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Impact of integrated weed management on weed biomass, growth and yield of maize (*Zea mays* L.) in Kunar, Afghanistan

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Abstract

Weeds are the major pest of maize and adversely affect growth and yield of crop. A field experiment was conducted during *spring* season of 2018 at Research Farm of Sayed Jamaluddin Afghani University (SJAU), Kunar, Afghanistan to assess the impact of integrated weed control methods on weed biomass and performance of maize crop. The experiment consisted of seven treatments, viz., T_1 Unweeded; T_2 Weed free; T_3 Two times hand weeding at 20 and 50 DAS; T_4 atrazine @ 0.75 kg a.i. ha^{-1} as pre-emergence; T_5 atrazine @ 1 kg a.i. ha^{-1} as pre-emergence; T_6 atrazine @ 0.75 kg a.i. ha^{-1}as pre-emergence with a hand weeding at 50 DAS and T_7 atrazine @ 1 kg a.i. ha^{-1}as pre-emergence with a hand weeding at 50 DAS and laid out in randomized block design (RBD) with three replications. The results indicated that there were many weeds species observed in the field of experiment, but the major weed species were *Cyperusrotundus, Sorghum halepense,Cynodondactylon, Convolvulus arvensis, Chenopodium album, Trianthema portulacastrum, Portulacaoleraceae, Parthenium hysterophorus and Setariaviridis*. The result showed that, the most effective treatment among other treatment in controlling weed population and increased the growth and grains yield of maize were weed free and atrazine @ 1 kg a.i. ha^{-1} as pre-emergence with a hand weeding at 50 DAS. These approaches of weed management significantly controlled weed and improved the yield and yield component of maize in the experiment. Thus, it was concluded that, atrazine @ 1 kg a.i. ha^{-1} as pre-emergence with a hand weeding at 50 DAS is more effective in term of weed control and yield of maize as compared to other treatments.

Key words: Integrated weed management, weed biomass, growth, yield, maize

Maize (*Zea mays* L.) is one of the most vital cereal crops in the world by means of a food, fodder crop for livestock and feed for poultry. In Afghanistan, the total production of maize in 2021-2022 was 0.180 million tones and total area was 0.921 million ha with the average productivity of maize is 1.95 tons ha^{-1}. This productivity is very low comparing with world's average yield of 5.8 tons ha^{-1}(FAOSTAT, 2021). Maize lower productivity is due to several reasons in our country, among them high weed infestation and their poor management and unsuitable planting methods are common problems. Maize is widely spaced crop and gets infested with various weeds and subjected to heavy weed competition especially in the early growth stage of crop, which often imposes huge grain yield of maize ranged from 27-60% (Kumar *et al*., 2015) for the reason that weeds are wild emerging and grow quickly harshly competing with the crop for growth resources like nutrients, moisture, sunlight and space during whole vegetative and early reproductive stages of maize. Weeds were managed mechanically by simple hand tools and bullock or tractor drawn implement at earlier time which was time and energy consuming and lack of agri-

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cultural labors is a main problem. Now a day, the use of chemical herbicides is alternative approach to manage weeds as they control them effectively (Ishrat *et al.,* 2012). Pre emergence applied herbicides with monitory cultural methods plays a vital role to control such as pre emergence applied atrazine with hand weeding control weeds effectively and economically (Singh *et al.,* 2015). Application of atrazine 1.0 kg ha^{-1} as pre emergence followed by hand weeding at 30 DAS minimize significantly weeds infestations and was more effective (Gowtham and Thalkar, 2020). Weed control through use of herbicides in maize has received little attention in Afghanistan. However, low weed population can be positive to the crop growth. In near future, agricultural labor will become scarce and expensive. Thus, it is essential to control the weeds in maize field by developing proper technique through mechanical methods with combined use of herbicides. Keeping above points in view, this experiment was conducted to evaluate the "Impact of integrated weed management on weed biomass, growth and yield of maize in Kunar, Afghanistan".

Materials and Methods

A field experiment was conducted during 2018 at Research Farm of Sayed Jamaluddin Afghani University (SJAU), Kunar, Afghanistan (34o 83' N latitude; 71o 12'E longitude and (827m AMSL) to evaluate the "Impact of integrated weed management on weed biomass, growth and yield of maize. The climate of the site is classified as warm and temperate. The hottest moth of the year was July, with maximum temperatures hovering around 36 ^{0}C, while the coldest month was January, with a mean low temperature of 2.45^{0}C. the average annual rainfall was roughly 960 mm, with approximately 595 mm falling during the crop growing season. The experiment was arranged in randomized block design with three replications. There were seven treatments Viz; T_1 Unweeded; T_2 Weed free; T_3 Two times hand weeding at 20 and 50 DAS; T_4 Atrazine @ 0.75 kg a.i. ha^{-1} as pre-emergence; T_5 Atrazine @ 1 kg a.i. ha^{-1} as pre-emergence; T_6 Atrazine @ 0.75 kg a.i. ha^{-1} as pre-emergence with a hand weeding at 50 DAS and T_7 Atrazine @ 1 kg a.i. ha^{-1} as pre-emergence with a hand weeding at 50 DAS. Urea, diammonium phosphate, and muriate of potash, respectively, served as the sources of the nutrients (N, P, and K). The considering recommended dose of fertilizer (RDF) 180 kg N ha^{-1}, 80 kg P ha^{-1} and 40 kg K ha^{-1} was applied in maize crop. The whole dose of P and K and half dose of N were administered at basal at sowing, and the remaining N was top dressed at the first and second irrigation. Across the study year maize hybrid cultivar "Gorila" two seeds per hill were hand dibbled on proper prepared seed bed during second week of April at 75 cm x 25 cm crop geometry and harvested at last week of August. The crop was raised with recommended package of practices. The herbicide was applied as pre-emergence a day after sowing using knapsack sprayer fitted with flat fan nozzle by mixing 500 liters water ha^{-1}. The observations of different parameters such as weedpopulation, weed dry weight, weed control efficiency (WCE), weed index (WI), plant height, No. of cobs $plant^{-1}$, 1000 grains weight, grains yield and harvest index were recorded by following the standard procedures. The following formulas were used to measure the weed control efficiency and weed index:

$$WCE\ (\%) = \frac{\text{Weed popullation in unweeded plot– weed population in treated plot}}{\text{weed population in unweeded plot}} \times 100$$

$$WI\ (\%) = \frac{\text{Weed dry weight in unweeded plot – weed dry weight in treated plot}}{\text{Weed dry weight in unweeded plot}} \times 100$$

The data collected of different parameters were subjected to appropriate statistical analysis under randomized block design by following the procedure of ANOVA analysis of variance(SAS Software packages, SAS EG 4.3). Significance of difference between means was tested through 'F' test and the least significant difference (LSD) was worked out where variance ratio was found significant for treatment effect. The treatment effects were tested at 5% probability level for their significance.

Results and Discussion

Impact on weeds

Integrated weed control methods showed that significantly negative impacts on weed popula-

tion and weed dry matter at 90 DAS as compared with the un-weeded plot. There were many weed species observed in the field experiment, but the major weed species were *Cyperusrotundus, Sorghum halepense, Cynodondactylon, Convolvulus arvensis, Chenopodium album, Trianthema portulacastrum, Portulacaoleraceae, Parthenium hysterophorus and Setariaviridis.* This report is almost in line with who reported similar weeds in maize field (Singh *et al.,* 2015; Kumar *et al.,* 2017; Paul *et al.,* 2023). Significantly highest weed population (115.0) and weed dry weight (102.4 g) were recorded in T_1, whereas, the lower weed population (14.1) and weed dry weight (2.23 g) values were seen in T_2 followed by T_7 and T_6 (Table 1). The same report was also given by Rawal *et al.,* 2017 and specified that the highest weed dry matter was observed underweedy check plot which was significantly higher than weed free during two years continual experiments. The highest weed control efficiency showed the most effective treatment against weeds in growing crops. In the present study highest weed control efficiency (63.6) was recorded in T_2 treatment followed by T_7 and T_6. This might be due to lesser competition of weeds achieved by effective control in first and second flush of weeds which resulted in reduction in weed density and dry weight. The same reports were given by Mathukia *et al.,* 2014. The maximum weed index (57.9) was found in T_1 treatment followed by T_3. However, the minimum weed index (3.5) was observed in T_7 and T_6. The significantly lower weed index value was found because of superiority of treatment than weed free check. It might be due to application of herbicides preventing weed germination, growth and development as compared to weedy check plot. The same results were observed by (Kantwa *et al.,* 2020).

Impact on growth

Data showed that plant height of maize was significantly enhanced by integrated weed management methods (Table 1). Weed free treatment T_2 noted the highest plant height (262.2 cm) as compared to the other treatments but remain statistical at par with T_7. On the other hand, T_1 treatment recorded the significantly lowest plant height (215.5 cm) as compare to other treatments, respectively. It indicates that weeds reduced the plant height due to competition for growth resources. These results were found to be almost similar with (Gowtham and Thalkar, 2020; Singh *et al.,* 2021). The highest leaf area index (4.24) value

Table 1. Weed population, weed dry weight, weed control efficiency, weed index, plant height, leaf area index, No. of cobs plant^{-1} and 1000 grains weight as influenced by integrated weed control methods

Treatments	Weed population m^{-2}	Weed dry weight (g)	Weed control efficiency (%)	Weed index (%)	Plant height (cm)	Leaf area index	Cobs plant^{-1}	1000 grains weight (g)
T_1: Unweeded (Control)	10.28 (115.0)	9.93 (102.4)	-	57.9	215.5	2.87	1.00	272.0
T_2: Weed free	3.74 (14.1)	1.79 (2.23)	63.6	-	262.2	4.22	1.60	340.0
T_3: Hand weeding at 20 and 50 DAS	8.25 (72.4)	8.41 (73.1)	19.8	47.7	220.3	3.41	1.13	308.3
T_4: Atrazine @ 0.75 kg a.i. ha^{-1} as pre-emergence	7.71 (63.9)	7.72 (60.6)	25.0	29.0	237.4	3.46	1.27	316.3
T_5: Atrazine @ 1 kg a.i. ha^{-1} as pre-emergence	7.12 (53.8)	7.05 (49.6)	30.7	4.0	245.2	4.24	1.67	310.0
T_6: Atrazine @ 0.75 kg a.i. ha^{-1} as pre-emergencewith a hand weeding @ 50 DAS	6.87 (51.1)	5.95 (37.7)	33.2	5.2	246.7	3.93	1.47	324.6
T_7: Atrazine @ 1 kg a.i. ha^{-1} as pre-emergencewith hand weeding at 50 DAS	6.71 (47.5)	5.71 (33.3)	34.7	3.5	257.6	4.22	1.53	349.3
SEm±	0.46	0.93	-	-	6.66	0.20	0.08	9.48
CD (P=0.05)	0.65	1.32	-	-	10.3	1.07	0.34	35.6

was observed with T_5, T_2 and T_7 while the lowest (2.87) leaf area index value was seen in T_1. This is might be due to proper weed control in respective treatments which resulted in less competition for space, sunlight, water and nutrients and finally it resulted in more leaf area index. Similar report was also given by (Gowtham and Thalkar, 2020) and found that higher leaf area index was in application of atrazine @ 1 kg ha^{-1} as pre emergence with hand weeding at 30 DAS applied plot.

Impact on yield attributes and yield

It is obvious from the data that number of cobs plant^{-1} were significantly affected by integrated weed control methods during the study period (Table 1). The supreme highest number of cobs plant^{-1} (1.67) were noted with T_5, T_2 and T_7 followed by T_3 and T_4. The minimum number of cobs plant^{-1} (1.0) were seen in T_1. This showed that, improved growth under these treatments might be due to removal of weeds by hand weeding and pre-emergence application of herbicide. These results are same with findings have been reported by (Barod *et al.*, 2016) and found that the highest cob yield was recorded in weed free treatment and significantly lower value was found in unweeded control. The highest 1000 grains weight (349 g) was recorded with T_7 and T_2 followed by T_6 and T_5. This might be due to cumulative effect of increased levels of yield attributes was due to lesser crop weed competition, better light transmission for photosynthesis, reduced nutrient removal by weeds and increased nutrient uptake by crop. However, the lowest 1000 grains weight (272 g) was obtained from T_1 because presence of weeds throughout the crop cycle which caused the depletion and less absorption of nutrient by the crop especially during reproductive stage. Similar results were observed by (Mastkar *et al.*, 2022).

The maximum grains yield (10.05 t ha^{-1}) was obtained with T_2, T_7, T_6 and T_5 followed by T_3 while the lowest (4.57 t ha^{-1}) was observed in T_1(Fig 1). The raise of in grains yield of maize by 45.7% due to effective weed control as compared to T_1 treatment because of less weed intensity and minimum weed crop weed competition due to these satisfactory environments, the results crop growth was enhanced and yield was higher. Similar results were reported by (Rawal *et al.*, 2017; Singh *et al.*, 2021). The highest stover yield (15.00) was produced with T_7 followed by T_2 and T_6 while the lowest (9.55) was obtained from T_1(Fig. 1). The higher production of dry matter in plant might have improved under different weed management treatments which resulted in higher stover yield of crop. These results were similar with (Singh *et al.*, 2021) report who reported that higher dose of atrazine 1.5 kg a.i. ha^{-1} produced higher stover yield as compare to lower doses. The maximum harvest index (41.2) was observed in T_5, T_2, T_6 and T_7 while the lowest (32.35) was seen in T_1(Fig. 1). The same results have been also dis-

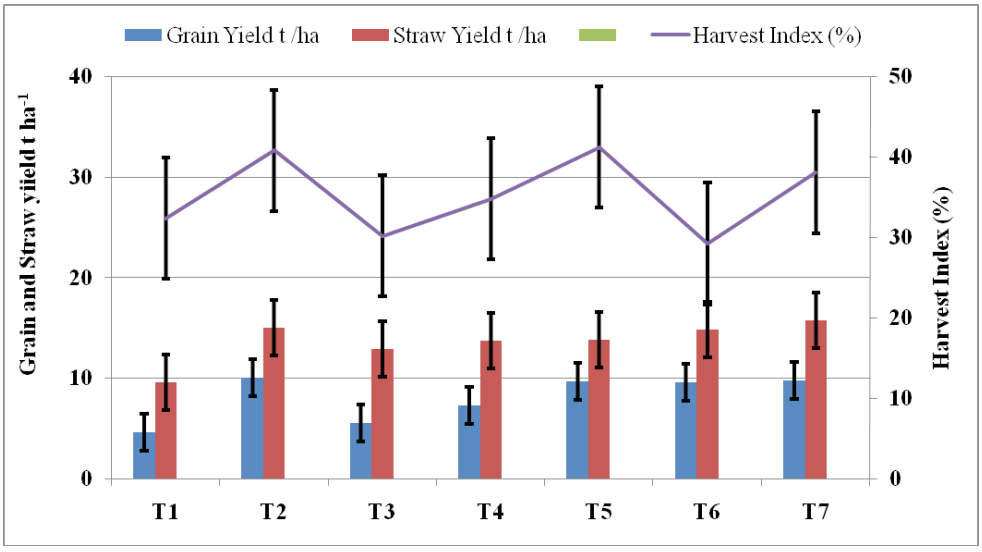

Fig. 1. Grains yield, stover yield and harvest index as influenced by integrated weed control methods

cussed by (Gowtham and Thalkar, 2020) who reported that atrazine 1.0 kg ha^{-1} followed by hand weeding at 30 DAS recorded highest harvest index.

Conclusion

Based on the findings of present study in can be inferred that application atrazne @1 kg a.i. ha^{-1} as pre-emergence with a hand weeding at 50 DAS is an economically sound and environmentally robust integrated weed management approach for reducing the weed population and sustainble production of maize crop in Kunar, Afghanistan and other similar agro ecoregion.

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