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EFFICIENCY OF *SORGAAB* (SORGHUM WATER EXTRACT) AND HERBICIDE FOR WEED CONTROL IN WHEAT (*TRITICUM AESTIVUM* L.) CROP

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ABSTRACT

An experiment was designed to investigate the feasibility of using extract of sorghum as a natural weed control approach in comparison with hand weeding and herbicides for wheat crop. The experiment was conducted at Agricultural University Research Farm of NWFP Agricultural University, Peshawar during 1999-2000. Ten treatments were studied in the experiment including check, hand wedding, herbicides Assert and Diazon and 20, 30 and 40 kg sorghum extract ha^{-1} applied once and twice. Herbicides Assert and Diazon were sprayed 55 days after sowing. Hand weeding was carried out as required while no weed control was done in check plots. Diazon application resulted in taller plants (98.25 cm), greatest number of grains spike^{-1} and highest grain yield (4545 kg ha^{-1}). Sorghum extract application at the rate of 30 kg ha^{-1} twice increased plant height (97.00 cm), 1000-grain weight (42.00 g), grain yield (4318 kg ha^{-1}) and biological yield (20130 kg ha^{-1}) as compared to check plots. Diazon applied also reduced weeds number (4.00) and weeds dry weight (1.37). It is concluded that use of farm grown sorghum for weed control is less costly, farmers' friendly and organic method of weed control that can be explored as cheap method for increasing wheat yield in weedy fields.

Key Words: Wheat, weed control methods, sorghum water extract and *sorgaab*.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely grown cereal grain crop in the world, except in the rice eating regions of Asia. Wheat products are the principal cereal foods of an over helming majority of the world's inhabitants. Wheat has great adaptability to a wide variety of soil and climatic conditions. But, the important wheat growing areas of the world are located in temperate zones. Wheat is occupying important positions in the economy of Pakistan. A better progress has been made in increasing the per acre yield of wheat in the country during the last few years. But, still Pakistan has a low yield as compared to advanced wheat growing countries. The reasons for low yield are many, but one of the most serious but less noticeable causes of the low yield is the presence of weeds. The crop in Pakistan suffers on the average, losses to the extent of 10 % due to weeds (Ahmad, 1967). Uncontrolled weeds can reduce wheat yield by 24 to 30 % in Pakistan (Nayyer *et al.*, 1994) or even higher depending upon weed infestation (Anonymous, 1997). However, for increasing per unit area yield of wheat, use of high yielding varieties and improved cultural practices are two dominant factors. Frisen and Kanwar (1980) suggested that the crop yield could not be increased without integrated weed management system. Now-a-days weeds are generally controlled by chemical

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methods that are costly and hazardous for health and cause environmental pollution problem. Due to awareness developed in farming community about the risks involved in herbicide usage, new methods of weed control are being evaluated which are safer and harmless for health and environment. Use of *sorgaab* (sorghum water extract) for weed suppression and increase in crop yield has been reported in field studies by Khaliq et al., (1999) and Cheema and Khaliq (2000). The concept of using allelochemicals crop extracts for controlling weeds was 1st given by Putnam and Duke (1974). They found that sorghum residues reduced normal weed population by 95 %. About the frequency of spray different reports have been given as Cheema *et al.*, (2000) and Kaliar (1989) reported that two sprays of *Sorgaab* were economical, while, Ahmad (1998) earlier stated that three *Sorgaab* sprays increased maize grain yield by 33%.

The primary objective of weed control treatment is to increase the yield unit-1 area with minimum expenditure. Now-a-days there is much emphasis on search for new methods of weed control that are safe, harmless, less expensive and uses farm produced material. Allelopathy has emerged as an important area of weed research and has been accepted very recently as important ecological phenomena. Allelopathic plants for example sorghum, sunflower and oats, contain a number of allelochemicals in low quality act as hormones and in high amount as herbicides. Allelopathic crop plants not only control weeds but also enhance crop growth and yield.

MATERIAL AND METHODS

The field experiment entitled "Efficiency of *sorgaab* (sorghum water extract) and herbicide for weed control in wheat (*Triticum aestivum* L.) crop" was conducted during Rabi season of 1999-2000 at Agriculture Research Farm of the NWFP Agricultural University, Peshawar. The plot size was 7 m by 2.8 m with 13 rows 22 cm apart and 7 m long in each plot. Standard agronomic practices were applied. Fertilizer at the rate of 120:90 kg NP ha-1 was applied and gave 5 irrigations. The experiment was conducted using a randomized complete block design with 4 replications. Wheat variety Inqilab-91 was used in the experiment which was sown at the rate 100 kg ha^{-1}. Mature sorghum herbage was used for obtaining water extract for weeds control. The sorghum plants with stem and leaves were cut in small pieces. The material was soaked in water for 24 hours in 1:20 ratio i.e. 1 kg plant herbage and 20 liters of water. Prior to spraying volume of the spray was calibrated by using ordinary water. Water extract of sorghum and herbicides in respective plots were sprayed 55 days after sowing wheat at 4-5 leaf stage. Second spray was done 85 days after sowing. The major weeds recorded in the different plots were *Convolvulus arvensis, Vicia sativa, Avena fatua, Cronopus didymus, Cynodon dactylon, Rumex dentatus, Fumaria parviflora* and *Phalaris minor.*

The following treatments were included in the experiment.

1. Check (No weeding)
2. Hand weeding
3. Assert herbicide (2.4 L ha^{-1})
4. Diazon herbicide (2.5 L ha^{-1})
5. Extract of 20 kg sorghum ha^{-1} sprayed once
6. Extract of 30 kg sorghum ha^{-1} sprayed once
7. Extract of 40 kg sorghum ha^{-1} sprayed once
8. Extract of 20 kg sorghum ha^{-1} sprayed twice
9. Extract of 30 kg sorghum ha^{-1} sprayed twice
10. Extract of 40 kg sorghum ha^{-1} sprayed twice.

Data were recorded on plant height (cm), spikes m^{-2}, non productive tillers m^{-2}, grains $spike^{-1}$, days to maturity, grain yield (kg ha^{-1}), biological yield (kg ha^{-1}) and 1000-grain weight (g).

The data were analyzed according to RCB design and the differences among the treatments were tested by using LSD test (Steel and Torrie, 1980).

Results and Discussion

Plant Height (cm)

Data recorded on plant height are presented in Table 1. Statistical analysis of the data showed that the weed control treatment had significant effect on plant height. The LSD test showed that the differences of weed control treatment with check were significant as they greatly increased plant height. The tallest plants with 98.25 cm plant height were noted in the plots on which Diazon had been sprayed followed by 98 cm tall plants in the plots to which Assert has been applied. The two herbicides produced significantly taller plants as compared to check treatment in which shortest plants having 89 cm plant height were produced. The plausible reason could be that plants sprayed with herbicides and sorghum extract twice resulted in less competition of plants with weeds for nutrients particularly for NPK and environmental factor like water and light which are usually needed in adequate amounts for proper growth. The lesser competition and greater availability of water, nutrient and light resulted in faster rate of growth and taller plants.

Spikes m^{-2}

The data recorded on number of spikes m^{-2} are presented in Table 1. The statistical analysis of the data showed that the weed control treatments had significant effect on number of spikes m^{-2}. The LSD test revealed that all the weed control treatments significantly increased the number of spikes m^{-2} except 20 and 40 kg sorghum extract applied once which slightly enhanced spikes m^{-2} as their differences with check were not significant. The maximum number of 364 spikes m^{-2} was recorded in plots sprayed with Assert herbicides followed by 362.50 spikes m^{-2} noted in plots sprayed with Diazon herbicide as compared to check treatment that produced 309.50 spikes m^{-2}. Application of sorghum extract also increased number of spikes m^{-2}. This may be due to favorable environmental conditions and greater availability of essential nutrients which increased the growth and tillering of plants, led to greater stimulation of vegetative growth and produced favorable conditions for tillering and thus produced more spikes. Similar results were obtained by Mukhapadhyay and Gosh (1980), who reported that herbicides controlled weed efficiently and increased spikes formation as compared to mechanical weed control method.

Non Productive Tillers m^{-2}

Data recorded for number of non productive tillers m^{-2} are given in Table 1. The statistical analysis of the data showed that the weed control treatments had significant effect on non productive tillers m^{-2}. The LSD test showed that all the weed control treatments significantly reduced number of non productive tillers m^{-2} as their differences with check were significant. Wheat in the plots which were sprayed with Diazon herbicide produced lowest number of 6 non productive tillers m^{-2} followed by 7 non productive tillers m^{-2} in plots sprayed with Assert herbicide while the check treatments produced maximum number of non productive tillers m^{-2}. Application sorghum also reduced non productive tillers m^{-2}. Less non productive tillers might be due to less competition between plants for up taking and utilizing nutrients efficiently at tiller formation stage and at later stages.

Grains Spike^{-1}

The data recorded on number of grains spike^{-1} are presented in Table 2. The statistical analysis of the data showed that the weed control treatments had significant effect on number grains spike^{-1}. The LSD test revealed that all the weed control treatments significantly increased the number of spikes m^{-2}, however 20 and 30 kg sorghum extract applied once and 40 kg sorghum extract applied twice slightly enhanced grains spike^{-1} as their differences with check did not reach the significant level. The check with the average of all other treatments was significant and on the average weed control treatments had about 8.67 more grains spike^{-1} as compared to check treatments. Similarly, the differences in number of grains spike^{-1} of wheat from herbicides and sorghum extract plots was also significant and plots treated with sorghum extract 5.67 grains spike^{-1} lesser than to herbicides application. Plots which had received sorghum extract twice produced 3.33 grains spike^{-1} more than plots treated with sorghum extract once and their difference was significant. The probable reason might be that decrease in number of weeds made the nutrients available to the crop that caused initiation of greater numbers of spiklets and florets spike^{-1} in plots where weeds were suppressed. Less grains spike^{-1} were observed in control plots and sorghum extract applied once plants which may be due too the competition of weeds with wheat plants for nutrients, space, light etc. similar results were obtained by Ahmad et al. (1984), who stated that herbicides increased the grains spike^{-1} as compared to hand weeding and no weed control treatments.

Days to Maturity

Data recorded on days to maturity of wheat as affected by weed control treatments are presented in Table 2. The statistical analysis of the data revealed that the weed control treatments had significant effect on days to maturity. The LSD test showed that all the weed control treatments significantly enhanced maturity, except 20, 30 and 40 kg sorghum extract applied once which slightly enhanced days to maturity as their differences with check were not significant. Wheat in the plots which were sprayed with Diazon herbicide took minimum of 171.50 days to maturity. Similarly the other herbicide Assert and 30 kg sorghum extract applied twice reduced days to maturity to 171.75 as compared to check treatment that took maximum of 173.75 days to maturity. The data show that comparison of check with average of all other treatments was significant and on the average weed control treatment enhanced maturity by 1.39 days. Similarly the difference in days to maturity in herbicides and sorghum extract treated plots was also significant and plots to which herbicides had been applied enhanced maturity by 0.96 days as compared to plots that had received sorghum extract. Wheat treated with sorghum extract twice revealed maturity stage 0.83 days earlier than sorghum extract application once and their differences was significant. The possible argument may be that herbicides and sorghum extract twice reduced competition between wheat and weeds for nutrients and environmental factors which may have accelerated development of wheat plants causing to mature early.

Grain Yield (kg ha^{-1})

Data recorded on grain yield are presented in Table 2. The statistical analysis of the data revealed that the weed control treatments had no significant effect on grain yield. The LSD test comparing the weed control treatments with check showed that all the weed control treatments significantly increased grain yield, except 20 kg sorghum extract applied once which slightly increased grain yield as its difference with check was not significant. The maximum grain yield of 4544 kg ha^{-1} was produced in plots sprayed with

Diazon herbicides followed by 4318 kg ha^{-1} in plots treated with 30 kg of sorghum extract applied twice as compared to 3279 kg ha^{-1} grain yield recorded in check treatment. These results are in the agreement with Cheema et al. (1997), who showed that increasing the concentration of sorghum extract from 50 % to 100 % improved wheat grain yield by 14 %. This may be due to the fact that all the yield components were higher in plants treated with herbicides and sorghum extract twice which increased grain yield ha^{-1}. The possible reason for high grain yield in the different weed control treatment may be that increase availability of nutrients and reduced competition stimulated vegetative growth which resulted in better spike population and more grains spike^{-1} and ultimately higher grain yield.

Biological Yield (kg ha^{-1})

Data recorded on biological yield are presented in Table 3. Analysis of the data revealed that the weed control treatments had significant effect on biological yield. The LSD test showed that the differences of all weed control treatments with check were significant, which means that weed control treatments significantly increased biological yield. The maximum biological yield of 20130 kg ha^{-1} was produced treated with 30 kg of sorghum extract applied twice followed by 19968 kg ha^{-1} in plots which sprayed with Assert herbicide. The lowest of biological yield 13636 kg ha^{-1} was noted in check treatments. These results are in agreement with Cheema et al. (1997), who showed that increasing the concentration of sorghum extract from 50 % to 100 % improved wheat grain yield by 14 %. This may be due to the fact that all the yield components were higher in plants treated with herbicides and sorghum extract twice which increased grain yield ha^{-1}. The possible reason or high grain yield in the different weed control treatments may be that increase availability of nutrients reduced competition simulated vegetative growth which resulted in better spike population and more grains spike^{-1} and ultimately higher grain yield.

1000-Grain Weight (g)

Data on 1000-grain weight of wheat as affected by weed control treatments are presented in Table 3. Analysis of the data revealed that the wed control treatments had significant effect on grains weight. All the weed control treatments significantly increased grain weight, however, 20 kg sorghum extract applied once slightly increased 1000-grain weight as their difference with check did not reach the significant level. The maximum 1000 grains weight of 42 g was recorded in plots which received 30 kg sorghum extract applied twice followed by 41.25 g in plots sprayed with Assert herbicides as compared to 34.75 g grain weight observed in check plots. The probable reason for higher yield in weed control plots might be that herbicides and sorghum extract twice reduced the wheat plants competition with weeds for nutrients, light, moisture and space and thus maximized the utilization of nutrients from the soil which finally developed heavy seeds. Similar results were obtained by Salisbury and Ross (1978), who found that sorghum extract increased grain weight by suppressing the vegetative growth.

Weed Density m^{-2}

Data recorded on weed density at 65 days presented in Table 4 revealed that all weed control treatments significantly affected the weeds density. Minimum number of weeds was noted in herbicides sprayed plots while 20 kg sorghum extract applied once produced higher number of weeds. It was noted that as the concentration and number of application of sorghum extract increased, the number of weeds were reduced accordingly. Theses results are in agreement with the findings of Putnam and Duke (1979), Bhowmik and Dolt (1982) and Parvis and Jessop (1985), they reported that

sorghum water extract suppressed weeds germination and growth more than that of wheat.

Weed Dry Weight (g m^{-2})

Table 4 showed the data on dry weight of weeds was significantly affected by weed control treatments. Plots sprayed with Diazon and Assert showed the lowest number of weeds recorded at 65 days. These results are in conformity with those of Jalis et al. (1979) and Hatam (1981). They reported that herbicides proved most effective even at their minimum rate. Sorghum extract application at the rate of 40 and 30 kg ha^{-1} twice produced lowest dry weight of weeds noted at 65 days after sowing. The highest dry weight of weeds noted in control plots. These findings are in agreement with Saleem and Fawusi (1983), who observed that lower concentration of sorghum water extract promoted the germination while higher concentration inhibited the germination and growth of weeds. Lower weeds dry matter may be due to the lower number of weeds and their lowest fresh weight.

It is concluded that among all the weed control treatments, herbicides gave the best results but the alleochemic effects of sorghum extract were also prominent and followed the herbicides. In case of sorghum increase the rate upto 30 kg ha-1 and number of application, gave better results accordingly. Sorghum extract affect weeds and wheat growth due to either inhibitory or stimulatory effects depending upon the quantity of sorghum and stage of growth of wheat.

Table-1. Plant Height (cm), Spikes m^{-2} and Non Productive Tillers m^{-2} of wheat as affected by weed control treatments with means for the meaningful comparisons

Treatments	Plant Height (cm)	Spikes m^{-2}	Non Productive Tillers m^{-2}
Check (No weeding)	89.50 e	309.50 c	16.00 a
Hand weeding	96.50 b	355.50 a	11.00 c
Assert	98.00 a	364.00 a	7.00 e
Diazon	98.25 a	362.50 a	6.00 f
Extract of 20 kg sorghum ha^{-1} sprayed once	91.25 d	319.50 bc	14.50 b
Extract of 30 kg sorghum ha^{-1} sprayed once	92.25 d	330.25 b	13.00 b
Extract of 40 kg sorghum ha^{-1} sprayed once	94.00 cd	326.25 bc	12.00 bc
Extract of 20 kg sorghum ha^{-1} sprayed twice	97.00 a	361.00 a	8.75 d
Extract of 30 kg sorghum ha^{-1} sprayed twice	97.00 a	360.75 a	8.00 d
Extract of 40 kg sorghum ha^{-1} sprayed twice	95.00 c	339.00 b	9.75 cd
LSD at 0.05 alpha level	1.25	18.04	1.26

Table-2. Grains Spike^{-1}, Number of Days to Maturity and Grain Yield (kg ha^{-1}) of wheat as affected by weed control treatment with means for the meaningful comparison

Treatments	Grains Spike^{-1}	Number of Days to Maturity	Grain Yield (kg ha^{-1})
Check (No weeding)	36.00 d	173.75	3279d
Hand weeding	46.00 a	172.50	4253a
Assert	46.75 a	171.75	4285a
Diazon	50.75 a	171.50	4545a
Extract of 20 kg sorghum ha^{-1} sprayed once	40.25 c	173.25	3831c
Extract of 30 kg sorghum ha^{-1} sprayed once	44.50 ab	173.00	4058b
Extract of 40 kg sorghum ha^{-1} sprayed once	39.50 c	172.75	3896c
Extract of 20 kg sorghum ha^{-1} sprayed twice	46.25 a	172.25	4253ab
Extract of 30 kg sorghum ha^{-1} sprayed twice	45.50 ab	171.75	4318a
Extract of 40 kg sorghum ha^{-1} sprayed twice	42.50 b	172.50	4025ab
LSD at 0.05 alpha level	6.72	1.08	554

Table-3. Thousand Grain Weight (g) and Biological Yield (kg ha^{-1}) of wheat as affected by weed control treatment with means for the meaningful comparison

Treatments	1000-Grain Weight (g)	Biological Yield (kg ha^{-1})
Check (No weeding)	31.25c	13636d
Hand weeding	39.00a	18993ab
Assert	41.25a	19968a
Diazon	40.75a	19643a
Extract of 20 kg sorghum ha^{-1} sprayed once	35.00b	16720c
Extract of 30 kg sorghum ha^{-1} sprayed once	37.00ab	16233c
Extract of 40 kg sorghum ha^{-1} sprayed once	39.00a	17045b
Extract of 20 kg sorghum ha^{-1} sprayed twice	38.75ab	18506ab
Extract of 30 kg sorghum ha^{-1} sprayed twice	42.00a	20130a
Extract of 40 kg sorghum ha^{-1} sprayed twice	39.75a	17208ab
LSD at 0.05 alpha level	4.78	1686

Table-4. Number of Weeds and Dry Weight of Weeds (g m^{-2}) of wheat as affected by weed control treatment with means for the meaningful comparison

Treatments	Number of Weeds m^{-2}	Weeds Dry Weight (g m^{-2})
Check (No weeding)	18.75 a	9.45 a
Hand weeding	10.00 bc	4.89 c
Assert	5.50 c	2.47 d
Diazon	4.00 c	1.37 e
Extract of 20 kg sorghum ha^{-1} sprayed once	13.00 b	5.91 ab
Extract of 30 kg sorghum ha^{-1} sprayed once	12.25 b	5.66 b
Extract of 40 kg sorghum ha^{-1} sprayed once	11.25 b	5.37 b
Extract of 20 kg sorghum ha^{-1} sprayed twice	10.50 bc	5.10 b
Extract of 30 kg sorghum ha^{-1} sprayed twice	10.00 bc	4.70 c
Extract of 40 kg sorghum ha^{-1} sprayed twice	9.25 bc	4.15 c
LSD at 0.05 alpha level	1.69	0.82

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