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Response of herbicides on the productivity and profitability of green fodder yield of maize: An exploratory study

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Abstract
The present investigation was carried out at the Research Farm, Department of Forestry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP), during the kharif season of 2017-18. The experiment was laid out in randomized block design, with 10 treatments replicated thrice. The soil of the experimental field was sandy clay loam in texture and almost neutral in reaction. The available NPK content in the soil were 208 (medium), 16.26 (medium) and 173 (medium) kg/ha, respectively. The treatment consisted of T1-Atrazine 1.0 kg ha-1T2- Pendimethalin 1.0 kg ha-1 T3-2,4-D EE 0.5 kg ha-1 T4- Atrazine 1.0 kg ha-1 fb 2,4-D EE 0.5 kg ha-1 T5- Pendimethalin 1.0 kg/ha fb 2,4-D EE 0.5 kg ha-1 T6 - Atrazine 1.0 kg ha-1 + Hand Weeding (30 DAS) T7 Pendimethalin 1.0 kg ha^{-1} + Hand Weeding (30 DAS), T8 - 2,4-D EE 0.5 kg ha-1 + Hand weeding (30 DAS), T9- Hand weeding (30 DAS) and T10 – Weedy check. The prominent weeds in fodder maize were *Echinocha colona*, *Cyperus rotundus*, *Digitaria sangunalis*, *Eclipta alba* and *Phyllanthus niruri*.
The pre-emergence application of Pendimethalin 1.0 kg ha-1 recorded significantly higher green fodder yield (675 q/ha), dry fodder yield (129.93 q/ha), crude protein yield (17.48 q/ha), net monetary return (Rs. 78008 /ha) and benefit cost ratio (4.0), as compared to other treatments after hand weeding.

Keywords: Fodder yield, variety, herbicides, growth characters, weed management

Introduction
Maize (*Zea mays* L.) is an important kharif cereal forage crop of India, due to congenial climate leading to excellent growth, quick re-growth and high nutritive value for both milch as well as drought livestock. Among the various factors of production, control of weeds greatly affects the productivity of green fodder yield of maize. Thus, the identification of weed species and their control by the use of suitable herbicides, is an important for getting higher forage yield under varying environment. Control of weeds play a vital role in forage production besides increasing the quantity of forage, it improves the quality of forage also. In fodder maize, weeds respond well to various herbicidal applications to produce more tonnage per unit area, per unit time, under favourable environmental conditions.
Mostly fodder varieties of maize are shy-seeders and have low yield potential. Meanwhile, adequate attention has not been paid seriously for managing the production and supply of forage maize. Generally, it is grown as a kharif crop, and is accompanied by a number of weed plants of various eco types. The magnitude of loss due to weed largely depends on its composition of weed flora, period of crop weed competition and its intensity. The season long weed competition causes considerable yield losses in maize (Dalley *et al.* 2006) [3]. The predominant weed flora is *Echinochloa*, *Cyperus rotundus*, *Digitaria sanguinalis*, *Eclipta alba*, *Amaranthus viridis*, *Digera arvensis*, *Portulaca oleracea* L., *Alternanthera sessilis and Phyllanthus niruri* (Arvadiya *et al*. 2012) [1].
Management of weeds is considered to be an important factor for achieving higher production. Due to increased cost and non-availability of manual labour in required quantity, timely for hand weeding, role of herbicides is significant. It not only controls the weeds timely and effectively, but also offers great scope for minimizing the cost of weed control. Hand weeding is the conventional method of weed control, which is not only troublesome due to continuous rains during the crop season, but also has its limitations, as labourers in adequate number are not available at the peak season of weeds. Therefore, chemical method of weed control remains the only choice. The use of pre and post emergence application of herbicide would make herbicidal weed control more acceptable to the farmers, which will not change the

existing agronomical practices, but will allow for complete control of weeds.

Keeping the above facts in view, the present investigation was undertaken with the object to find out the suitable herbicide to single cut maize fodder for higher tonnage and monetary returns.

Methods and Materials

The present study was carried out at the Research Farm of Department of Forestry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP) during kharif season of 2017-18. The soil of the experimental field was sandy clay loam in texture and almost neutral in reaction, having 208, 16.26 and 173 available NPK kg/ha, respectively. The experiment was laid out in randomized block design, with 10 treatments replicated thrice. The treatments consisted of Atrazine(1.0kgha-1), Pendimethalin (1.0kg ha-1), 2,4-D(0.5kgha-1), Atrazine (1.0kgha-1)fb 2,4-D(0.5kg ha-1), Pendimethalin(1.0kgha-1)fb2,4-D(0.5kgha-1), Atrazine (1.0kgha-1)+ Handweedingat30DAS, 2,4-D(0.5kgha-1)+HandWeeding, Hand weeding (30DAS) and Weedycheck. The fodder maize variety African Tall was seeded @ 20 kg/ha. The weed population was recorded at 45 DAS. The random least count quadrate (50 cm x 50 cm) method (Misra, 1968), was adopted for noting the weed species. The random quadrates were marked by fixing the wooden sticks and densities (45 DAS) and weed biomass (80 DAS) were recorded accordingly. First cutting of fodder was done on 85 DAS. The data were subjected to statistical analysis as described by Sendecor and Cochran (1967) to find out the relationship of weeds with crop growth and green fodder yield and predicted to the extent of loss due to weed competition and their consistency in the population of different weed species in maize fodder.

Results and Discussions

The growth characters of the crop were recorded at the harvest.

Plant Population

The plant population of fodder maize at harvest showed no significant effect due to various treatments. The treatments did not cause any phytotoxicity on the seedlings, nor inhabit the growth of the plants, resulting in almost similar population under all the herbicidal treatments, to that of weedy check and hand weeded plot. Similar findings have also been reported by Sunitha *et al.*, (2010) [5].

Plant Height

The plant height was significantly by various treatments. The height of the plants was considerably more under hand weeded plot (219.86 cm), as compared to rest of the treatments. This may be due to the weed free conditions in the field and all the growth resources were optimally utilized by the crop plants. This led to better plant height over weedy check plots. The results are in close conformity to the findings of Chakor and Awasthi, (1983) [2].

Dry matter production

Different dry matter treatments caused significant production on the dry matter per plant. Weedy check and pendimethalin @ 1.0 kg/ha, recorded the minimum dry matter per plant. Hand weeded plot gained maximum dry matter production (422.5 g/plant) and proved superior over all other treatments (Table 1). Similar results were also reported by Sinha *et al.* (2001) [4] and Verma *et al.* (2009) [6].

Stem Girth

The weedy check plots had the minimum stem girth of the plant, as compared to all other treatments. The stem girth of the plants increased appreciably in plots receiving weed control treatments. Alone application of herbicide obtained less stem girth as compared to their combination with herbicide or manual method.

Leaf Area Index

The LAI differ significantly due to different herbicidal treatments. The LAI was maximum in hand weeded plot (7.77), whereas, minimum value of LAI was recorded in weedy check plot (4.67). Similar results were also reported by Sinha *et al.* (2001) [4] and Verma *et al.* (2009) [6].

Table 1: Influence of weed control treatments on growth characters of fodder maize at harvest

Treatments	Plant population (m^2)	Plant Height (cm)	Dry weight (g/plant)	Stem girth (cm)	LAI
T1-Atrazine1.0 kg ha-1	12.56	207.97	405.80	1.84	6.59
T2- Pendimethalin 1.0 kg ha-1	12.69	207.28	300.09	1.86	6.26
T3-2,4-D EE 0.5 kg ha-1	12.65	200.32	387.56	1.83	5.77
T4- Atrazine1.0 kg ha-1 fb 2,4-D EE 0.5 kg ha-1	12.84	211.80	412.57	1.92	6.92
T5-Pendimethalin 1.0 kg/ha fb 2,4-D EE 0.5 kg ha-1	2.77	210.93	409.54	1.90	6.71
T6 -Atrazine1.0 kg ha-1 + Hand Weeding (30 DAS)	13.09	216.41	419.86	2.00	7.72
T7- Pendimethalin1.0 kg ha-1 + Hand Weeding (30 DAS)	13.04	213.45	416.34	1.98	5.43
T8- 2,4-D EE 0.5 kg ha-1 + Hand weeding (30 DAS)	12.65	200.32	387.56	1.89	5.77
T9- Hand weeding (30 DAS)	13.12	219.86	422.15	2.01	7.77
T10 - Weedycheck	12.66	182.48	373.73	1.71	4.67
SEm±	0.16	0.32	1.09	0.02	0.10
CD 5%	NS	0.94	3.28	0.06	0.30

Yield Studies

Green fodder yield

The data on green fodder yield of maize revealed that fodder yield was affected due to various treatments. Hand weeding produced significantly the maximum green fodder yield (725 q/ha). Amongst the herbicidal treatments, pendimethalin (1.0 kg/ha) produced the fodder yield of 675 q/ha followed by 2, 4–D EE 0.5 kg/ha (567 q/ha).

Dry matter yield (q ha-1)

The lowest dry matter yield (37.87 q ha-1) was observed in weedy Check due to presence of more weeds which suppressed the growth and development of the crop. The maximum dry matter yield (137.88 q ha-1) was recorded under hand weeding at 30 DAS. This is due to lesser number of weeds present in the plots (Table 2).

Crude protein yield (q ha-1)

Hand weeded plots recorded the maximum crude protein yield (18.55 q/ha) followed by pendimethalin 1.0 kg/ha (17.48 q/ha). Weedy check recorded significantly the lowest crude protein yield (4.64 q/ha).

Table 2: Effect of weed management practices on Green fodder yield, crude protein content and crude protein yield

Treatment		Green fodder Yield (qha-1)	Dry matter Yield (qha-1)	Crude Protein content in Leaves and Stem (%)	Crude Protein yield (qha-1)
T1	Atrazine1.0 kg ha-1	490	95.80	13.02	12.47
T2	Pendimethalin1. 0kg ha^{-1}	675	129.93	13.46	17.48
T3	2,4-D EE 0.5 kg ha-1	567	109.32	12.81	14.00
T4	Atrazine 1.0 kg ha-1 fb 2,4 D EE 0.5 kg ha-1	506	98.12	12.81	12.56
T5	Pendimethalin 1.0 kg ha-1 fb 2,4 D EE 1.0 kg ha-1	579	112.11	13.35	14.96
T6	Atrazine 1.0 kg ha-1 + Hand Weeding (30 DAS)	544	105.51	13.02	13.73
T7	Pendimethalin 1.0 kg ha-1 + Hand Weeding (30 DAS)	608	116.35	13.24	15.40
T8	2,4 D EE 0.5 kg ha-1 Hand Weeding (30 DAS)	555	108.90	13.25	14.42
T9	Hand weeding (30 DAS)	724	137.88	13.46	18.55
T10	Weedy check	351	37.87	12.26	4.64
	SEm±	49.52	8.76	0.4	0.6
	CD (P = 0.05)	141.14	24.96	NS	1.92

Economic analysis of the treatments

The economic analysis of weed control treatments was determined on per hectare area basis, which includes cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio (profitability per rupee of investment) under different treatments.

Cost of cultivation

Cost of cultivation was determined treatment wise on the basis of market price of various common and variable agro input used. Data revealed that the cost of cultivation varied under different treatments. The highest cost of cultivation was observed in hand weeding (30 DAS) treatment (Rs 21650 ha-1) followed by Atrazine 1.0 kg ha-1+ Hand Weeding (30 DAS) (Rs 20955 ha-1). Minimum cost of cultivation was recorded under weedy check (Rs 19050 ha-1).

Gross monetary returns

Maximum gross return was recorded under hand weeding at 30 DAS (Rs 102392 ha-1) followed by Pendimethalin 1.0 kg ha-1(Rs 97478 ha-1) and minimum gross return was recorded in weedy check (Rs 75061 ha-1) followed by Atrazine 1.0 kgha-1 (Rs 79002 ha-1)

Net monetary returns

The net monetary returns were significantly influenced by different treatments. The highest net monetary returns were observed in hand weeding at 30 DAS (Rs 80742 ha-1) followed by pendimethalin 1.0 kg ha-1 (Rs 78008 ha-1). However, the lowest net monetary returns were observed in weedy check (Rs 56023 ha-1).

Benefit: cost ratio

Benefit: cost ratio had significantly influenced by various treatments. The highest benefit cost ratio was observed in pendimethalin 1.0 kg ha -1 (4.0) and was at par with hand weeding at 30 DAS (3.7) and pendimethalin 1.0 kg ha1 fb 2,4-D 0.5 kg ha-1 (3.5). Significantly lowest benefit cost ratio was noted under weedy check (2.9).

Table 3: Economic analysis of different weed control treatments in Fodder maize.

Treatment		Cost of cultivation (Rs ha-1)	Gross monetary returns (Rs ha-1)	Net monetary returns (Rs ha-1)	B:C Ratio
T1	Atrazine 1.0 kg ha-1	20375	79002	58627	2.9
T2	Pendimethalin 1.0 kg ha-1	19470	97478	78008	4.0
T3	2,4-D EE 0.5 kg ha-1	19630	86724	67094	3.4
T4	Atrazine 1.0 kg ha-1 fb 2,4 D EE 0.5 kg ha-1	20013	80600	60587	3.0
T5	Pendimethalin 1.0 kg ha1fb 2,4 D EE 1.0 kg ha-1	20795	87931	67136	3.2
T6	Atrazine 1.0 kg ha-1 + Hand Weeding (30 DAS)	20955	84443	63488	3.0
T7	Pendimethalin 1.0 kg ha-1 + Hand Weeding (30 DAS)	20050	90824	70774	3.5
T8	2,4 D EE 0.5 kg ha-1 + Hand Weeding (30 DAS)	20593	85480	64887	3.1
T9	Hand weeding (30 DAS)	21650	102392	80742	3.7
T10	Weedy check	19050	75061	56023	2.9
	SEm±			4951.79	0.2
	CD(P= 0.05)			14114.29	0.69

Conclusion

From the above going findings, it may be concluded that variety African Tall exhibited its superiority by producing taller plants, higher LAI, crude protein yield and green fodder yield, may be due to its genetic constitution and adaptability to the existing environmental conditions. Amongst the different herbicidal treatments, Pendimethalin (1.0kg ha-1) significantly reduced the infestation of all associated weed and was more effective in curbing the weed growth. This herbicide was also found more economically viable with NRM (Rs 78008 /ha) and B:C ratio (4.0).

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