



Original Research Article

Effect of weed management in productivity of Spring Maize in Mid-hills of Nepal

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ABSTRACT

An experiment was conducted in IAAS, Lamjung research field in 2017 in spring Maize with split plot design to evaluate the effect of weed management practice and tillage system on productivity of spring maize. In tillage system, no-till and conventional tillage were kept as main factor whereas seven weed management practices (viz. sequential application of atrazine at 0.75 kg a.i. ha⁻¹ and 2,4-D at 1.5 kg ha⁻¹; pre-emergence tank mix application of atrazine at 0.75 kg ha⁻¹ and glyphosate at 2.5ml lit⁻¹ of water; pre-emergence tank mix application of atrazine at 0.75 kg ha⁻¹ and pendimethalin at 2ml lit⁻¹ of water; cowpea co-culture; black polythene mulch with control treatment weed free and weedy check as sub-plot. Tillage method had not significant effect on the weed dry matter accumulation in different stages. However, weed dry matter accumulation was varied with different weed management practices. The weed check plot was of highest dry matter accumulation (273.38g m⁻², 361.95 g m⁻² and 235.95 g m⁻² in three different stages (30, 60 and 90 DAS respectively). The highest grain, straw yield and yield attributes was found in plastic mulch plot and no-till system with less severe to weed infestation and index which is statically at par with intercropping with cowpea. Though none of weed management practices completely eliminated weeds, black polythene mulching resulted in best grain yield. Besides the environmental protection, cowpea co-culture treatments yielded almost similar grain yield as compared with common herbicidal weed management practices.

Introduction

Weed is undesirable plant that reduces the maize yield and higher cost in food production, prior to losing 37% to 100 % (Dahal and Karki, 2014). Although maize yield was determine by cultivars,

species and number of weed per area, weed competition period and duration, but weeds have potential of reducing yield by 40-70% (Mandal, 1990). Karki et al. (2010) recorded 48% reduction of grain yield in maize due to weed infestation in the hills of Nepal and yield loss depends upon types of weed flora and severity. Nature of weed problem in Spring maize is quite different from that of the rainy season maize. In the rainy season emergence of maize and weed start simultaneously and first 20- 30 days are most critical to crop-weed competition. Contrarily in the Spring maize, weed emerges most often after the first irrigation (Mathukia et al. 2014).

Besides, Tillage operation are desired for the better crop yield but due to heavy destruction of soil structure degrade the soil quality and which accelerate the surface runoff and soil erosion as well as the reduction of soil organic carbon (SOC) content 20% after 20 years (Mann, 1986). No-till or reduced are less prone to erosion, temperature extremes, water loss which contribute to good quality soil, reduce the cost of production, reduce the yield losses due to weed infestation and produce the sustainable yield in longer run, which lead to the sustainability of rice-maize cropping system (Dahal et al. 2014) in proper weed and nutrient management practices. The best results of weed control can only be seen in case of integrated weed management practices. Integrated weed management is the need of the day, because of its sustainability and higher productivity (Riaz et al. 2007). Therefore, an attempt was made in order to evaluate the impact of tillage, and weed management on weed dynamics, crop growth, yield attributes and yield of Spring maize in mid-hills of Nepal.

Materials and Methods

The field experiment was conducted in IAAS, research field during Spring season from September 2016 to March 2017. Experiment was conducted in split plot design with three replications where main-plot factor represent tillage practices and sub-plot factor contained different weed management practices. Details of factor and their levels used in experiment are given below:

Main plot: Tillage

- i) No tillage (NT).
- ii) Conventional tillage (CT).

Sub plot: Weed management practice (Table 1):

Table 1- Sub-Plot Factors (Weed management Practices).

Treatment	Practice	Frequency and Dosage
1	Weedy Check	-
2	Weedy Free	Hand weeding at 10days interval
3	Polythene Mulching	Black Polythene
4	Cowpea intercropping	Maize cowpea 1:2
5	Atrazine+Glyphosat (pre-emergence tank mixture)	Atrazine: 0.75 kg a.i ha ⁻¹ or 1.5kg ha ⁻¹ (Pre-emergence application) Glyphosate: 0.80lt/ha, 1-2 kg a.i ha ⁻¹
6	Atrazine + Pendimethalin(pre-emergence tank mixture)	Pendimethalin: 2 ml lt ⁻¹ water (1-1.5) kg a.i ha ⁻¹
7	Atrazine fb 2,4-D(sequential application)	2,4-D: 1.5 kg ha ⁻¹

$$\text{Formulation of commercial product} = \frac{\text{Recommended rate (a. i.)} \times 100}{\% \text{ a. i in commercial product}}$$

$$\text{Liters of Emulsify Concentration required} = \frac{\text{Recommended rate} \left(\frac{\text{kg}}{\text{ha}} \right) \times \text{area (m}^2\text{)}}{\% \text{ a. i in commercial product EC}}$$

The size of individual plot was 6m×4m (24m²). Maize was sown continuously in line with spacing of 60 cm × 25 cm.

Variety for Location Lamjung

The varieties used in the experiment were hybrid-2. The hybrid RML32/RML17 was used as a parentage and presently developed Rampur hybrid 4, which can be grown in hills area, having yield potential of 6.95 t/ha with grain color orange. Specialty of this variety is it stay green up to maturity, semi erect, moderately resistant to borer and leaf blight with average plant and ear bearing height of 175 and 95 cm, respectively (NMRP, 2016). This hybrid can be harvested within 170 days in spring season. Data entry was done in Microsoft Excel, analyzed from R-stat and Gen-stat and interpretation was done in Microsoft Word 7.

Results and discussion

Tillage method doesn't show significant effect on the weed dry matter accumulation in different stages viz: 30 DAS, 60 DAS and 90 DAS. However, weed dry matter accumulation was varied with different weed management practices (Table 2). Higher the weed, higher will be the dry matter accumulation. The weed check plot was of highest dry matter accumulation (273.38g m⁻², 361.95 g m⁻² and 235.95 g m⁻² in three different stages (30, 60 and 90 DAS respectively).

Total weed dry weight

Table 2- Total weed dry weight (g m⁻²) as influenced by tillage method and weed management practices at different date of observation in Spring maize

Treatment	Total weed dry weight (g m ⁻²)		
	30 DAS	60 DAS	90 DAS
<i>Tillage methods</i>			
No Tillage	13.0 (175.53)	15.58 (246.03)	11.83 (145.38)
Conventional Tillage	15.2 (238.08)	17.42 (312.21)	12.98 (174.27)
SEm (±)	0.428	0.902	0.748
LSD (=0.05)	ns	ns	ns
<i>Weed management Practices</i>			
Cowpea co-culture	14.1 ^b (209.38)	14.6 ^b (216.59)	10.5 ^c (112.11)
Atrazine 0.75 kg a.i. ha ⁻¹ + Pendimethalin	15.7 ^a (249.17)	16.5 ^{ab} (274.5)	12.8 ^b (167)
Atrazine 1.5 kg a.i. ha ⁻¹ fb 2,4-D	12.5 ^c (157.82)	15.5 ^b (246.35)	11. ^{bc} (131.78)
Atrazine 0.75 kg a.i. ha ⁻¹ + Glyphosate	11.71 ^c (144.3)	16.87 ^{ab} (296.)	12.18 ^{bc} (152.)
Weedy check	16.4 ^a (273.28)	18.8 ^a (361.9)	15.2 ^a (235.95)
SEm (±)	0.445	0.784	0.674
LSD (=0.05)	1.334	2.351	2.022
CV%	19.15	16.13	19.98
Grand Mean	14.1 (206.81)	16.50 (279.12)	12.41 (159.82)

Note: Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values; Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5 % level of significance.

The application of the atrazine and pendimathalin and Glyphosate and followed by 2,4-D has similar effect in the dry matter accumulation in the different stages. Dry matter accumulation was statistically at par with chemical applied plot. Tank mixture application and complement herbicides mixture has similar effect but more effective to check plot. Atrazine is a broad- spectrum but mainly a broad leaved killer herbicides with some action on grasses (Das, 2008). It is also used as non-

selective herbicides in non-crop areas and in minimal or no tillage programs in maize and sorghum (Rao, 2000) whereas pendimethalin both pre and early post emergence to control most of grasses and certain broad leaf weeds (Valverde et al., 2001) and glyphosate controls a broad spectrum of annual and perennial grass and broadleaf weeds (Culpepper, 2007). The cowpeas worked as cover crop and suppresses the weed and have least weed number and least weed dry matter accumulation. The dry matter at 30, 60 and 90 DAS was 209.38 g m⁻², 216.59 g m⁻² and 112.11 g m⁻² respectively. Weed emergence was not found in the black polythene mulches.

Table 3- Yield attributes as influenced by tillage methods and weed management practices in Spring Maize.

Treatments	No. ears harvested per ha	No. kernel rows ear ⁻¹	No. kernels row ⁻¹	No. kernels ear ⁻¹	1000 grain weight (g)	Sterility (%)
Tillage methods						
No Tillage	74573	11	30 ^a	328 ^a	204.22	16.76
Conventional Tillage	66558	11	28 ^b	299 ^b	210.70	15.24
SEm (±)	1728.80	0.117	0.236	2.86	4.33	1.654
LSD (=0.05)	Ns	Ns	1.434	17.42	ns	ns
Weed management Practices						
Cowpea co-culture	64750 ^c	13 ^{ab}	29 ^b	322.00 ^b	198.14	14.06 ^{bc}
Black polythene mulch	87972 ^a	13.00 ^a	32 ^a	375.00 ^a	209.71	11.21 ^c
Atrazine 0.75 kg a.i. ha ⁻¹ + Pendimethalin	63778 ^c	11 ^c	28 ^b	283.67 ^b	198.22	15.27 ^{bc}
Atrazine 1.5 kg a.i. ha ⁻¹ fb 2,4-D	72027 ^b	12 ^{abc}	28 ^b	309.67 ^b	206.73	18.59 ^b
Atrazine 0.75 kg a.i. ha ⁻¹ + Glyphosate	64194 ^c	12 ^{bc}	27 ^b	283.33 ^b	214.75	19.58 ^b
Weed free	78944 ^{ab}	13 ^{abc}	29 ^b	317.00 ^b	224.17	11.61 ^c
Weedy check	61277 ^c	12 ^{abc}	28 ^b	302.00 ^b	190.99	26.67 ^a
SEm (±)	3105.90	0.33	0.76	15.13	8.73	1.78
LSD (=0.05)	9065.60	0.71	2.23	44.16	Ns	5.19
A*B	Ns	Ns	Ns	Ns	Ns	Ns
CV,%	19.95	8.88	9.70	15.42	11.60	43.71
Grand Mean	70565	12	29.81	314.24	206.96	17.00

Note: Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance. Ns: non-significant

Grain per cob was affected by tillage method. The higher grain number was found in zero tillage plot (327) and least in conventional tillage (289). It signifies the zero tillage promotes on grain

number per cob. Similarly, grain number was significantly affected by the weed management practices. Higher number of grain was in Black polythene mulched plot whereas other weed management practices have statistically similar number of grain number (Table 3). Thousand grain weights were not dependent on tillage method and weed management practices. Sterility was not significant with tillage methods. Weedy check has highest grain sterility; it's due to the weed interference to grain filling time and fertilization whereas plant with less robustness which is followed by the chemical application. The chemical treatment was only for pre-emergence, where weed infestation become high during grain filling stage i.e 60 DAS.

Table 4- Grain yield (kg ha⁻¹), straw yield (kg ha⁻¹), harvest index (%) and weed index (%) as influenced by tillage methods and weed management practices in Spring Maize.

Treatment	Yield (kg ha ⁻¹)	Straw dry weight (kg ha ⁻¹)	Harvest index (%)	WI
Tillage methods				
No Tillage	5584 ^a	6280.33 ^a	46.49 ^a	11.48
Conventional Tillage	3981 ^b	5231.94 ^b	42.12 ^b	25.1
SEm (±)	96.00	19.70	0.112	3.70
LSD (=0.05)	584.20	120.10	0.679	Ns
Weed management Practices				
Cowpea co-culture	4065.5 ^{cd}	5909.80 ^c	39.18 ^c	30.7 ^{ab}
Black polythene mulch	7071.0 ^a	8308.13 ^a	45.93 ^{abc}	-20.6 ^d
Atrazine 0.75 kg a.i. ha ⁻¹ + Pendimethalin	4115.1 ^{cd}	4563.91 ^e	46.01 ^{abc}	30.8 ^{ab}
Atrazine 1.5 kg a.i. ha ⁻¹ fb 2,4-D	5186.4 ^{bc}	4919.48 ^{de}	50.18 ^a	12.2 ^{bc}
Atrazine 0.75 kg a.i. ha ⁻¹ + Glyphosate	3954.8 ^{cd}	4867.56 ^{de}	43.8 ^{abc}	34.6 ^{ab}
Weed free	5916.2 ^{ab}	6693.57 ^b	46.80 ^{ab}	0.00 ^{cd}
Weedy check	3168.1 ^d	5030.50 ^d	38.20 ^c	40.27 ^a
SEm (±)	399.30	118.70	1.980	7.36
LSD (=0.05)	1165.50	346.60	5.779	21.48
CV%	38.42	25.58	14.85	167.6
Grand Mean	4782.51	5756.14	44.31	18.30

Note: Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance, DAS, days after sowing ; ns, non-significant

Zero tillage (5584 kg ha⁻¹, and 6280.33 kg ha⁻¹) contribute to higher grain and stover yield than conventional tillage (3981 kg ha⁻¹ and 5231.94 kg ha⁻¹). Besides, weed management practices has significant effect. The grain and stover yield was found highest in black polythene mulch plot. The highest grain yield was 7071.06 kg ha⁻¹ followed weed free condition (5916.29 kg ha⁻¹), Atrazine fb 2,4-D (5186.48 kg ha⁻¹), Atrazine+pendimethalin (4115.14 kg ha⁻¹) and Atrazine+glyphosate

(3954.86 kg ha⁻¹) as compared to weedy check plot (3168.16 kg ha⁻¹). Similar effect was also found in stover yield. Harvest index was directly proportional to grain yield and indirect to stover as well biomass. Therefore, Atrazine fb 2,4-D has highest harvest index (501.18 %) and lowest to cowpea culture (39.18 %) and weedy check plot (38.20 %) (Table 4).

No tillage resulted the lower weed density and dry weight as compare to conventional tillage which may be due to weed seed bank below the soil is taken up in conventional tillage creating favorable place for germination of weed seeds. Shrestha et al. (2002) also supported this finding. Similar results have been reported by (Dahal and Karki, 2014) who found no tillage and residue retained level had significantly lower number of grasses, sedges , broad leaf population and dry weight as compared to conventional tillage and residue removed level during all 30, 60 and 90 DAS observations of maize. Zhang et al. (1992) reported that black plastic mulch controlled 100% of the weeds in plantings of tomato and corn. Rajablariani et al. (2012) concluded that black plastic mulch reduced weed dry weights by 94.7% in sweet corn. Hussain et al. (2013) found that intercropping treatment resulted in 35-56% reduction in weed population and showed 6.4 to 23.93% increase in maize yield. Weed index is the availability of the weed in the respective plot of weed management. Weed index was not significant to tillage method. However, higher weed index was of conventional tillage in term of value compared to zero tillage. Weed index have significant effect on weed management practices. Higher weed index was found in weedy check plot where no weed management practice was conducted and assumption of higher weed severity and least weed index in black polythene mulched plot which completely suppressed the weed, where in application of different chemical herbicide in tank and complement mixture was statistically at par with each other and to weedy check plot. Tank mixture application of atrazine and glyphosate had found significantly reduced in total weed density at initial stage which may be due of the fact that glyphosate is slow in action and controls weeds effectively resulting in higher grain yield. Result was in line with Reddy and Reddy (2012). Similarly tank mixture application of atrazine and pendimethalin found to reduce the weed dry weight at 60 DAS. Khan et al. (2014) found less number of weeds was found in plots where atrazine and metalocholar tank application was sprayed.

Conclusion

Due to less knowledge and monopolistic price of technical people, herbicides application increased the yield of maize and reduces the cultivation cost and increase revenue whereas no-till condition system suits for highest yield over conventional. Though none of weed management practices completely eliminated weeds, black polythene mulching resulted in best grain yield. Besides the environmental protection, cowpea co-culture treatments

yielded almost similar grain yield as compared with common herbicidal weed management practices.

Conflict of interest

Authors declare no conflict of interest.

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