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RESEARCH ARTICLE

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Response of chemical weed management in maize and cowpea intercropping system grown for quality fodder in Eastern Uttar Pradesh

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ABSTRACT : Field experiment was carried out during *Kharif* 2005 and 2006 using different herbicides to study the response of weed control treatments in maize and cowpea intercropping system for quality fodder. Pre-emergence application of alachlor, metolachlor and pendimethalin @ 1.00 and 1.50 kg a.i./ha each and post emergence application of imazethapyr @ 0.10 and 0.15 kg a.i./ha at 20 days of crop sown combined with weedy and weed-free conditions. All the herbicides at each dose effectively controlled the weeds and reduced its dry weight as compared to weedy condition. Alachlor, metolachlor and pendimethalin at 1.5 kg a.i./ha and pendimenthalin at 1.0 kg a.i./ha significantly reduced the population and dry weight of total weeds over the other rates of herbicides. Pendimethalin @ 1.5 kg/ha gave maximum green forage and dry matter yield (448 and 102 q/ha) among herbicide treated plots which were at par with that of weed free condition (466 and 109 q/ha). All the herbicides at higher doses followed the same trend in reduction of dry matter accumulation of weeds and increased in green forage and dry matter yield of maize and cowpea mixed fodder over control. Similarly, with increase in the dose of herbicide the crude protein, nitrogen uptake and DM (dry matter) per cent increased significantly.

KEY WORDS : Herbicides, Intercropping, Maize, Cowpea, Weed control efficiency, Weed index

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INTRODUCTION

In India about 70 per cent of the population lives in villages and their livelihood depends upon agriculture and animal husbandry. The country possesses about 196 million cattle and 80 million buffaloes producing 77 million tonnes of milk (Kadirvel, 2002). Animal population is increasing rapidly whereas fodder resources are quite limited. The area under cultivated fodder crops (4.3%) has remained stagnant for the last many years (Patil and Ali, 1983). India's annual requirements of feed and fodders have been estimated to be 650.70 million tonnes straw, 761.53 million tonnes green fodder and 79.40 million tonnes concentrate but their availability is 387.86, 573.50 and 42.98 million tonnes, respectively. Thus, there is a deficit of 40.4, 24.7 and 47.1 per cent of straw, green

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fodder and concentrate, respectively (Ranjhan, 1997). Land utilized for growing green fodder hardly exceeds 5 per cent of the cultivable area due to high pressure for growing cereals and other cash crops for human consumption. Therefore, only alternative left is to improve the quality of feed and fodder through appropriate agronomic manipulation. Intercropping of non legume fodder with leguminous fodder has been considered to be one of the attempts for achieving high nutritious fodder production from unit area per unit time. Maize (*Zea mays* L.) is considered as ideal crop for fodder because of its growth, succulence, high yield, more palatability and richness in protein. Cowpea (*Vigna unguiculata* L.), locally known as lobia, is one of the fast growing, warm season annual forage legume. Maize and cowpea are generally grown in rainy and summer season because of favourable moisture and temperature. Due to heavy infestation of weeds, yield and quality of fodder become poor.

Forage production in *Kharif* season could be affected by weed competition for space, light and nutrients. Weeds can impact livestock production by decreasing yield potential, impacting forage quality, producing anti-quality factors, increasing the cost of livestock production and reducing value of forage land. Maize and cowpea grown during the rainy season coupled with wider row spacing and initial slow growth suffer heavily due to severe weed infestation. Irrespective of cropping systems practiced, the weed problem remains a major cause of yield loss in crops and detailed knowledge and understanding of their biology, survival mechanism and life cycle can help in further research to reduce devastating effects of weeds on agricultural farms. The objective of this study was to evaluate the weed management response on quality fodder of maize and cowpea intercrops. Thus, field studies were carried out to evaluate various herbicides and their respective doses for weed control management in maize and cowpea intercropping system for quality fodder production.

EXPERIMENTAL METHODS

The field experiment was carried out at the KVK instructional farm at Crop Research Station, Masodha, Faizabad during *Kharif* season of 2005 and 2006, in which 12 treatments comprising alachlor, metolachlor, pendimethalin @ 1.00 and 1.50 kg *a.i.*/ha as pre emergence and imazethapyr @ 0.10 and 0.15 kg *a.i.*/ha at 20 days of crop with weedy and weed free condition (Table A and B) were evaluated in Randomized Block Design with three replications. Herbicides were applied as per treatment as spray of aqueous solution at the rate of 600 litres of water per hectare. The herbicides solution was sprayed uniformly and carefully with the help of Maruti foot sprayer having flat fan nozzle. Hand weeding operation was carried out by *Khurpi* in weed free plots and weeds were removed manually as and when necessary. Weedy plot remain infested with native population of weeds till the whole crop season.

Table A : Effect of herbicides on weed population, dry weight, weed control efficiency and weed index in maize and cowpea mixed crops (pool data of two years)

Treatments	Rate	Weed population (per m^2)	Weed dry weight (g/m^2)	Weed control efficiency (%)	Weed index (%)
Alachlor	1.00	2.48 (11)	1.93 (05.87)	94.15	17.60
Alachlor	1.50	1.39 (03)	1.09 (01.97)	98.04	15.67
Pendimethalin	1.00	0.00 (00)	0.00 (0.00)	100.00	11.37
Pendimethalin	1.50	0.00 (00)	0.00 (0.00)	100.00	3.86
Metolachlor	1.00	3.09 (21)	2.15 (07.60)	92.43	16.09
Metolachlor	1.50	2.08 (07)	1.41 (03.10)	96.91	07.51
Imazethapyr	0.10	3.73 (41)	3.01 (19.30)	80.78	16.52
Imazethapyr	0.15	3.09 (21)	1.90 (05.70)	94.32	07.94
Weed Free	(M+C)	0.00 (00)	0.00 (0.00)	100.00	0.00
Weedy	(M+C)	4.97 (144)	4.61 (100.40)	-	27.90
Weedy	(M)	5.23 (186)	5.00 (148.58)	-	61.59
Weedy	(C)	0.00 (00)	0.00 (0.00)	-	43.99
C.D. (P=0.05)		1.67	1.67	-	-

Original figure are shown under parenthesis M - Maize, C - Cowpea, M+C - Intercropping

Table B: Effect on herbicides on forage and dry matter yield of maize and cowpea mixed fodder (pool data of two years)

Treatments	Rate	Green forage yield (q/ha)			Dry matter yield (q/ha)			Maize cowpea ratio	
		Maize	Cowpea	Total	Maize	Cowpea	Total	Maize	Cowpea
Alachlor	1.00	242	142	384	55	27	82	63	37
Alachlor	1.50	261	132	393	61	24	85	66	34
Pendimethalin	1.00	257	156	413	59	29	87	62	38
Pendimethalin	1.50	275	173	448	66	35	102	61	39
Metolachlor	1.00	243	148	391	56	28	84	62	38
Metolachlor	1.50	267	164	431	66	34	99	62	38
Imazethapyr	0.10	245	144	389	57	27	83	63	37
Imazethapyr	0.15	265	162	429	65	33	98	62	38
Weed Free	(M+C)	285	181	466	70	39	109	61	39
Weedy	(M+C)	215	121	336	44	21	66	64	36
Weedy	(M)	179	-	179	49	-	49	100	-
Weedy	(C)	-	261	261	-	44	44	-	100
C.D. (P=0.05)		21.3	12.2	29.0	7.6	5.2	13.5		

Original figure are shown under parenthesis M - Maize, C - Cowpea, M+C - Intercropping

The crop was sown in the second fortnight of June and harvested at second fortnight of September. Maize variety Vijay and cowpea variety UPC 5286 were sown in alternate rows at 30 cm apart in gross plot size of 5.0 x 3.6 m area. The soil type was sandy clay loam in texture having pH 6.8, low in available nitrogen and phosphorus and medium in available potash. Crops were fertilized with 100 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare in the form of urea, SSP and MOP, respectively. Half of the nitrogen and full dose of phosphate and potash were applied at the time of field operation as basal and rest amount of nitrogen was top dressed at 30 days of sowing. The weed intensity was recorded with the help of quadrate (1.0 x 1.0 m) placed in the sampling area of each plot.

During the course of investigation, in each plot there were 12 rows of maize and cowpea in the ratio of 1:1. In each plot, border of two rows was left on both sides of the plot and 50 cm was left on either side of the plot length wise. The remaining area (4 x 2.4 m) was divided in two parts. One part for sampling (0.5 x 2.4 m) and other for yield estimation (3.5 x 2.4 m). From sampling area samples from 0.5 m row length were taken randomly for each sampling. From net plot area, green forage yield of maize and cowpea crop were recorded separately. Species wise observations on weeds were also taken from the sampling areas. Log transformation (X+1) is used for weed population and weed dry weight.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on weed flora :

The predominant weeds were *Echinochloa colonum* (L.) Link., *Trianthema monogyna* (L.), *Cyperus rotundus* (L.), *Celosia argentea* Linn., *Phylanthus niruri* Linn., *Corchorus acutangulus* Linn., *Digitaria sanguinalis* (L.) Scop., *Eleusine indica* (L.) Gaertn. and *Cynodon dactylon* (L.) Pers. Out of total nine weed species, *Echinochloa colonum* among grassy, *Trianthema monogyna* among broad leaf and *Cyperus rotundus* in sedges were pre dominant for which per cent population are given in Fig. 1. In weedy plot, *Echinochloa colonum* contributed 57.10 per cent, *Trianthema monogyna* 22.73 per cent and *Cyperus rotundus* 13.16 per cent of the total weed population and having 24.80, 62.44 and 7.14 per cent of the total weed dry weight, respectively at 30 days of sowing. Singh and Prasad (1994) also reported from Pantnagar that relative density of *E. colonum* and *T. portulacastrum* was 57.1 and 32.2 per cent, respectively during *Kharif* season in maize crops.

All the herbicides reduced total population and dry weight of weeds with its increasing rate of application compared to the weedy check (Table 1). Among the

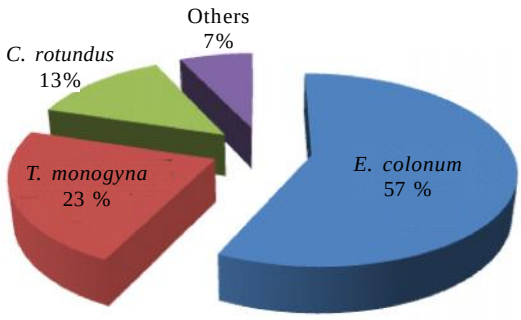

Fig. 1: Major weed species in weedy plot at 30 days stage of crops

treatments, maximum reduction in weed population and dry weight were found with the pre emergence application of pendimethalin @ 1.0 and 1.5 kg/ha, alachlor @ 1.5 kg/ha and cowpea (pure crop) as weedy upto the level of weed free condition and also reported maximum weed control efficiency (98 to 100%). Singh and Prasad (1987) and Thind *et al.* (1993) also reported the similar type of results. Alachlor and metolachlor @ 1.0 kg/ha and imazethapyr @ 0.10 kg/ha though reduced the population and dry weight of weeds but not upto the mark of its higher doses. However, weed control efficiency was found better and more than 80 per cent and weed index between 17.60 to 11.37 per cent (Table 1). Higher weed control efficiency might be due to smothering effect of cowpea in maize based cropping system. Cowpea pure crop as weedy reduced the population and dry weight of weeds upto the level of weed free probably due to its smothering effect. Rana and Pal (1989) also reported similar findings.

Effect on green forage yield :

All the herbicide treatments gave significantly higher green forage and dry matter yield than that of weedy check. Uncontrolled weeds in weedy check caused maximum reduction (27.90%) in total green forage yield as compared to weed free condition (466 q/ha) in intercropping system, however, it was lowest in pure stand (as weedy) of maize (239 q/ha) and cowpea (261 q/ha). This reduction is upto tune of 48.51 to 43.99 per cent, respectively. Weed free plot produced highest total green forage and dry matter yield (109 q/ha) followed by pendimethalin @ 1.5 kg/ha (448 and 102 q/ha) which was at par with the weed free condition. Herbicides at higher rates gave significantly higher green forage and dry matter yield as compared to its lower rates, however, alachlor at all rates did not show significant differences as higher rates of alachlor showed phytotoxicity to cowpea in respect of its growth characters. Akobundu (1982) and Thind *et al.* (1993) also reported that alachlor at 2.0 kg/ha was phytotoxic to cowpea and showed reduction in yield. Metolachlor @ 1.5 kg/ha and imazethapyr @ 0.15 kg/ha also proved superior with its respective lower rates and were statistically at par with pendimethalin @ 1.5 kg/ha. Thakur *et al.*(1990) and Singh and Prasad (1994) also showed similar trends. Intercrops of maize and cowpea produced significantly higher green

Table 1: Forage quality of maize and cowpea crops as influenced by weed control treatments in intercropping system (pool data of two years)

Treatments	Rate	Crude protein (%)		Nitrogen uptake (kg/ha)			Dry matter (%)		
		Maize	Cowpea	Maize	Cowpea	System	Maize	Cowpea	System
Alachlor	1.00	6.79	16.99	60.04	87.94	147.98	22.77	20.80	21.78
Alachlor	1.50	7.21	15.81	69.74	67.55	137.29	23.27	19.03	21.15
Pendimethalin	1.00	7.10	16.35	66.99	75.19	142.18	22.85	18.43	2064
Pendimethalin	1.50	7.39	17.56	78.50	99.02	177.52	24.67	20.67	22.67
Metolachlor	1.00	6.79	16.19	60.91	72.36	133.27	23.03	18.83	20.93
Metolachlor	1.50	7.29	17.23	76.75	93.39	170.14	24.26	20.63	22.45
Imazethapyr	0.10	6.61	15.50	60.24	66.04	126.28	23.17	18.53	20.85
Imazethapyr	0.15	6.78	16.69	71.20	88.54	159.74	24.46	20.47	22.46
Weed Free	(M+C)	7.60	17.98	85.08	113.45	198.53	24.83	21.380	23.32
Weedy	(M+C)	6.21	14.00	43.99	47.44	91.43	20.67	17.50	19.08
Weedy	(M)	6.04	-	47.20	-	47.20	20.40	-	10.20
Weedy	(C)	-	14.42	-	78.89	78.89	-	20.17	10.08
C.D. (P=0.05)		0.17	0.23	7.79	14.97	23.1	0.79	1.40	0.31

Original figure are shown under parenthesis

M - Maize, C - Cowpea, M+C - Intercropping

forge and dry matter yield as compared to its pure stand. This may be due to intercropping system as it utilizes the sites moisture, nutrients, light and space on the one hand and decrease the population of weeds by utilizing the inter row space on the other hand. Dubey (1998) also reported similar results in soybean based intercropping system.

Effect on forage quality :

Herbicides application significantly influenced the crude protein content. With increase in the dose of herbicide the crude protein, nitrogen uptake and DM (dry matter) per cent increased significantly (Table 1). It showed that herbicide treated maize and cowpea plants mined higher uptake of nitrogen from the soil, have contributed more towards the synthesis of protein. Similar results were obtained by Thind *et al.* (1996) with the application of atrazine in sudex hybrid. Maximum crude protein, DM per cent and nitrogen uptake was recorded with pendimethalin at 1.5 kg/ha and was followed by metolachlor at 1.5 kg/ha. The uptake of nitrogen, crude protein and nitrogen per cent were more at higher doses of herbicides as compare to its lower doses. This may be due to lesser crop-weed competition at higher doses of herbicides and higher green forage and dry matter yield. Lower green forage and dry matter yield of both maize and cowpea in weedy condition caused lower percentage of nitrogen, crude protein and dry matter and ultimately lower nitrogen uptake.

The above study concluded that pendimethalin @ 1.5 kg/ha was the best treatment for effective control of weeds and produced maximum green forage and dry matter yield in maize and cowpea intercrops followed by metolachlor @ 1.5 kg/ha and it also produced the balanced fodder of 61:39 ratio of maize and cowpea, respectively. Higher rate of alachlor is phytotoxic to pulse crops.

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