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Efficacy of various herbicides on yield and growth of wheat

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Abstract

Wheat (*Triticum aestivum* L.) is a staple food crop globally, providing essential nutrients and energy for billions of people. Its cultivation is challenged by various weeds that compete for resources, leading to reduced yields and lower quality grains. Effective weed management is crucial for maximizing wheat production, and herbicides play a significant role in this process. Therefore the objective of this research is to find the most effective herbicide Studies were carried out to evaluate the efficacy of various post emergence herbicides on weeds in wheat crop at Agricultural faculty farm, Kabul University under irrigated conditions, during 2020-21. chemical control of weeds was hypothesized to be the best solution for wheat's weeds and for this purpose, a field study was carried out to evaluate the relative efficacy of various post-emergence herbicides viz. 2,4-D @ 1.0 L ha^{-1}, MCPA+2,4-D @ 1.0 L ha^{-1}, Buctril-super 60 EC (Bromoxynil + MCPA) @ 0.750 L ha^{-1}, Atlantis 3.6 WG (Mesosulfuron + iodosulfuron) @ 0.7 Kg ha^{-1} and Starane-M (fluroxypyr +MCPA) @ 0.750 L ha^{-1} for controlling weeds in wheat. The results of field experiment clearly showed that the plots treated with Buctril-super, 2,4-D, MCPA+2,4-D, Starane-M, Atlantis and hand weeding produced a higher number of tillers, plant height, spike length, and biological yield when compared with other treatments. The highest biological yield (10.611 t. ha^{-1}) and grain yield (4.812 t. ha^{-1}) were recorded in plots treated with Buctril-super compared to other applied herbicides. Therefore, Buctril-super is recommended for best control of broad-leaved weeds and taking an economical yield of wheat.

Keywords: Comparative efficiency, Post-emergence herbicides, Broadleaved weeds and wheat yield and growth.

د غنمو په ودې او حاصل باندې د مختلفو هرزه ګیاوو وژونکو اغیزمنتوب

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لنډیز

غنم (*Triticum aestivum L.*) د نړۍ په کچه د خوراکي توکو یو مهم نبات دی، چې د ملیاردونو خلکو لپاره اړین غذایي مواد او انرژي چمتو کوي. دغه نبات د مختلفو زیان رسوونکو واښو لخوا ننګول کیږي چې د سرچینو لپاره ورسره سیالي کوي، چې د حاصلاتو کمښت او د ټیټ کیفیت لرونکو دانو لامل کیږي. د زیان رسوونکو واښو اغیزمن مدیریت د غنمو تولید اعظمي کولو لپاره خورا مهم دی، او واښه وژونکي پدې پروسه کې مهم رول لوبوي. د دې څیړنې موخه دا ده چې تر ټولو اغیزمن واښه وژونکي وموندل شي. د مني موسم 2020-21 په جریان کې د کابل پوهنتون د کرنې پوهنځي فارم کې د غنمو په نبات کې د زیان رسوونکو واښوکنټرول په اړه د بوټو وژونکو د اغیزمنتیا ارزولو لپاره مطالعات ترسره شوي. د زیان رسوونکو واښو کیمیاوي کنټرول اټکل شوی و، چې د غنمو د زیان رسوونکو واښو کنترول لپاره غوره حل لاره دی او د دې هدف لپاره، ساحوي څیړنه ترسره شوه ترڅو د نبات راڅرګندیدو وروسته په غنمو کې د زیان رسوونکو واښو کنټرول لپاره د مختلفو بوټو وژونکو لکه 2,4-D @ 1.0 L ha^{-1}, MCPA+2,4-D @ 1.0 L ha^{-1}, Buctril-super 60 EC (Bromoxynil + MCPA) Atlantis 3.6 WG (Mesosulfuron + iodosulfuron) @ 0.7 Kg ha^{-1}, Starane-M @ 0.750 L ha^{-1} (fluroxypyr +MCPA) او د Buctril-super ، 2,4-D MCPA + ، 2,4-D، Starane-M ، Atlantis او د ha^{-1} نسبي اغیزمنتیا وارزول. د ساحوي تجربې پایلو په روښانه توګه وښودله چې لاس په واسطه خشاوه شوي پلاټونه د یو بل په پرتله د لوړ شمیر ټیلرونو (فرعي ساقو)، د نبات قد لوړوالی، د سپیک (وړي) اوږدوالی، او بیولوژیکي حاصل تولید کړی. د هرزه وژونکو استعمال تر ټولو لوړ بیولوژیکي حاصل (10.611 t. ha^{-1}) او د دانو حاصل (4.812 t. ha^{-1}) د نورو استعمال شوو بوټو وژونکو په پرتله د بکټریل سوپر سره استعمال شوي پلاټونو کې ثبت شوي و. له همدې امله، Buctril-Super د پلن پاڼو لرونکو زیان رسوونکو واښو غوره کنټرول او د غنمو اقتصادي حاصل اخیستلو لپاره سپارښتنه کیږي.

کلیدي ټکي: مقایسوي موثریت، د نبات را ټوکیدو وروسته هرزه واښه وژونکي، پلن پاڼي زیان رسوونکي واښه او د غنمو حاصل او وده.

Introduction

Wheat (*Triticum aestivum* L.) A strategic grain crop that is important locally and world, where food is the staple of most of the world's population and has an important role play in food security and the most important crops in Afghanistan. It ranks first in the area of Agriculture but that is a weak competitor for weed compared Stages of growth, the weed is causing a loss of up to 45% (13).

The area of wheat cultivation in Afghanistan is more than 2.00 million hectares with an average yield of 3.60 million tons (6). Wheat is used for making chapatti, bread, biscuit, cakes, pasta, noodles, etc. Wheat straw is used to feed livestock, making chipboard, poultry bedding and mixed with mud to spread on the roofs of the houses, etc. Despite the combined efforts of scientific and farming com- munity, the potential yield, i.e. (6 t ha^{-1}) could not be achieved still. The gap between the actual and potential yield of wheat is due to many factors like an infestation of insects, diseases, and weeds. Regardless of all the other ways of crop yield enhancement, weed control is one of the important key factors in crop yield improvement particularly in Kabul Province to cope with the annual weed population blast. Weeds compete with crops for available moisture, nutrients, space, and light and provide shelter for harmful insect-pests which result in yield reduction.

They exude all allopathic chemicals in the soil; provide environments for disease-causing agents along with the allocation of substitute host for several insects; and increase the cost of harvesting (11). Weeds are responsible for declining crop yield, not only through competing for essential limiting factors of plant growth and development but also through the release of certain allelochemicals from the root system and other parts of plants into the root zone of desired crop plants. Herbicides successfully control weeds and improve the grain yield of crops (8, 20, 27). In the cropping system, it is a very effective method of weed control as it minimizes the crop productivity losses due to weed invasion and reduces the subsequent infestation of weeds at low and persistent levels. Weed management is a decision-making process based on the basic principles of science that bring together the information of climate, weed lifespan i.e. seeds, newly emerged plant, vegetative growth stages, flowering and seed set, and their relationship to the environment and all accessible approaches for weed management by the most cost-effective and environ- mentally sustainable ways. Weed seeds contaminate the crop seeds and increase the harvesting cost (26). Thus weeds decrease the yield, quality and market value of crop seeds (9).

Chemical weed control is preferred because of less labor investment and no mechanical damage to the crop that happens during manual weeding. The literature reviewed on the subject indicated that the chemical method to control weeds had been found comparatively efficient and economical (10, 23). Chemical weed control is efficient in producing higher grain yield even than hand weeding (5). For obtaining best results, chemical control of weeds emphasis should be on the best choice for herbicide selection, environment and effective dose of herbicide as the non-judicious use of herbicides can reduce the crop productivity instead of improving yield (29).

Keeping in view the importance of wheat and weed associated problems in changing the environment as well as market situations this study might be considered an essential component of weed management. The need of time is to check the relative effectiveness of newly introduced post-emergence herbicidal chemistry for the guidance of farming community. Keeping all these factors in view the objectives of this study were to compare and evaluate the relative efficacy of post-emergence herbicidal chemistry against broad-leaved weeds suppression and to evaluate the growth and establishment of the wheat crop.

Materials and methods

The experiment was conducted at Research Farm, Agronomy Department of, Kabul University Kabul, Afghanistan during rabi season of 2020-21. Kabul is located at 34 54' 44.1" N latitude and 700 10' 9.2" longitudes and altitude 1791 meters (5876 Ft) above sea level. The climate of the experimental site in

Kabul is cold in winter, with an average temperature in January of -1 ^{0}C (30 ^{0}F), usually freezing nights and with possible peaks of -20/-25 ^{0}C (-4/-13 ^{0}F). Snowfalls are fairly frequent and sometimes heavy. Summer is hot during the day but nights remain usually cool. Precipitation in Kabul is (300 mm) per year. The rainiest season is spring. In the summer it rarely rains.

The land was prepared by two ploughing with cultivator followed by planking. The experiment was laid out in Randomized Complete Block design (RBD) with seven treatments viz. Weedy check, weed free check, 2,4-D @ 1.0 L ha^{-1}, MCPA+2,4-D @ 1.0 L ha^{-1}, Buctril-super 60 EC (Bromoxynil + MCPA) @ 0.750 L ha^{-1}, Atlantis 3.6 WG (Mesosulfuron + iodosulfuron) @ 0.7 Kg ha^{-1} and Starane-M (fluroxypyr +MCPA) @ 0.750 L ha^{-1} and replicated thrice, with plot size of 3 x 4 m^2. All the cultural practices were followed according to the recommendations except treatments.

The wheat variety "Kabul-13" was sown with a tractor-drawn rabi drill with a seeding rate of 110 kg ha^{-1}. The soil of the experimental field was sandy loam with low organic matter and available nitrogen, medium in available potassium but low in available phosphorus. Soil pH and EC were 8.1 and 0.16 dSm^{-1}, respectively. Urea granules (46%N) and DAP (18%N, 46% P_2O_5) were used for supplying 120 kg N and 60 kg P_2O_5/ha. One third N and full dose of P_2O_5 were applied as plough sole placement before sowing and the remaining urea granules (46%N) were applied as 1/3 at the jointing stage and remaining 1/3 at the anthesis stage.

Wheat parameters viz. number of tillers/m^2, plant height (cm), spike length (cm), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}) and harvest index (%) were also measured. The statistical analysis of mean data was done by using the software STAR. The least significant difference (LSD) test at 0.05 probability levels was applied to compare the difference among treatments means.

Results and Discussion

Plant height (cm)

The data pertaining to plant height is presented in Table 1. It is evident from the data that there was no significant difference among treatments for plant height as all the herbicidal treatments were at par with one another except Atlantis which gave minimum plant height of 82.68 cm. The results of this study are in correspondence with the findings of (28) who stated that the expression of growth attributes is more associated with inheritance than herbicidal treatments. The minimum plant height (79.91 cm) was recorded in case of control treatment indicating suppressive effect of weeds. In the study in hand, Atlantis affected plant height character more apparently in plots where Atlantis was applied. Sherawat *et al.* (29) who have reported the similar findings and narrated that Atlantis decreased the plant height when applied at recommended rates.

Number of tillers (m^{-2})

Analysis of the data revealed that various herbicides showed a significant effect on the number of wheat tillers m^{-2} (Table 1). Comparison of the treatment means revealed that the maximum numbers of tillers (439.45 m^{-2}) were recorded with the application of Buctril-super followed by 2,4-D (424.60 m^{-2}) and Starane-M (398.10 m^{-2}). Remaining treatments produced an almost similar number of tillers. The minimum number of tillers m^{-2} was observed against weedy check. Buctril-super suppressed weeds efficiently, so in the absence of weeds the crop plants established well and produced the maximum number of tillers m^{-2}. Malik *et al*. (24) reported that number of tillers significantly improved with the control of broadleaved weeds when Buctril-super was applied at recommended doses compared to other herbicides used in this study.

Spike length (cm)

Data concerning spike length were analyzed statistically and are presented in Table 1. Maximum spike length (8.96 cm) obtained with 2,4-D application followed by Buctril-super (8.62 cm). Increase in spike length may be attributed to minimum crop-weeds competition in treated plots as significant weed mortality. Ahmad *et al*. (1) and Marwat *et al*. (25) have reported the similar results for Buctril-super. The minimum spike length (8.11 cm) was recorded against weedy check that was at par with MCPA+2,4-D (8.25 cm) and Atlantis (8.30 cm), which clearly indicated poor weed control compared to the above-mentioned herbicides, so competition for light, CO_2 , O_2 , water, etc. existed and in turn reduced spike length. Similar results have been reported by Borras *et al*. (14).

Number of grains spike^{-1}

The data pertaining to the number of grains spike^{-1} are given in Table 1. The greater number of grains spike^{-1} were recorded in plots treated with 2,4-D (57.85) compared to the rest of the treatments. It was found at par with Buctril-super (57.83). It was probably due to better weed control in treated plots that provided a favorable environment to the crop plants to utilize natural resources efficiently for producing a large number of grains spike^{-1}. The weedy check produced a smaller number of grains spike^{-1} (42.14) followed by Atlantis (46.60) and MCPA+2,4-D (51.10). It was probably because of congenial environment provided for weeds to compete with main crop plants for natural sources which reduced the spike length as well as number of grains spike^{-1}. Cheema and Akhtar (15) observed the similar results and concluded a small number of grains spike-1 in plots who received no treatment and resulted in poor weed control.

1000-grain weight (g)

The data given in Table 1 showed significant differences among treatments regarding 1000-grain weight (g). The highest1000-grain weight (g) (43.98 g) was recorded for weed-free check followed by Buctril-super (42.61 g) and 2,4-D (42.38 g). As both these herbicides provided increased spike length, grains spike and grain weight spike due to the optimum weed control efficacy. Weedy check produced minimum 1000-grain weight (38.71g) followed by Atlantis (39.31 g) and others. Atlantis caused plant injury and resulted in reduced plant height and other yield parameters which produced minimum 1000-grain weight. In weedy check, no treatment was applied to control weeds. Therefore they caused significant competition with crop and reduced 1000-grain weight. These findings are in conformity with those of Bibi *et al*. (2), Cheema and Akhtar (15) and Khan *et al*. (21), who found that weedy check treatment, showed significant crop-weeds competition for natural resources which restricted the crop plants to utilize inputs efficiently, therefore resulted in poor crop production.

Biological yield (kg ha)

The data related to biological yield are given in Table 1. The data indicated that all applied treatments provided similar results for biological yield means and were at par with each other except weedy check that showed the minimum value for biological yield (6.298 t ha^{-1}) followed by Atlantis (7.868 t ha^{-1}). It was probably due to the poor performance of herbicide to control weeds, so weeds dominance restricted crop plants from the utilization of natural resources effectively and resulted in lower biological yield as compared to other treatments. Ahmad *et al*. (1), Malik *et al*. (24) and Marwat *et al*. (25) also observed that herbicides increased biological yield in wheat. Therefore, it is essential to control weeds effectively to harvest maximum possible grain yield of wheat with superior quality (Marwat *et al*., (25). Most prevalent Data pertaining to harvest index are presented in Table 1. It indicated that the maximum value was observed with weed free check (50.51 %) which was followed by a weedy check (34.11 %). Rests of the other treatments were at par with each other.

Grain yield (kg ha)

The data related to grain yield are given in Table 1. The data of Table 1 indicated that weed-free check plot produced maximum grain yield (4.858 t ha^{-1}) followed by Buctril Super applied plot (4.812 t ha^{-1}) and Starane-M (4.363 t ha^{-1}), MCPA+2,4-D (4.509 t ha^{-1}) which were statistically at par with each other. Grain yield was minimum (2.148 t ha) in the weedy check plots followed by others plots. The minimum grain yield in weedy check and Atlantis applied plots may be probably due to the poor performance of herbicide to control weeds, so weeds dominance restricted crop plants from the utilization of natural resources effectively and resulted in lower grain yield as compared to other treatments. Ahmad *et al*. (1), Malik *et al*. (24) and Marwat *et al*. (25) also observed that herbicides increased grain yield in wheat. Therefore, it is essential to control weeds effectively to harvest maximum possible grain yield of wheat with superior quality (Marwat *et al*., (25).

Table 1. Effect of various herbicide treatments on wheat growth and yield.

Treatments	Number of tillers (m^{-2})	Plant height (cm)	Spike length (cm)	Number of grains $spike^{-1}$	1000 Grain weight (g)	Biological yield (t ha^{-1}	Grain yield (t ha^{-1})	Harvest index (%)
Weedy check	314.30 ^{*e}	79.91 ^{c}	8.11^{e}	42.14 ^{c}	38.71 ^{de}	6.298 ^{c}	2.148 ^{c}	34.11 ^{c}
Weed free check	368.30 ^{d}	94.45 ^{a}	8.50^{abcd}	54.35^{ab}	43.98^{a}	9.618^{a}	4.858 ^{a}	50.51 ^{a}
2,4-D	424.60 ^{b}	96.65 ^{a}	8.96^{a}	57.85^{a}	42.38^{abc}	9.687^{a}	4.183 ^{bc}	43.15 ^{b}
MCPA+2,4-D	366.20 ^{d}	95.85 ^{a}	8.25 ^{de}	51.10^{abc}	41.19^{abcd}	10.520^{a}	4.509 ^{ab}	42.86 ^{b}
Buctril-super	439.45 ^{a}	96.34 ^{a}	8.62 ^{abc}	57.83^{a}	42.61^{ab}	10.611^{a}	4.812 ^{a}	45.12 ^{b}
Atlantis	356.25 ^{de}	82.68 ^{b}	8.30 ^{cde}	46.60^{bc}	39.31^{cde}	7.868^{b}	3.502 ^{d}	44.52 ^{b}
Starane-M	398.10 ^{c}	96.62 ^{a}	8.35 ^{*bcde}	44.82^{c}	40.18^{bcde}	10.590^{a}	4.363 ^{abc}	41.99 ^{b}

**Any two means in a column not sharing a letter in common differ significantly at 5 % probability level.*

Conclusion

Weed free check (Hand weeding) and Buctril-super proved to be more efficient, productive and economical herbicide in controlling broad-leaved weeds in wheat compared to other applied herbicides. Moreover, grain yield of wheat were highest under Weed free check (Hand weeding) and Buctril-super plots. In a field experiment on wheat, observed that among the weed control treatments, hand weeding gave the highest grain yield and was significantly superior to herbicide treatments but the highest net return of investment was recorded in case of Buctril-super followed by hand weeding and other applications. Therefore, Buctril-super is recommended for best control of broad-leaved weeds and to get an economical yield of wheat.

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