EFFECT OF WEED MANAGEMENT PRACTICES ON WEED DYNAMICS, YIELD AND YIELD ATTRIBUTES OF MAIZE IN CHITWAN, NEPAL

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ABSTRACT

Field trial was conducted for the assessment of different weed management practices in farmer's field of Chitwan, Nepal in randomized complete block design using five treatments replicated four times in summer season of 2022. Weed density and weed dry weight were taken at 30, 60 and 90 days after sowing (DAS) of maize, and yield and yield attributes were recorded at the time of maize harvesting. The result revealed that at 30 DAS both weed density and weed dry weight were lower and both weed control efficiency and weed control index were higher in both tembotrione 42% SC and atrazine 50% SC. But at 60 DAS and 90 DAS weed density, weed dry weight, weed control efficiency and weed control index were found higher in two-hand weeding than other treatments. Days to silking were later in weedy check than other. Ear diameter, kernels per rows, thousand kernels weight and shelling percentage of maize was seen significantly highest in two-hand weeding and lowest in weedy check. Significantly highest grain yield was recorded in two-hand weeding followed by tembotrione 42% SC, atrazine 50% SC and one-hand weeding. So, two-hand weeding and tembotrione 42% SC could be recommended for effective weed management and higher yield of maize.

Key words : Atrazine, rajkumar, tembotrione, weed density, weed management

INTRODUCTION

Maize (*Zea mays* L.) belongs to the Poaceae family and in the world it is the most important cereal crops after wheat and rice. Maize had been domesticated first by the natives of Mesoamerica and more diversity has been recorded in Mexico (Khan et al., 2018). In Nepal, maize is second important crop after rice which had the production of 3.1 million tons, cultivated in the area of 0.98 million ha with average productivity of 3.15 mt/ha (MoALD, 2023).

Biotic and abiotic factors are the major constraints for successful maize cultivation and production. Biotic factors include weeds, insect pest, diseases, wild animals and rodents and abiotic factors include flood, hailstorm, drought, soil type, nutrient deficiency and topographic features (Ransom et al., 1993). Among the biotic factors, weeds play the prime role for lowering the grain yield of maize. Weeds, which is major pest group of the crop is reported to reduce the maize production worldwide by 40% due to the crop-weed competition (Chikoye et al., 2004). There is the huge yield gap seen in the production of maize obtained in different counties of the world and Nepal. So there is the huge potential to minimize the yield gap by increasing the production per unit area. Weeds compete for nutrients, water, light and carbon dioxide and reduce soil moisture and fertility of soil and also it cause problem in crop husbandry which finally increases the cost of cultivation of crop. There is increase in the weed seed bank in soil and there will be threat for more weed attack sown after maize

crop. Weed cause yield loss by 37% which is the highest record followed by loss due to the animal pests of 18%, bacterial and fungal diseases of 16% and viruses of 2% loss (Chikoye et al., 2004).

Weeds compete with the maize crop at early growth stage cultivated in wider spacing and it is non tillering crop. So crop weed competition becomes high in between 20-30 days after maize sowing. So weed management is very important for better harvest of crop. Generally weed management increased the grain yield of maize by 77 to 96.7% over the weedy check. Among different weed control methods chemical and mechanical methods are the mostly used methods for management of weeds. Hand weeding is one of the mechanical weed control methods which are still practiced but it is more labor requiring, more time consuming and more expensive. Weeding take greater than 50% of the total labor required for maize cultivation and women and children were mainly engaged in weeding operation of maize (Akobundu, 1996; Ellis-Jones et al., 1993). Alternative to the hand weeding weed control by the herbicides is being popular because of less labor requirement, faster and cheaper which have better control of weed (Chikoye et al., 2004). Increased yield of maize and better control of weed had also been reported by the application of herbicides (Haider et al., 2009). So the research was initiated to study the efficacy of different weed management practices on weed, yield and yield attributes of maize.

MATERIALS AND METHODS

A trial was set-up in the farmer's field of Chitwan, Nepal during the summer season of year 2022 with the geographical location 27°37'12.7" North latitude and 84°16'59.6" East longitudes and 228 meter elevation. The soil of experimental field was slightly acidic and sandy loam.

Single factorial randomized complete block design was used to evaluate the efficacy of different weed management practices using five treatments which was replicated four times with the individual plot size of 4.8 m × 5 m. Gap of 1m was maintained in between two replications and 0.5 m was maintained in between two plots. Maize seed was planted maintaining the row to row spacing of 60 cm and plant to plant spacing of 25 cm. Five treatments includes weedy check (no weeding was done during the entire crop duration), single hand weeding at 20 days after sowing (DAS) of maize seed, two hand weeding; first at 20 DAS and second at 40 DAS of maize seeds, application of atrazine 50% soluble concentrates (SC) which was applied at the rate of 2 ml per liter of water in the same day after sowing of maize seed and last treatment include application of tembotrione 42% SC at the rate of 2 ml per liter of water which was sprayed in 2-3 leaf stage of weeds in the maize field.

Seeds of maize of variety 'Rajkumar' were planted in 4th February 2022 with 2 seeds per spot. Fertilizer was applied at the rate of 120:60:40 NPK kg/ha. One third N and full dose of P and K were applied at the time of land preparation and remaining nitrogen was applied equal in two split dose at knee high and tasseling stages of maize plant. Thinning of maize was done 15 days after sowing for maintaining the required plant stand in each row. Irrigation water was applied to the field as and when required by the crop. During the entire crop duration no diseases was recorded but chloropyrifos 50% + cypermethrin 5% was sprayed first at 25 DAS for the control of army worm and second at 75 DAS for the control of corn ear worm. Harvesting of maize crop was done on 1st June 2022.

Data of weed was taken at 30, 60 and 90 DAS of maize seed. In each plot 1 m^2 quadrant was selected randomly and the weeds were cut down at the ground level and weeds number and dry weight were

recorded by categorizing in grasses, broadleaf and sedges. For determining the dry weight, samples of weeds were oven dried at 105 ˚C till the constant weight is determined and data is recorded. For the maize data on days to 50% silking, ear length, ear diameter, kernels per rows, shelling percentage, thousand kernels weight and grain yield was recorded. During the harvesting time moisture content of grain was determined was grain yield of maize was adjusted to 14% moisture content. All the recorded data were processed by using Excel 2010 and R-stat was used for data analysis. Analysis of variance was done and significant treatments were subjected for least significance difference (LSD) at 5% level for mean separation (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Weed density and weed control efficiency at 30 DAS of maize

Weed density per square meter was significantly affected by the weed management practices at 30DAS (Table 1). Number of grasses, broadleaf, sedges and total weed per square meter were significantly higher in weedy check treatment but significantly lowest weed count was seen in tembotrione 42% SC and atrazine 50% SC treatments. Kamble et al. (2015) observed less weed density by the application of atrazine @ 1.25 kg/ha than other weed control practices. Weed control efficiency over weedy check was found highest in tembotrione 42% SC followed by atrazine 50% SC and two hand weeding and lowest was seen in one-hand weeding.

Table 1. Efficacy of different weed management practice on number of different weeds at 30 DAS

Treatments	Weed number at 30 DAS (No./m^2)				Weed control efficiency (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	4.0^{a}(15)	11.5^{a}(139.5)	5.4^{a}(30)	13.5^{a}(184.5)	0
One-hand weeding	3.0^{ab}(8)	4.9^{b}(32.5)	3.6^{ab}(16.8)	6.8^{b}(57.3)	68.9
Two-hand weeding	2.4^{bc}(5.8)	4.8^{b}(22.5)	2.1^{bc}(4.3)	5.7^{b}(32.5)	82.3
Atrazine 50% SC	1.8^{bc}(3)	1.0^{c}(0)	1.8^{bc}(2.5)	2.4^{c}(5.5)	97
Tembotrione 42% SC	1.3^{c}(1)	1.7^{c}(3)	1.4^{c}(1.3)	2.1^{c}(5.3)	97.1
Grand mean	2.5(6.6)	4.8(39.5)	2.9(11)	6.1(57)	69.1
F-test	**	***	**	***	
$LSD_{0.05}$	1.2	3	1.9	3.1	
CV, %	30.3	40.9	42	32.8	
SEm (±)	0.4	0.9	0.6	1	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Weed dry weight and weed control index at 30 DAS of maize

Dry weight of grasses, broad leaf and sedges were significantly affected by the weed management practices as 30 DAS (Table 2). Total dry weight per square meter and dry weight of grasses, broad leaf and sedges were found significantly higher in weedy check but lowest dry weight of grasses and sedges was found in tembotrione 42% SC but lowest dry weight of broad leaf was found in atrazine 50% SC. tembotrione 42% SC and atrazine 50% SC had statistically similar and lowest dry weight per square meter. Kamble et al. (2015) obtained lower weed dry weight per square meter by the application of atrazine @ 1.25 kg/ha than other weed management practices. Weed control index over weedy check was found highest in tembotrione 42% SC followed by atrazine 50% SC and two-hand weeding and lowest was seen in one-hand weeding.

Table 2. Efficacy of different weed management practice on dry weight of different weeds at 30 DAS

Treatments	Weed dry weight at 30 DAS (g/m^2)				Weed control index (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	2.4^{a} (4.9)	5.7^{a}(33.3)	2.9^{a}(8.2)	6.8^{a}(46.4)	0
One-hand weeding	1.9^{ab}(2.8)	2.9^{b}(9.4)	2.1^{ab}(4.1)	3.8^{b}(16.2)	65
Two-hand weeding	1.6^{bc}(1.9)	2.8^{b}(7.2)	1.5^{bc}(1.5)	3.3^{b}(10.6)	77.3
Atrazine 50% SC	1.3^{c}(0.7)	1.0^{c}(0)	1.3^{bc}(0.9)	1.5^{c}(1.6)	96.7
Tembotrione 42% SC	1.1^{c}(0.3)	1.3^{bc}(0.8)	1.1^{c}(0.2)	1.4^{c}(1.3)	97.4
Grand mean	1.7(2.1)	2.7(10.1)	1.8(3)	3.4(15.2)	67.4
F-test	***	***	**	***	
$LSD_{0.05}$	0.5	1.6	0.9	1.6	
CV, %	20.3	37.7	33.3	30.7	
SEm (±)	0.2	0.5	0.3	0.5	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Weed density and weed control efficiency at 60 DAS of maize

Weed density of grasses, broad leaf and sedges at 60 DAS were significantly affected by weed management practices (Table 3). Total weed count and number of grasses, broad leaf and sedges were significantly higher in weedy check. Total weed count and grasses number were lowest in two-hand weeding. tembotrione 42% SC, one-hand weeding and atrazine 50% SC had significantly similar total count of weed per square meter. Sharma et al. (2000) also concluded that number of weed can be reduced to the lower level if hoeing followed by earthing up at 2 and 4 (weeks after sowing) WAS, respectively. Kumar et al. (2017) observed lower weed density of major weed species in two-hand weeding. Weed control efficiency over weedy check was found highest in two-hand weeding followed by tembotrione 42% SC and atrazine 50% SC and lowest was seen in one-hand weeding. Sinha et al. (2003) also reported weed control efficiency of hand weeding to about 91.9%.

Table 3. Efficacy of different weed management practice on number of different weeds at 60 DAS

Treatments	Weed number at 60 DAS (No./m^2)				Weed control efficiency (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	6.1^{a}(38.5)	9.3^{a}(85.5)	6.2^{a}(38)	12.7^{a}(162)	0
One-hand weeding	4.5^{bc}(19.8)	5.8^{b}(33.3)	4.2^{b}(17)	8.4^{b}(70)	56.7
Two-hand weeding	3.6^{c}(12)	4.6^{b}(20.8)	3.6^{b}(12.8)	6.8^{c}(45.5)	71.9
Atrazine 50% SC	5.0^{ab}(25.3)	4.9^{b}(23)	4.1^{b}(16.3)	8.1^{b}(64.5)	60.1
Tembotrione 42% SC	3.8^{bc}(13.8)	4.9^{b}(23.8)	4.4^{b}(18.5)	7.5^{bc}(56)	65.4
Grand mean	4.6(21.9)	5.9(37.3)	4.5(20.5)	8.7(79.6)	50.8
F-test	**	***	**	***	
$LSD_{0.05}$	1.2	1.1	1.1	1.1	
CV, %	16.7	12.6	15.4	8.4	
SEm (±)	0.4	1.4	0.4	0.4	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Weed dry weight and weed control index at 60 DAS of maize

Total dry weight and dry weight of grasses, broad leaf and sedges were significantly affected by weed management practices at 60 DAS (Table 4). Weedy check had significantly higher dry weight of all categories of weeds. Two-hand weeding had lowest total dry weight but one-hand weeding had more dry weight of weed which were statistically similar with atrazine 50% SC and tembotrione 42% SC. Thakur (1994) observed lower weed dry weight and weed count in two-hand weeding done at 3 and 5 WAS. Kumar et al. (2017) found lower dry weight of major weed species in two-hand weeding. Weed control index over weedy check was found highest in two-hand weeding followed by tembotrione 42% SC and atrazine 50% SC and lowest was seen in one-hand weeding.

Table 4. Efficacy of different weed management practice on dry weight of different weeds at 60 DAS

Treatments	Weed dry weight at 60 DAS (g/m^2)				Weed control index (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	3.8^{a}(14.3)	11.3^{a}(126.3)	5.9^{a}(36)	13.3^{a}(176.6)	0
One-hand weeding	3.0^{b}(8.3)	5.1^{b}(25.5)	4.1^{b}(16.1)	7.1^{b}(49.9)	71.8
Two-hand weeding	2.6^{b}(5.6)	3.3^{c}(10.5)	3.9^{b}(14.8)	5.6^{c}(30.9)	82.5
Atrazine 50% SC	3.3^{ab}(10.1)	4.0^{bc}(14.8)	4.3^{b}(17.8)	6.6^{bc}(42.6)	75.8
Tembotrione 42% SC	2.5^{b}(5.6)	3.9^{bc}(15.1)	4.1^{b}(15.6)	6.1^{bc}(36.2)	79.5
Grand mean	3(8.8)	5.5(38.4)	4.5(20.1)	7.7(67.2)	61.9
F-test	*	***	*	***	
$LSD_{0.05}$	0.8	1.3	1.2	1.1	

Treatments	Weed dry weight at 60 DAS (g/m^2)				Weed control index (%)
	Grasses	Broadleaf	Sedges	Total	
CV, %	16.6	15	17.6	9.7	
SEm (±)	0.2	0.4	0.4	0.4	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Weed density and weed control efficiency at 90 DAS of maize

Weed management practices significantly affect the number of weeds per square meter at 90 DAS (Table 5). Total, broad leaf and sedges weed count were highest in weedy check but all other weed management had statistically similar total weed count. Kolage et al. (2004) also observed reduced density of weed by two-hand weeding done at 3 and 5 WAS significantly. Kandasamy and Chandrasekhar (1998) also reported two-hand weeding was efficient for control of weed count. Kumar et al. (2017) observed lower weed density of major weed species in two-hand weeding. Weed control efficiency over weedy check was found highest in two-hand weeding followed by tembotrione 42% SC and atrazine 50% SC and lowest was seen in one-hand weeding. Sinha et al. (2003) also reported higher weed control efficiency of hand weeding than other weed management practices.

Table 5. Efficacy of different weed management practice on number of different weeds at 90 DAS

Treatments	Weed number at 90 DAS (No./m^2)				Weed control efficiency (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	6.2(39.5)	9.0^{a}(80.8)	8.6^{a}(73.8)	14.0^{a}(194)	0
One-hand weeding	6.1(36.8)	7.0^{b}(48.5)	4.9^{b}(23.3)	10.4^{b}(108.5)	44
Two-hand weeding	5.0(24.5)	5.6^{c}(30.8)	4.5^{b}(20.3)	8.7^{b}(75.5)	61
Atrazine 50% SC	5.9(34.3)	6.8^{bc}(45.8)	4.8^{b}(22.3)	10.1^{b}(102.3)	47.3
Tembotrione 42% SC	5.8(35.5)	6.2^{bc}(38.8)	5.0^{b}(24.5)	9.8^{b}(98.8)	49.1
Grand mean	5.8(34.1)	6.9(48.9)	5.6(32.8)	10.6(115.8)	40.3
F-test	NS	***	***	***	
$LSD_{0.05}$	1.5	1.3	1.5	1.7	
CV, %	16.5	12.2	17.1	10.3	
SEm (±)	0.5	0.4	0.5	0.6	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; NS, non-significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Weed dry weight and weed control index at 90 DAS of maize

Weed management practices had significant effect of weed dry weight at 90 DAS (Table 6). Total dry weight and dry weight of broad leaf and sedges were highest in weedy check. Two-hand weeding had lowest total dry weight than other treatments. One-hand weeding, atrazine 50% SC and tembotrione 42% SC had similar total dry weight of weed. Weed control index over weedy check was found highest in two-hand weeding followed by tembotrione 42% SC and one-hand weeding and lowest was seen in atrazine 50% SC. Intodia et al. (1996) observed that hand weeding as more effective method to reduce both the dry matter and density of weeds than chemical method because after 4 WAS, working capacity of chemical decreased more. Kumar et al. (2017) also found lower dry weight of major weed species in two-hand weeding.

Table 6. Efficacy of different weed management practice on dry weight of different weeds at 90 DAS

Treatments	Weed dry weight at 90 DAS (g/m^2)				Weed control index (%)
	Grasses	Broadleaf	Sedges	Total	
Weedy check	5.2(27.6)	14.3^{a}(204.3)	8.9^{a}(79.6)	17.7^{a}(311.5)	0
One-hand weeding	4.7(22.5)	7.5^{b}(55.5)	5.4^{b}(28.5)	10.3^{b}(106.5)	65.7
Two-hand weeding	3.9(14.8)	5.4^{c}(29)	4.6^{b}(21.6)	8.1^{c}(65.3)	79
Atrazine 50% SC	4.8(22.4)	8.1^{b}(66.2)	5.0^{b}(24.6)	10.6^{b}(113.1)	63.6
Tembotrione 42% SC	4.9(22.9)	7.0^{b}(49)	5.2^{b}(26.6)	9.9^{b}(98.5)	68.4
Grand mean	4.7(22)	8.5(80.8)	5.8(36.2)	11.3(139)	55.3
F-test	NS	***	***	***	
$LSD_{0.05}$	1.3	1.3	1.5	1.4	
CV, %	18.3	9.7	17.1	8.1	
SEm (±)	0.4	0.4	0.5	0.5	

Note: Data were subjected to square root √(x+1) transformation before analysis and figures in parenthesis are original value; ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; NS, non-significance; DAS, Days after sowing. Treatments means followed by different letter (s) are significantly different among each other.

Phenology, yield attributes and yield of maize

Flowering, yield attributes and yield of maize were significantly affected by weed management practices (Table 7). Days to silking were later in weedy check but all other treatments had significantly later and similar days to silking. Ear diameter, kernels per rows, thousand kernels weight, shelling percentage and grain yield of maize was seen significantly highest in two-hand weeding and lowest was obtained in weedy check. Stanzen et al. (2016) also recorded higher thousand kernel weight, number of grains per cob and yield of maize in two-hand weeding. One-hand weeding, atrazine 50% SC and tembotrione 42% SC had significantly at par grain yield but all these treatments were significantly lower than two hand weeding. Thakur (1994) observed that the grain yield of maize obtained by two-hand weeding were similar with the yield in chemical application but Kumar et al. (2017) obtained the highest grain yield on maize in two-hand weeding done at 15 and 30

DAS of maize that other treatments. Sarma and Gautam (2010) also observed higher grain yield by hand weeding done at 25 and 45 DAS.

Table 7. Efficacy of different weed management practice on days to silking, yield attributes and yield of maize

Treatments	Days to silking	Ear length (cm)	Ear diameter (cm)	Kernels per row	Grain yield (t/ha)	Thousand kernels weight (g)	Shelling (%)
Weedy check	72.5^{a}	16.8	4.5^{c}	31.2^{c}	3.8^{c}	285.1^{c}	68.1^{c}
One-hand weeding	70.7^{ab}	17.8	4.8^{b}	33.1^{bc}	8.5^{b}	301.4^{bc}	75.2^{bc}
Two-hand weeding	70.2^{b}	19	5.4^{a}	39.3^{a}	10.3^{a}	334.3^{a}	83.9^{a}
Atrazine 50% SC	69^{b}	17.8	4.9^{b}	34.3^{bc}	8.8^{b}	318.2^{ab}	79.9^{ab}
Tembotrione 42% SC	69.5^{b}	17.6	5.1^{b}	36.4^{ab}	8.8^{b}	305.2^{bc}	78.8^{ab}
Grand mean	70.4	17.8	4.9	34.8	8	308.8	77.2
F-test	*	NS	***	*	***	**	**
$LSD_{0.05}$	1.9	2.1	0.2	4.5	0.5	24	7.5
CV, %	1.8	7.7	3.5	8.3	4.1	5	6.3
SEm (±)	0.6	0.7	0.1	1.5	0.2	7.8	2.4

Note: ***, indicates very high significant differences at 0.1% level of significance; **, indicates highly significant differences at 1% level of significance; *, indicates significant differences at 5% level of significance; NS, non-significance. Treatments means followed by different letter (s) are significantly different among each other.

CONCLUSIONS

During the earlier days tembotrione 42% SC was found effective but at the later days two-hand weeding was found to be effective with lower weed density and weed dry weight per square meter. Also weed control index and weed control efficiency was found higher in two-hand weeding. Grain yield of maize and yield attributes were found good in two-hand weeding. If difficult to manage labor for weeding then chemicals tembotrione 42% SC could be used. So, two-hand weeding and tembotrione 42% SC could be recommended for weed management for effective weed control and higher yield of maize.

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