts, including flowers, leaves, plant litter, stems, bark, roots, soil and soil leachates and their derived compounds, can have allelopathic activity that varies over a growing season. Allelopathic chemicals can also persist in soil, affecting both neighboring plants as well as those planted in succession. Although derived from plants, allelochemicals may be more biodegradable than commercial herbicides but may also have

undesirable effects on non-target species, necessitating ecological studies before its widespread use.

Selective activity of tree allelochemicals on crops and other plants has also been reported. *Leucaena* spp. has been shown to reduce the yield of wheat but increase the yield of rice. Leachates of the chaste tree or box elder can retard the growth of pangolagrass but stimulate growth of bluestem, another pasture grass. Allelochemical concentrations in the producer plant may also vary over time and in the plant tissue produced. Foliar and leaf litter leachates of *Eucalyptus* spp. for example, are more toxic than bark leachates to some food crops.

Congress grass (*Parthenium hysterophorus* L.) is the most unwanted weed in Indian subcontinent. It is commonly known as congress weed, carrot weed, gajar ghas, false rag weed, fever few, chatak chandani, ramphool etc (Oudhia *et al.,* 2000; Oudhia, 2000). It has been noted in many studies that different parts of same plant show different allelopathic effects (Oudhia and Tripathi, 2000a, 2000b; Oudhia, 2000b). The chemical analysis has indicated that all the plants parts, including trichomes and pollen, contain toxins called sesquiterpene lactones. The major components of toxic being parthenin and other phenolic acids such as caffeic acid, vanillic acid, ansic acid, p-anisic acid, chlorogenic acid, and parahydroxy benzoic acid are lethal to human beings and animals.

The present research was initiated with the objective to explore the effect of various concentrations of congress grass along with reduced doses of commercial herbicides for weed management and higher yield of wheat under the agro-ecology of Dera Ismail Khan, Pakistan.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Institute, Dera Ismail Khan, Pakistan during the year 2010-11. The land was prepared by giving 3-4 ploughings (including disc plough, cultivator and rotavator operation) to ensure a fine seedbed. The crop was sown in last week of October by man driven hand drill with a plant to plant and row to row distance of 10 and 30cm, respectively. The net plot size was 1.8m x 5m. There were 6 rows, 5m long and 30 cm apart in each plot. A seed rate of 100 kg ha^{-1} of wheat variety "Gomal-8" was used in this experiment. The experimental treatments were weedy check (control), Buctril super (full and half recommended doses), Puma super (full and half recommended doses), congress grass water extract (full dose), congress grass water extract (full dose) + Buctril super (half recommended dose), congress grass water extract (full dose) + Puma super (half recommended dose), congress grass water

extract (half dose) + Puma super (half recommended dose) and hand weeding.

The experiment was laid out in a randomized complete block design with three replications. 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. Concentrated water extract of congress grass and hand weeding was done 30 and 60 days after sowing (DAS). The water extract was prepared by soaking leaves of congress grass in distilled water in a ratio of 1:5 for 36 h. It was then filtered to collect the respective extracts. The data on weed density (m^{-2}), dry weed biomass (g), leaf area index, leaf area duration, crop growth rate, number of tillers (m^{-2}), number of grains ($spike^{-1}$), 1000-grain weight (g) and grain yield (kg ha^{-1}) were recorded and analyzed statistically using analysis of variance techniques (Steel *et al*., 1997) and means were separated by least significance difference test using MSTATC software program (MSTATC, 1991).

RESULTS AND DISCUSSION

Weed density (m^{-2}) 30 and 60 DAS

The data revealed that weed management practices significantly affected weeds density (m^{-2}) at 30 days after sowing (Table-1). Maximum weed density (41.3 m^{-2}) was recorded in weedy check plots. It was however, statistically at par with Congress grass at full dose and Congress grass half dose + Puma super half dose which had 35.6 and 34.7 (m^{-2}), respectively. Minimum weed density (23.7 and 25.0 m^{-2}) was recorded in hand weeding and Buctril super full dose treatments, respectively. Maximum weed density in weedy check was due to the reason that weeds remained unchecked throughout the growing season. During the initial crop growth stages, only broad leaved weeds emerge and compete with the crop for resources (nutrients, moisture, light, CO_2 and space). Since Buctril super is effective against broad leaved weeds, therefore it controlled most of the germinating weeds during initial crop growth stage at 30 days after sowing. The results are supported by Abbas *et al.* (2009) who reported minimum number of weeds by the application of Buctril Super. Similarly, statistically at par number of weeds in T4 and T10 to that of weedy check explained the ineffectiveness of congress grass water extract (both full and half dose) and its combination with Puma super, which is generally recommended for narrow leaved weeds that emerged during later crop growth stages.

The data on weed density recorded 60 days after sowing

showed maximum number of weeds (88.3 m^{-2}) in T1 (weedy check). It was, however, statistically at par with T4 (Congress grass full dose).

Table-1. Weed density (m^{-2}) 30 and 60 DAS as affected by congress water extract alone and in combination with commercial herbicides in wheat.

Treatments	Weed density (m^{-2})	
	30 DAS	**60 DAS**
T1: Weedy check (Control)	41.3 a	88.3 a
T2: Buctril Super (Full)	25.0 c	54.0 bc
T3: Buctril Super (Half)	28.7 bc	54.7 bc
T4: Congress grass (Full)	35.7 ab	77.7 ab
T5: Congress grass (Full)+ Buctril Super (Half)	29.0 bc	63.7 abc
T6: Congress grass (Half)+ Buctril Super (Half)	28.7 bc	55.3 bc
T7: Puma Super (Full)	29.7 bc	55.3 bc
T8: Puma Super (Half)	33.0 b	59.0 bc
T9: Congress grass (Full) + Puma Super (Half)	33.0 b	66.0 abc
T10: Congress grass (Half) + Puma Super (Half)	34.7 ab	66.3 abc
T11: Hand weeding	23.7 c	50.3 c
$LSD_{0.05}$	7.9	26.5

Means followed by different letter(s) in a column are significantly different at 5% level of probability.

The minimum number of weeds was recorded in hand weeding treatment. The maximum number of weeds in T1 and T4 was either due to no weed control measures taken or ineffective allelopathic effects of congress grass on weeds in these treatments. The minimum weed count noted in hand weeding treatment might be due to the reason that all germinated weeds were uprooted before their critical competition with the crop plants for nutrients, light, water etc.

Dry weed biomass (g m^{-2}) 30 and 60 DAS

Data on dry weed biomass recorded at 30 days after sowing are presented in Table-2. The results showed that maximum dry weed biomass (91.60g) was recorded in T1 (weedy check). It was however, statistically at par with T4 (Congress grass full dose), T8 (Puma Super half dose), T9 (Congress grass full dose + Puma Super half dose) and T10 (Congress grass half dose + Puma Super half dose) with dry weeds biomass of 79.70, 78.87, 78.87 and 77.70g, respectively. The application of congress grass water extract was not effective; either used alone or in combination with Puma Super, during initial crop growth stages. This is because Puma Super effectively controls narrow leaved weeds which usually emerge during the later crop growth stages 75-80 days after sowing.

Similarly, dry weed biomass recorded 60 days after sowing was the maximum (83.67g) in T1 (check) while the minimum dry weed

biomass (57.67g) was noted in T11 (hand weeding). The maximum dry weed biomass obtained in weedy check plot might be due to the reason that no herbicide or cultural practices were done in this treatment and all germinated weeds remained unchecked throughout the crop season. The minimum dry weed biomass in hand weeding might be due to lower weed flora in this treatment (Dadari and Mani, 2005).

Table-2. Dry weed biomass (g m^{-2}) 30 and 60 DAS as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	Dry weed biomass (g m^{-2})	
	30 DAS	60 DAS
T1: Weedy check (Control)	91.6 a	83.7 a
T2: Buctril Super (Full)	69.5 b	71.7 abc
T3: Buctril Super (Half)	71.6 b	74.3 abc
T4: Congress grass (Full)	79.7 ab	79.0 ab
T5: Congress grass (Full)+ Buctril Super (Half)	71.0 b	69.3 abc
T6: Congress grass (Half)+ Buctril Super (Half)	66.6 b	64.0 bc
T7: Puma Super (Full)	75.3 b	69.3 abc
T8: Puma Super (Half)	78.9 ab	65.7 bc
T9: Congress grass (Full) + Puma Super (Half)	78.9 ab	71.7 abc
T10: Congress grass (Half) + Puma Super (Half)	77.7 ab	78.3 ab
T11: Hand weeding	66.3 b	57.7 c
$LSD_{0.05}$	14.5	17.1

Means followed by different letter(s) in a column are significantly different at 5% level of probability.

Leaf area index (LAI) 45 and 90 DAS

The leaf area index recorded 45 days after sowing showed non-significant differences among treatments (Table-3). However, significant differences in LAI were noted 90 days after sowing. The maximum and statistically at par leaf area index was recorded in T7 (Puma Super full dose), T8 (Puma Super half dose) and T11 (hand weeding) 90 days after sowing. The minimum leaf area index was recorded in T1 (check) and T4 (Congress grass full dose). It might be attributed to lower weed density in T7, T8 and T11, which exerted less pressure on crop plants while the minimum leaf area index obtained in T1 and T4 might be due to maximum infestation of weeds which ultimately suppressed wheat plants growth and the leaf area index.

Leaf area duration (LAD) 45 and 90 DAS

Leaf area duration expressed the magnitude and persistence of leafiness during the crop growth period. Different weeds management practices significantly affected leaf area duration 45 days after sowing

(Table-4). The maximum (1.04) leaf area duration was recorded in T7 (Puma Super full dose), which was statistically at par with T11 (hand weeding), T2 (Buctril Super full dose) and T8 (Puma Super half dose). The use of congress grass full dose (T4) had the minimum (0.78) leaf area duration.

Table-3. Leaf area index (LAI) 45 and 90 DAS as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	Leaf area index	
	45 DAS	90 DAS
T1: Weedy check (Control)	0.13 ^{NS}	1.630 e
T2: Buctril Super (Full)	0.15	1.980 abc
T3: Buctril Super (Half)	0.15	1.943 bcd
T4: Congress grass (Full)	0.13	1.633 e
T5: Congress grass (Full)+ Buctril Super (Half)	0.16	1.883 d
T6: Congress grass (Half)+ Buctril Super (Half)	0.18	2.000 abc
T7: Puma Super (Full)	0.17	2.037 a
T8: Puma Super (Half)	0.17	2.020 a
T9: Congress grass (Full) + Puma Super (Half)	0.15	1.940 bcd
T10: Congress grass (Half) + Puma Super (Half)	0.13	1.930 cd
T11: Hand weeding	0.17	2.013 ab
$LSD_{0.05}$	--	0.076

Means followed by different letter(s) in a column are significantly different at 5% level of probability. NS = Non-significant

Table-4. Leaf area duration (after 45 and 90 DAS) as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	Leaf area duration	
	45 DAS	90 DAS
T1: Weedy check (Control)	0.82 bc	22.82 e
T2: Buctril Super (Full)	0.94 abc	27.72 abc
T3: Buctril Super (Half)	0.92 abc	27.21 bcd
T4: Congress grass (Full)	0.78 c	22.87 e
T5: Congress grass (Full)+ Buctril Super (Half)	0.90 abc	26.37 d
T6: Congress grass (Half)+ Buctril Super (Half)	0.82 bc	28.00 abc
T7: Puma Super (Full)	1.04 a	28.51 a
T8: Puma Super (Half)	0.98 ab	28.28 a
T9: Congress grass (Full) + Puma Super (Half)	0.92 abc	27.16 bcd
T10: Congress grass (Half) + Puma Super (Half)	0.82 bc	27.02 cd
T11: Hand weeding	1.00 a	28.19 ab
$LSD_{0.05}$	0.1616	1.066

Means followed by different letter(s) in a column are significantly different at 5% level of probability.

Similarly, LAD was significantly affected by various weed management practices 90 days after sowing. The maximum and statistically at par leaf area duration (28.52, 28.28 and 28.19) was recorded in T7 (Puma Super full dose), T8 (Puma Super half dose) and T11 (hand weeding), respectively. The minimum and statistically similar leaf area duration (22.82 and 22.87) was recorded in T1 (weedy check) and T4 (Congress grass full dose). The maximum leaf area duration in T7, T8 and T11 might be due to luxuriant vegetative growth of crop plants on account of less competition of weeds while the reverse was true in other treatments with relatively more weeds infestation.

Crop growth rate (CGR)

The data pertaining to crop growth rate showed significant differences among treatments (Table-5). The maximum and statistically at par crop growth rate (32.29, 32.25, 32.00, 31.92 and 31.88) was recorded in T8 (Puma Super half dose), T11 (hand weeding), T2 (Buctril Super full dose), T7 (Puma Super full dose) and T6 (Congress grass half dose + Buctril Super half dose), respectively. The minimum crop growth rate (22.41 and 23.12) was recorded in T4 (Congress grass full dose) and T1 (check). It might be attributed to maximum crop growth rate recorded in various treatments due to less severe competition for resources on account of lower number of weeds per unite area.

Number of tillers (m^{-2})

The data regarding number of tillers are presented in Table-5. The results revealed that number of tiller was significantly affected by different weeds management practices. The maximum number of tiller was recorded in T7 (Puma Super full dose) which was statistically at par with T8 while the minimum (380.3 and 383.3) was recorded in T4 (Congress grass full dose) and T3 (Buctril Super half dose). Tiller production is usually initiated after 55-65 days after sowing in wheat. At this stage, narrow leaved weeds start to emerge and compete with crop plants. Number of tillers increased substantially if narrow leaved weeds are managed efficiently at this critical growth period of tillers initiation. The use of Puma Super effectively controlled all narrow leaved weeds at this stage and contributed considerably towards off-shoots production. Cheema *et al.* (2005) reported significant increase in the number of tillers per unit area by applying Puma Super herbicide.

Number of grains (spike^{-1})

The potential of spike is measured in term of its number of grains that is an important yield component. The data regarding grains spike^{-1} showed significant difference among treatments (Table-6).

Table-5. Crop growth rate (CGR) and number of tillers (m^{-2}) as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	CGR	Number of tillers (m^{-2})
T1: Weedy check (Control)	23.12 c	387.3 bc
T2: Buctril Super (Full)	32.00 a	421.0 abc
T3: Buctril Super (Half)	30.50 ab	383.3 c
T4: Congress grass (Full)	22.41 c	380.3 c
T5: Congress grass (Full)+ Buctril Super (Half)	29.38 b	449.3 abc
T6: Congress grass (Half)+ Buctril Super (Half)	31.88 a	437.3 abc
T7: Puma Super (Full)	31.92 a	473.0 a
T8: Puma Super (Half)	32.29 a	464.3 ab
T9: Congress grass (Full) + Puma Super (Half)	30.71 ab	412.7 abc
T10: Congress grass (Half) + Puma Super (Half)	29.80 b	416.7 abc
T11: Hand weeding	32.25 a	444.7 abc
$LSD_{0.05}$	1.991	79.69

Means followed by different letter(s) in a column are significantly different at 5% level of probability.

Maximum number of grains $spike^{-1}$ (69.33) was recorded in T7 (Puma Super full dose), which was statistically at par with all other treatments except treatment T9, T10 and T11. Treatment T1 produced the minimum number of grains $spike^{-1}$ (56.33). The possible reason of minimum number of grains per spike in T1 might be due to the presence of more number of weeds thereby resulting in competition for resources like nutrients, water, light etc. between weeds and crop plants. These results are supported by Khan *et al*. (2001, 2002, 2003) reported that herbicidal applications produced more grains $spike^{-1}$ than the untreated control.

1000-grain weight (g)

Grain weight is a strong genetic character and is least influenced by treatments. The data regarding 1000-grain weight are presented in Table-6, which showed non-significant differences among treatments. However, maximum 1000-grain weight (46.00g) was recorded in T6 (Congress grass half dose + Buctril Super half dose) while the minimum grain weight (43.67g) was recorded in T4 (Congress grass full dose).

Grain yield (kg ha^{-1})

The data regarding grain yield are presented in Table-7. The maximum grain yield (4183 kg ha^{-1}) was recorded in T7 (Puma Super full dose). It was statistically at par with T8 (Puma Super half dose). The minimum grain yield (2889 kg ha^{-1}) was recorded in T1 (weedy check). The minimum grain yield obtained in weedy check might be due to heavy weed infestation that competed for resources with crop

plants at all growth stages. The results are in line with Hashim *et al.* (2002) who reported that herbicidal treatments significantly increased the grain yield in wheat.

Table-6. Number of grains (spike^{-1}) and 1000-grain weight (g) as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	Number of grains (spike^{-1})	1000-grain weight (g)
T1: Weedy check (Control)	56.33 c	44.00 ^{NS}
T2: Buctril Super (Full)	67.67 a	44.67
T3: Buctril Super (Half)	67.33 ab	44.33
T4: Congress grass (Full)	66.00 ab	43.67
T5: Congress grass (Full)+ Buctril Super (Half)	65.67 ab	44.00
T6: Congress grass (Half)+ Buctril Super (Half)	65.33 ab	46.00
T7: Puma Super (Full)	69.33 a	45.33
T8: Puma Super (Half)	68.00 a	44.67
T9: Congress grass (Full) + Puma Super (Half)	63.33 abc	44.33
T10: Congress grass (Half) + Puma Super (Half)	60.33 bc	45.00
T11: Hand weeding	62.67 abc	44.67
$LSD_{0.05}$	7.049	--

Means followed by different letter(s) in a column are significantly different at 5% level of probability. NS = Non-significant

Table-7. Grain yield (kg ha^{-1}) as affected by water extract of congress grass alone and in combination with commercial herbicides in wheat.

Treatments	Grain yield (kg ha^{-1})
T1: Weedy check (Control)	2889.0 e
T2: Buctril Super (Full)	3812.0 abc
T3: Buctril Super (Half)	3405.0 cd
T4: Congress grass (Full)	3322.0 de
T5: Congress grass (Full)+ Buctril Super (Half)	3583.0 cd
T6: Congress grass (Half)+ Buctril Super (Half)	3555.0 cd
T7: Puma Super (Full)	4183.0 a
T8: Puma Super (Half)	4083.0 ab
T9: Congress grass (Full) + Puma Super (Half)	3705.0 abcd
T10: Congress grass (Half) + Puma Super (Half)	3605.0 bcd
T11: Hand weeding	3823.0 abc
$LSD_{0.05}$	480.8

Means followed by different letter(s) in a column are significantly different at 5% level of probability.

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