Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [1] 2017: 498-503

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Efficacy of different herbicides on weed dynamics, yields attributes and yield of maize

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ABSTRACT
A field experiment was conducted at research farm of Bihar Agricultural University, Sabour, Bhagalpur during rabi season 2011-12 and 2012-13 to find out the suitable chemical herbicide for effective control of weeds in winter maize. To evaluate the bio-efficacy of acetochlor herbicide against grassy and non grassy weeds in maize, total nine treatments viz., acetochlor 90% EC at 1.25, 1.875, 2.5, 3.125 and 5.0 l/ha, atrazine 50% WP at 2.0 kg/ha and 2, 4-Diethyl ester 38% EC at 1.315 l/ha, weed free and weedy check were laid out in randomized block design replicated thrice. All the doses of acetochlor 90% EC showed effective control of grasses, sedges and broad leaved weeds. Higher doses of acetochlor 90% EC as PE at 3.125 and 5.0 l/ha were marginally more effective in reducing the density of weeds as compared to its lower dose. Highest grain yield (83.4 q/ha) was recorded in weed free plot which was statistically at par with acetochlor 90% EC @ 5.0 l/ha (82.1 q/ha) and acetochlor 90% EC @ 3.125 l/ha (81.0 q/ha). Among herbicides, acetochlor 90% EC @ 5.0 l/ha registered maximum grain yield being at par with acetochlor 90% EC @ 3.125 l/ha and atrazine 50% WP @ 2.0 kg/ha. Lowest yield was recorded in weedy check (71.2 q/ha).
Keywords: *Herbicide, Weeds, Maize and Yield*

Received 02.08.2017 Revised 18.08.2017 Accepted 30.08. 2017

INTRODUCTION

Rabi maize is well adapted to climatic and soil situations of Bihar and is considered, now-a- days, the third most important cereal crop after rice and wheat. The area and production of maize is increasing day by day due to our linear increase in demand for poultry feed and others. The feasibility to increase per unit yield is more as there is a large gap between potential and actual yield per hectare. Besides other factors, yield is greatly affected by presence of obnoxious weeds in the maize field. Weeds being injurious, harmful or poisonous are a constant source of trouble for the successful growth and development of maize. Rabi season maize suffers from severe weed competition and depending upon the intensity, nature, stages and duration of weed infestation causes yield losses varying from 28-100% (7).Weeds being the major yield limiting factor reduced crop yield by 20-40% depending upon weed species and density (5).Yield losses due to weeds have been reported up to 35% (6).Weeds compete with crop for light, moisture, space and plant nutrients and other environmental requirements and consequently interfere with the normal growth of the crop. Weeds pose severe problem for crop husbandry, reducing the soil fertility and moisture and develop a potential threat to succeeding crop. (3) reported that grain yield has significantly increased by herbicides treatments in maize. Keeping in view these issues, the present investigation was carried out to assess the impact of different herbicides on several varieties of weeds and also know the response of maize crop to such herbicides in terms of weed suppression, yield and yield attributes of maize.

MATERIALS AND METHODS

The experiment was conducted at Bihar Agricultural University, Sabour in 2011-2012 and 2012-13. Maize used in the experiment was laid out in randomized block design with three replications with nine treatments namely, acetochlor at 1.25, 1.875, 2.5, 3.125 and 5.0 l/ha, atrazine at 2.0 kg/ha and 2, 4-Diethyl ester at 1.315 l/ha, weed free and weedy check in each replication. Herbicidal treatments were

sprayed after sowing of seed with hand knapsack sprayer. The maize crop was fertilized with 120 kg N/ha, 75 kg P_2O_5/ha and 50 kg K_2O_5/ha in the form of urea, di-ammonium phosphate and muriate of potash, respectively. One third of nitrogen and full dose of P and K fertilizers were incorporated into the soil during final land preparation. Remaining nitrogen was top-dressed in two equal splits at knee high and tasseling stages in maize rows. Weed samples were collected using 50 cm x 50 cm quadrate from randomly selected two places from each plot at 15, 30, 45 and 60 days after sowing. Density and dry weight of weeds were recorded. Yield and yield contributing characters were recorded and analyzed statistically by adopting the methods appropriate to the design (1).

RESULTS AND DISCUSSION

Data indicated that the density of weeds per m^2 was significantly affected by different herbicides in maize (Table 1).

Effect on weed density

Among the grassy weeds, *Cynodon dactylon* and *Avena ludoviciana* were the major one which accounts 14.4 and 0.7 per cent, respectively among the total weed density in weedy check plot at 15 DAS. At 15 DAS, the density of all grassy and non grassy weeds was influenced significantly due to various weed control treatments (Table 1). All the herbicides were able to reduce weed density as compared to weedy check. Drastic reduction in weed density was recorded with increasing doses of acetochlor 90% EC from 1.25 to 5.0 l/ha. Acetochlor 90% EC at all the doses was found effective to reduce the weed density of grassy weeds like *Cynodon dactylon, Avena ludoviciana*, sedges like *Cyperus rotundus* and broad leaved weeds like *Chenopodium album*, *Anagallis arvensis*, *Croton sparsiflorus*, *Coronopus dydimus, Fumaria parviflora* as compared to other herbicidal treatments including weedy check. Higher doses of acetochlor 90% EC at 3.125 to 5.0 l/ha as pre-emergence were found more effective in reducing weed density as compared to its lower dose.

All the herbicidal application was found non-significant in controlling *Avena ludoviciana* over weedy check. However, acetochlor 90% EC at 3.125 and 5.0 l/ha and weed free provided complete control of *Avena ludoviciana*. Weed density was recorded zero in weed free treatment over rest of the treatments at all the stages. Weed free treatment, which received four hand weeding at regular intervals indicated that complete weed control was possible only by manual and cultural methods. However, this will neither be economical nor possible where there is scarcity of labour. This is in conformity with the findings of (12) and (8).

Table 1. Weed density (No. /m^2) in maize as affected by different treatments (Pooled mean over two years)

Treatment	Dose (l/ha)	Weed density (No. /m^2)															
		Cynodon dactylon		*Avena ludoviciana*		*Chenopodium album*		*nagallis revensis*		*Fumaria parviflora*		*Croton sparsiflorus*		*Coronopus dydimus*		*Cyperus rotundus*	
		15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS
Acetochlor 90% EC	1.25	4.2 (2.16)	9.2 (3.11)	0.75 (1.11)	2.05 (1.59)	4.75 (2.29)	10.1 (3.25)	2.8 (1.81)	6.1 (2.56)	1.8 (1.51)	3.5 (2.02)	2.25 (1.65)	4.65 (2.26)	1.75 (1.5)	4.0 (2.12)	14.4 (3.86)	31.9 (5.69)
Acetochlor 90% EC	1.875	4.85 (2.31)	8.95 (3.07)	0.60 (1.04)	1.75 (1.5)	4.4 (2.21)	9.9 (3.22)	2.6 (1.76)	5.45 (2.43)	1.55 (1.43)	3.05 (1.88)	2.05 (1.59)	4.2 (2.16)	1.45 (1.39)	3.4 (1.97)	14.25 (3.84)	29.1 (5.44)
Acetochlor 90% EC	2.5	3.35 (1.96)	8.5 (3.0)	0.65 (1.07)	1.45 (1.39)	3.9 (2.09)	9.45 (3.15)	2.4 (1.70)	5.25 (2.39)	1.4 (1.37)	2.65 (1.77)	1.95 (1.56)	3.8 (2.01)	1.1 (1.26)	2.95 (1.85)	10.75 (3.35)	27.25 (5.26)
Acetochlor 90% EC	3.125	3.3 (1.94)	8.25 (2.95)	0.0 (0.71)	0.0 (0.71)	3.8 (2.07)	9.15 (3.10)	2.15 (1.62)	5.0 (2.34)	1.25 (1.32)	2.2 (1.64)	1.65 (1.46)	3.1 (1.89)	0.8 (1.14)	2.65 (1.77)	10.3 (3.28)	24.7 (5.01)
Atrazine 50% WP	2.0	3.7 (2.04)	13.85 (3.78)	0.65 (1.07)	2.35 (1.68)	4.25 (2.17)	8.35 (2.97)	2.45 (1.71)	4.9 (2.32)	1.45 (1.39)	2.45 (1.71)	2.2 (1.64)	2.6 (1.76)	1.45 (1.39)	1.6 (1.44)	12.8 (3.64)	36.4 (6.07)
2,4-Diethyl ester 38% EC	2.65	5.0 (2.34)	13.85 (3.78)	1.15 (1.28)	2.3 (1.67)	0.35 (0.92)	0.65 (1.07)	0.5 (1.0)	1.3 (1.34)	0.55 (1.02)	1.35 (1.36)	0.05 (0.74)	0.55 (1.02)	0.0 (0.71)	0.3 (0.89)	16.7 (4.14)	41.3 (6.46)
Weedy	-	9.05 (3.09)	19.55 (4.47)	0.90 (1.18)	3.05 (1.88)	7.6 (2.84)	14.6 (3.88)	4.15 (2.15)	8.2 (2.94)	2.55 (1.74)	5.6 (2.46)	2.95 (1.85)	6.25 (2.59)	3.3 (1.94)	5.3 (2.40)	36.1 (6.04)	61.55 (7.87)
Weed free	-	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)
Acetochlor 90% EC	5.0	2.9 (1.84)	7.2 (2.77)	0.0 (0.71)	0.4 (0.94)	3.25 (1.93)	8.75 (3.04)	1.7 (1.48)	4.5 (2.23)	0.9 (1.18)	2.25 (1.65)	1.15 (1.28)	2.75 (1.80)	0.45 (0.97)	2.75 (1.80)	7.4 (2.81)	22.35 (4.78)
CD (P=0.05)		0.17	0.32	NS	0.28	0.20	0.17	0.28	0.23	0.24	0.23	0.19	0.33	0.30	0.31	0.62	0.29

All the herbicidal application was found significantly superior in controlling *Cynodon dactylon* over weedy check. Application of acetochlor 90% EC at 5.0 l/ha provided maximum control of *Cynodon dactylon* as compared to other herbicidal treatments. *Chenopodium album*, *Anagallis arvensis*, *Fumaria parviflora*, *Croton sparsiflorus*, *Coronopus dydimus* were the main weeds among broad leaf weeds which accounted 37.2, 20.0, 12.3, 14.4 and 16.0 per cent share, respectively among the total weed density of broad leaf weeds in weedy plot at 15 DAS. *Cyperus rotundus* was dominant among sedges accounting 41.5 per cent towards total weed density in weedy check plot at 15 DAS (Table 1).

At 45 DAS, the density of all the weeds was also influenced significantly due to various herbicidal treatments (Table 1). Acetochlor 90% EC at 3.125 and 5.0 l/ha had complete reduction over the density of *Avena ludoviciana* among the grassy weeds as compared to its rest of the doses over weedy check. All the treatments significantly reduced the density of *Avena ludoviciana* rather than *Cynodon dactylon* over weedy check. Density of *Cynodon dactylon* was found lowest under acetochlor 90% EC at 5.0 l/ha which was at par with its lower dose at 3.125 l/ha and was significantly superior over rest of herbicidal applications. Total density of grassy weeds was also found minimum in acetochlor 90% EC at 5.0 l/ha among herbicidal treatments, which was at par with its lower dose at 3.125 l/ha and was found superior over weedy check, 2,4-Diethyl ester 38% EC at 2.65 l/ha and atrazine 50% WP at 2.0 kg/ha.

Among broad leaved weeds, *Chenopodium album*, *Anagallis arvensis*, *Croton sparsiflorus*, *Coronopus dydimus, Fumaria parviflora* were significantly controlled by application of 2,4-Diethyl ester 38% EC at 2.65 l/ha (Table 1). Application of acetochlor 90% EC at each level of application registered significantly lower weed density of *Chenopodium album*, *Anagallis arvensis*, and *Coronopus dydimus* than weedy check. Next to 2,4-Diethyl ester 38% EC, the density of *Fumaria parviflora* was found minimum under acetochlor 90% EC at 5.0 l/ha, followed by acetochlor 90% EC at 3.125 l/ha and atrazine 50% WP at 2.0 kg/ha. However, next to 2,4-Diethyl ester 38% EC, density of *croton sparsiflorus* was found low under atrazine 50% WP at 2.0 kg/ha. Application of acetochlor 90% EC at 5.0 l/ha recorded lowest weed density of sedges *i.e. Cyperus rotundus*, which was at par with its lower dose at 3.125 and 2.5 l/ha and was significantly superior over rest of the herbicidal treatments and weedy check.

Effect on weed dry weight

Weed dry weight also showed more or less similar trend of effectiveness of the treatments as observed from weed density in maize crop (Table 2). Statistical analysis of the data presented in Table 2 indicated that weed dry weight was significantly affected by various herbicides in maize. Application of acetochlor 90% EC increased from 1.25 to 5.0 l/ha, dry weight of weeds decreased at 30 DAS, however, differences in weed dry weight was significant. Application of acetochlor 90% EC at 5.0 l/ha recorded lowest weed dry weight which was followed by application of same herbicide at 3.125 l/ha.

Table 2. Weed dry weight (g/m²) in maize as affected by different treatments (Pooled mean over two years)

Treatment	Dose (l/ha)	Weed dry weight (g/m2)															
		Cynodon dactylon		*Avena ludoviciana*		*Chenopodium album*		*Anagallis aevensis*		*Fumaria parviflora*		*Croton sparsiflorus*		*Coronopus dydimus*		*Cyperus rotundus*	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Acetochlor 90% EC	1.25	2.6 (1.76)	6.65 (2.67)	1.2 (1.30)	1.7 (1.48)	3.65 2.03)	7.25 (2.78)	2.8 (1.81)	4.85 2.31)	1.85 (1.53)	4.45 (2.22)	2.35 (1.68)	3.15 (1.91)	2.25 (1.65)	2.2 (1.64)	3.0 (1.78)	10.75 (3.35)
Acetochlor 90% EC	1.875	2.35 (1.68)	6.25 (2.59)	1.0 (1.22)	1.2 (1.96)	3.35 1.96)	6.65 (2.67)	2.65 (1.77)	4.4 2.21)	1.65 (1.46)	3.95 (2.10)	2.0 (1.58)	2.6 (2.6)	2.05 (1.59)	1.75 (1.50)	2.7 (1.78)	10.05 (3.24)
Acetochlor 90% EC	2.5	2.0 (1.58)	5.6 (2.46)	0.85 (1.16)	0.75 (1.11)	2.9 (1.84)	5.95 (2.53)	2.4 (1.70)	4.05 2.13)	1.4 (1.37)	3.5 (2.0)	2.0 (1.58)	2.0 (1.58)	1.9 (1.54)	1.95 (1.56)	2.5 (1.73)	7.7 (2.86)
Acetochlor 90% EC	3.125	2.3 (1.67)	5.1 (2.36)	0.0 (0.71)	0.3 (0.89)	2.6 (1.76)	5.25 (2.39)	2.1 (1.61)	3.45 (1.98)	1.5 (1.41)	2.7 (1.78)	2.05 (1.58)	1.8 (1.51)	1.9 (1.54)	1.15 (1.28)	2.35 (1.68)	7.15 (2.76)
Atrazine 50% WP	2.0	2.65 (1.77)	5.85 (2.51)	0.85 (1.16)	1.85 (1.53)	3.1 (1.89)	7.75 (2.87)	2.0 (1.58)	4.8 (2.30)	1.6 (1.44)	2.3 (1.67)	2.1 (1.61)	3.3 (1.94)	1.85 (1.53)	1.75 (1.50)	2.55 (1.74)	9.95 (3.23)
2,4-Diethyl ester 38% EC	2.65	1.95 (1.56)	10.65 (3.33)	0.65 (1.07)	3.85 (2.08)	1.9 (1.54)	1.35 (1.36)	1.7 (1.48)	0.9 (1.18)	0.65 (1.07)	1.35 (1.36)	1.4 (1.37)	0.66 (1.07)	0.95 (1.20)	0.6 (1.04)	3.8 (2.07)	45.0 (6.74)
Weedy	-	4.95 (2.33)	33.75 (5.85)	2.05 (1.59)	11.55 (3.47)	7.0 (2.73)	37.5 (6.16)	5.2 (2.38)	28.0 5.33)	5.05 (2.35)	21.0 (4.63)	5.05 (2.35)	13.25 (3.70)	4.4 (2.21)	11.1 (3.40)	7.6 (2.84)	67.8 (8.23)

Weed free	-	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)
Acetochlor 90% EC	5.0	2.2 (1.64)	5.05 (2.35)	0.0 (0.71)	0.0 (0.71)	2.25 (1.65)	5.1 (2.36)	1.95 (1.56)	3.1 (1.89)	1.65 (1.46)	2.7 (1.78)	1.4 (1.37)	2.2 (1.64)	1.45 (1.39)	1.2 (1.30)	2.05 (1.59)	7.35 (2.80)
CD (P=0.05)		0.14	0.22	0.43	0.34	0.31	0.16	0.21	0.19	0.21	0.19	0.29	0.27	0.27	0.33	0.17	0.21

At 30 DAS, dry weight of all the weeds was influenced significantly due to various herbicidal treatments (Table 2). All the weed management practices significantly reduced the dry weight of weeds over weedy check. Progressive increase in doses of acetochlor 90% EC from 1.25 to 5.0 l/ha resulted in decreased dry weight of all the weed species. Acetochlor 90% EC at 3.125 and 5.0 l/ha provided complete control of *Avena ludoviciana* present in the experimental field.

Among broad leaved weeds, *Chenopodium album*, *Anagallis arvensis*, *Croton sparsiflorus* and *Coronopus dydimus* were significantly controlled by application of 2,4-Diethyl ester 38% EC at 2.65 l/ha and was found superior over rest of the herbicidal application including weedy check (Table 2). However, weed dry weight of *Fumaria parviflora* was found lowest under 2, 4-Diethyl ester 38% EC at 2.65 l/ha which was significantly superior over rest of the treatments at 30 and 60 DAS. All the herbicidal applications were found very effective to control sedges *Cyperus* rotundus over weedy check. The lowest dry weight of weeds was recorded with 2, 4-Diethyl ester 38% EC at 2.65 l/ha followed by application of acetochlor 90% EC at 5.0 l/ha, while highest dry weight of weeds was recorded with weedy check followed by application of acetochlor 90% EC at 1.25 l/ha. Among herbicidal treatments, application of atrazine 50% WP at 2.0 kg/ha and acetochlor 90% EC at 3.125 l/ha was found more effective against dry weight of broad leaved weeds as compared to other herbicidal treatments.

At 60 DAS, dry weight of all the weeds was also influenced significantly due to various herbicidal treatments (Table 2). Acetochlor 90% EC at 5.0 l/ha and 2, 4-Diethyl ester 38% EC at 2.65 l/ha showed complete reduction of *Avena ludoviciana* among grassy weeds as compared to its rest of the herbicidal treatments. All the treatments significantly reduced dry weight of *Avena ludoviciana* rather than *Cynodon dactylon* over weedy check. Dry weight of *Cynodon dactylon* was found low under acetochlor 90% EC at 5.0 l/ha which was at par with its lower dose at 3.125 l/ha and atrazine 50% WP at 2.0 kg/ha, which were found superior over rest of herbicidal treatments including weedy check.

Among broad leaved weeds, *Chenopodium album*, *Anagallis arvensis*, *Croton sparsiflorus*, *Coronopus dydimus, Fumaria parviflora* were completely controlled by application of 2, 4-Diethyl ester 38% EC at 2.65 l/ha and was found superior over rest of the herbicidal treatments including weedy check. Application of 2, 4-Diethyl ester 38% EC at 2.65 l/ha registered lowest weed dry weight of *Chenopodium album* and *Anagallis arvensis* and was followed by acetochlor 90% EC at 5.0 l/ha. At 30 DAS, after almost control of *Fumaria parviflora* by 2, 4-Diethyl ester 38% EC at 2.65 l/ha, its dry weight was found minimum under acetochlor 90% EC at 2.5 l/ha, followed by acetochlor 90% EC at 3.125 l/ha, however, it was found lowest under 2, 4-Diethyl ester 38% EC at 2.65 l/ha, followed by atrazine @ 2.0 kg/ha at 60 DAS. However, next to 2, 4-Diethyl ester 38% EC, dry weight of *Croton sparsiflorus* was found low under acetochlor 90% EC at 5.0 l/ha, followed by acetochlor 90% EC at 3.125 l/ha at 30 and 60 DAS. Dry weight of *Coronopus dydimus* was found minimum under 2, 4-Diethyl ester 38% EC@ 2.65 l/ha, followed by acetochlor 90% EC at 5.0 l/ha. Moreover, application of acetochlor 90% EC at 5.0 l/ha recorded lowest weed dry weight of sedges *Cyperus rotundus,* which was at par with its lower dose at 3.125 and 2.5 l/ha and was significantly superior over rest of the herbicidal treatments and weedy check at 30 DAS and it was found lowest under acetochlor 90% EC at 3.125 l/ha, followed by acetochlor 90% EC at 5.0 l/ha at 60 DAS (Table 2).

The effectiveness of treatments was also found in same order in most of the cases in weed density when compared on the basis of dry weight of weeds (Table 2). On the basis of findings, acetochlor 90% EC @ 5.0 l/ha was found effective to reduce the weed density and weed dry weight in maize crop. At all the crop growth stages, weedy check recorded significantly higher weed dry weight that was mainly due to higher and uninterrupted growth of weeds which made best use of growth resources. On the other hand, lower weed dry weight was noticed in weed free treatment recorded zero value than rest of the treatments at all the growth stages. This might be attributed to control of weeds by cultural methods at regular intervals, which resulted in reduced dry matter accumulation by weeds. These results are in conformity with the findings of (13). The lower weed dry weight in the above treatments was mainly due to better weed control efficiency with these herbicides which resulted in lower weed density.

Among the herbicides, acetochlor 90% EC @ 1.25 l/ha recorded higher weed dry weight which was attributed largely due to more weed density involved. These results are in conformity with the findings of (14).

Effect on yield and yield attributes

Statistical analysis of the data (Table 3) revealed that different treatments had no significant effect on plant height of winter maize. Pooled mean of the data indicated that highest plant height was observed in weed free plot and the lowest plant height was in weedy check plot. Difference in plant height was attributed to the various intensities of weed competition with maize plant. The plant height of maize crop suffered due to severe weed competition in weedy check.

Yield attributing characters *viz.* no. of grain rows/cob, no. of grains/row, length of cob of winter maize was significantly varied due to different treatments indicating their maximum value under weed free treatment. Moreover, among herbicidal applications, acetochlor 90% EC @ 5.0 l/ha registered highest value which showed close statistical parity with acetochlor 90% EC @ 3.125 l/ha. The lowest value of yield attributes was noted obviously in weedy check (Table 3).

Among the herbicidal treatments, application of acetochlor 90% EC @ 5.0 l/ha recorded significantly higher number of grains/row (27.5) which was at par with acetochlor 90% EC @ 3.125 l/ha, atrazine 50% WP @ 2.0 kg/ha and 2, 4-Diethyl ester 38% EC @ 2.65 l/ha.

Table 3. Data regarding yield and yield attributes of maize as affected by different treatments (Pooled mean over two years)

Treatment	Dose (l/ha)	Plant height (cm)	No. of grain rows/cob	No. of grains/row	Length of cob (cm)	Grain yield (q/ha)
Acetochlor 90% EC	1.25	197.8	14.2	25.6	16.2	76.4
Acetochlor 90% EC	1.875	198.7	14.2	25.7	16.4	77.2
Acetochlor 90% EC	2.5	199.4	14.3	26.0	16.5	78.2
Acetochlor 90% EC	3.125	199.8	14.5	27.4	17.0	81.0
Atrazine 50% WP	2.0	196.4	14.4	26.9	16.8	79.5
2,4-Diethyl ester 38% EC	2.65	196.7	14.4	26.8	16.6	78.6
Weedy	-	193.4	13.7	25.2	16.2	71.2
Weed free	-	201.0	14.7	27.7	17.3	83.4
Acetochlor 90% EC	5.0	200.5	14.6	27.5	17.2	82.1
CD (P=0.05)		NS	0.1	1.3	0.7	4.3

Among the herbicidal treatments, application of acetochlor 90% EC @ 5.0 l/ha recorded significantly higher number of grain rows/cob (14.6) and was at par with acetochlor 90% EC @ 3.125 l/ha. Among the herbicidal treatments, application of acetochlor 90% EC @ 5.0 l/ha recorded significantly maximum length of cob (17.2 cm) and was at par with acetochlor 90% EC @ 3.125 l/ha, atrazine 50% WP @ 2.0 kg/ha, 2, 4-Diethyl ester 38% EC @ 2.65 l/ha and acetochlor 90% EC @ 3.125 l/ha and was significantly superior to rest other treatments that might be attributed to better translocation of metabolites for grain development. It was largely due to reduced weed competition in these treatments.

Grain yield of winter maize were significantly varied by different treatments indicating highest yield (83.4 q/ha) from weed free plot which was at par with acetochlor 90% EC @ 5.0 l/ha (82.1 q/ha) and acetochlor 90% EC @ 3.125 l/ha (81.0 q/ha). Among herbicides, acetochlor 90% EC @ 5.0 l/ha registered maximum grain yield (82.1 q/ha) which was at par with application of acetochlor 90% EC @ 3.125 l/ha and atrazine 50% WP @ 2.0 kg/ha. All the treatments were found significantly superior over weedy check (71.2 q/ha). Variation in grain yield was found non-significant between acetochlor 90% EC @ 3.125 l/ha and its lower dose @ 2.5 and 1.875 l/ha. This might be probably due to creation of modified micro-climate in terms of physical environment for mechanical manipulation of soil and lower crop–weed competition under weed free plot led to better yield attributes and thus resulted in higher yield (4). Under weed free treatment, persistence and broad spectrum control of weeds kept the weed density under check by arresting or inhibiting the germination of weed seeds and arresting the weed growth which provide weed-free environment to the crop resulted into better manifestation of growth and yield attributes and ultimately enhanced the crop yield. These results are in conformity with those reported by (9).

Yield advantage due to different weed control treatments over weedy check was mainly attributed for better yield attributes and cooperatively less weed density and weed dry weight along with higher weed control efficiency. It was mainly due to minimum crop-weed competition throughout the growth period, thus enabling the crop for maximum utilization of nutrients, moisture, light and space which had significant influence on growth and yield attributes. These results were also corroborated with the findings of (11) and (10). More grain yield in these treatments might be due to improved growth and yield attributes was the consequence of lower crop-weed competition, which shifted the balance in favour

of crop in utilization of nutrients, moisture, light and space. These results are in conformity with the findings of (2).

It can be concluded that weed free is the best means to control weeds and getting higher yield but shortage of labour and higher cost are great hurdles for adoption of this method. Acetochlor 90% EC @ 5.0 l/ha treated plot gave the second highest yield which was statistically at par to weed free. So, using of acetochlor 90% EC @ 5.0 l/ha could be suitable for adoption of weed control in maize.

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CITATION OF THIS ARTICLE

Shashank Tyagi, S.K. Mandal, Birendra Kumar, Sunil Kumar and Vinod Kumar. Efficacy of different herbicides on weed dynamics, yields attributes and yield of maize. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 1, 2017: 498-503