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GROWTH AND YIELD RESPONSE OF AUTUMN PLANTED MAIZE (*ZEA MAYS* L.) AND ITS WEEDS TO REDUCED DOSES OF HERBICIDE APPLICATION IN COMBINATION WITH UREA

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Abstract

A field experiment was conducted to assess the growth and yield response of autumn planted maize and its weeds to application of a new post-emergence herbicide Equip (foramsulfuron + isoxadifen-ethyl) alone and in combination with urea. The experiment comprised weedy check, manual weed control, foramsulfuron + isoxadifen-ethyl @ 1125 g a.i. ha^{-1} alone, foramsulfuron + isoxadifen-ethyl @ 1125, 1012 and 900 g a.i. ha^{-1} with 3% urea solution. Result revealed that application of full dose of herbicide in combination with urea gives better result than the use of full dose of herbicide alone. Weeds density and total weed dry weight 20, 40 days after spraying (DAS) and at harvest decreased significantly when foramusulfuron + isoxadifen-ethyl along with urea as adjuvant at 1125 g a.i. ha^{-1} was applied compared to application of herbicide alone at 1125 g a.i. ha^{-1}. Full dose of herbicide foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone showed statistically similar results as reducing dose of herbicide foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea in reducing weeds density, dry weight and increasing yield of maize. The study revealed that the herbicide dose can be reduced up to 10-12% if urea solution was used as adjuvant to obtain the same efficiency as with full dose without compromising on maize yield.

Introduction

Maize (*Zea mays* L.) is the world’s third most important cereal grain after wheat and rice. Maize is grown primarily for grain and secondarily for fodder. In Pakistan, it is grown on an area of 1.022 million hectares with the production of 3.560 million tones and an average grain yield of 3483 kg ha^{-1} (Anon., 2006). It has high nutritive value as it contains 72% starch, 10% protein, 4.8% oil, 9.5% fiber, 3% sugar and 1.7% ash (Chaudhary, 1983).

There is a great potential of increasing its yield as maize varieties with high yield potential are under cultivation yet the average yield is still far below as compared to achievable potential of varieties. Among various factors responsive for low yield, weed infestation is of supreme importance.

Weeds reduce crop yield by competing for light, water, nutrients and carbon dioxide, interfere with harvesting and increase the cost involved in crop production. Control of weeds from the fields of maize is, therefore, very essential for obtaining good crop harvest. Weed control practices in maize resulted in 77 to 96.7% higher yield than weed check (Khan *et al.*, 1998). Weeds can be controlled by cultural, biological and chemical measures. No doubt cultural methods are still useful tools but are laborious, time consuming and getting expensive. Moreover, the labour problem is becoming acute day by day and it will not be possible and economical to stick the traditional cultural weed control practices (Oreck & Dehne, 2004; Oerke, 2005).

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Keeping in view these limitations, chemical weed control is an important alternative. Herbicide application is an efficient way to check weed infestation that helps in achieving a speedy break through for increasing maize production. Weed control in maize with herbicides has been suggested by many researchers (Devender *et al*., 1998; Toloraya *et al*., 2001). It is, therefore, imperative to develop comprehensive information regarding their safe and effective use on various crops.

A new post-emergence herbicide Equip (foramsulfuron + isoxadifen-ethyl) was used in this study. After application, translocation of this herbicide takes place through leaves and roots of the weeds and then their growth stops and dies. Post emergence herbicides are generally absorbed through leaves. Leaf cuticle is composed of waxes and cutin that affects the herbicide absorption. The use of adjuvant in combination with herbicide enhances the herbicide retention on leaf surface and penetration through the cuticle (Young & Hart, 1998). Herbicide applied in combination with urea gives better result up to 12 to 13.5% than the use of herbicide alone (Getmanetz *et al*., 1991).

Keeping these factors in view, this experiment was conducted to study the effect of a new post emergence herbicide Equip (foramsulfuron + isoxadifen-ethyl) alone and in combination with urea on weeds and growth and yield of maize.

Materials and Methods

The experiment was carried out to study the effect of herbicide in combination with urea on growth, yield and weeds of autumn planted maize at Agronomic Research Area, University of Agriculture, Faisalabad. The trial was laid out in randomized complete block design with three replications having a net plot size of 5 m x 3 m. The analysis indicated that the soil was sandy clay loam with pH, 7.6; electrical conductivity, 2.5 dS m^{-1}; organic matter, 0.72%; total nitrogen, 0.05%; available phosphorus, 9.7 mg kg^{-1} and extractable potassium, 139 mg kg^{-1}.

Maize hybrid R-4210 was sown on 1st July, 2005 with single row hand drill using a seed rate of 35 kg ha^{-1} in 75 cm apart rows. Plant to plant distance of 25 cm was maintained by thinning at an early growth stage.

Recommended dose of NPK @ 160-80-50 kg ha^{-1} was applied as urea, di-ammonium phosphate (DAP) and muriate of potash (MOP). Fertilizers, P and K were applied as basal dose and half of the nitrogen was broadcast and incorporated into soil at sowing while remaining half of the nitrogen was top dressed with 2nd irrigation. Good quality canal water [electrical conductivity, 0.03 dS m^{-1}; sodium adsorption ratio, 0.26 (mmol L^{-1}) $^{1/2}$ and residual sodium carbonate, 0] meeting the irrigation quality criteria for crops (Ayers & Wescot, 1985) was used for irrigation.

The experiment comprised the following treatments

W_1 = Weedy check
W_2 = Manual hoeing (2 hoeing)
W_3 = Foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone
W_4 = Foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea
W_5 = Foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea
W_6 = Foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea

The spray volume was determined by calibration before spraying the herbicide. The herbicide was sprayed after crop and weeds emergence by "Knapsack" hand sprayer using flat fan nozzle at field capacity condition. Hoeing was done twice with the help of a hand hoe in manual hoeing treatment when soil was at field capacity condition after 1^{st} and 2^{nd} irrigation. All other agronomic practices were kept normal and uniform for all treatments. Data regarding weeds density and weeds biomass was recorded from an area of 1 m^2 from two randomly selected areas. Ten plants were selected at random from each plot to record plant height, cob length, 100-grain weight, biological yield, grain yield and harvest index.

Harvest index (%) was calculated by the formula as under.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Statistical analysis: The data collected on weed and crop parameters was analyzed statistically by using Fisher's analysis of variance technique and least significant difference test was applied at 5% probability level to compare treatment means (Steel *et al*., 1997).

Results

Weed infestation in maize is one of the supreme problems limiting its yield. Effect of different doses of a new herbicide was studied on growth and yield of maize and weeds at the Agronomic Research Area, University of Agriculture, Faisalabad. *Trianthema portulacastrum*, *Cyperus rotundus* and *Coronopus didymus* were the main weeds.

Density of *T. portulacastrum* and *C. rotundus* (m^2) 20 and 40 DAS: The weed control treatments significantly controlled *T. portulacastrum* density compared to weedy check (Table 1). The significantly maximum weed density of *T. portulacastrum* 20 and 40 days after sowing was recorded in weedy check (W_1) and was followed by foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea (W_6). The significantly minimum weed density of *T. portulacastrum* was recorded in manual hoeing (W_2). The application of herbicide along with urea @ 1125 g a.i. ha^{-1} (W_4) resulted in significantly lower weed density of *T. portulacastrum* compared to foramsulfuron + isoxadifen-ethyl alone (W_3). The weed density of *T. portulacastrum* however, increased at lower herbicide dose along with urea (W_5) & (W_6) compared to foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea (W_4). The lower doses of herbicide along with urea (W_5) gave the results which were statistically similar to the full dose of herbicide alone (W_3) showing that the herbicide dose can be reduced if urea is used as adjuvant.

Similarly, all the weed control treatments significantly controlled weed density of *C. rotundus* as compared to weedy check (Table 1). The significantly maximum reduction (91.07%) in *C. rotundus* density 20 and 40 days after sowing was recorded in manual hoeing treatment and from foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} along with 3% urea 40 days after sowing. The maximum *C. rotundus* density (21.33) was recorded in weedy check plots. The reduce dose of herbicide alongwith urea (W_5&W_6) showed statistically similar density of *C. rotundus* indicated that herbicides are effective for controlling *C. rotundus* only when used in full dose alone or in combination with urea.

Table 1. Density of *T. portulacastrum* and *C. rotundus* 20 and 40 DAS as influenced by various weed control treatments.

(Average of 3 replicates)

Treatments	*T. portulacastrum* density 20 DAS (m^2)	*C. rotundus* density 20 DAS (m^2)	*T. portulacastrum* density 40 DAS (m^2)	*C. rotundus* density 40 DAS (m^2)
Weedy check	324.00 a*	18.67a	253.30 a	21.33 a
Manual hoeing (2 hoeing)	7.66 e	1.66 c	45.33 e	10.67 c
Foramsulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone.	206.00 c	16.00 a	158.70 c	13.33 bc
Foramusulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea	152.70 d	12.67 b	94.00 d	10.00 c
Foramsulfuron+isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea	218.70 c	17.33 a	163.30 c	18.67 ab
Foramsulfuron+isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea	235.30 b	13.33 a	210.70 b	20.00 a
LSD values	15.75	5.883	11.73	6.232

*Any two means sharing same letters did not differ significantly at 5 % level of probability.

Table 2. Density and dry weight of *C. didymus* and *C. rotundus* at harvest as influenced by various weed control treatments.

(Average of 3 replicates)

Treatments	*C. didymus* density at harvest (m^2)	*C. rotundus* density at harvest (m^2)	*C. didymus* dry weight at harvest ($g\ m^{-2}$)	*C. rotundus* dry weight at harvest (gm^{-2})
Weedy check	33.33 ^{NS}	28.00 a*	24.09 a	9.94 ^{NS}
Manual hoeing (2 hoeing)	32.00	14.67 bc	19.17 ab	7.02
Foramsulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone.	24.00	21.33 ab	12.46 d	8.31
Foramusulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea	24.00	9.33 c	8.31 d	7.49
Foramsulfuron+isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea	28.00	14.67 bc	10.93 d	8.53
Foramsulfuron+isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea	30.00	16.00 bc	16.31 bc	6.82
LSD values	10.54	9.853	4.986	2.319

NS: non-significant

*Any two means sharing same letters did not differ significantly at 5 % level of probability.

Density of *C. didymus* and *C. rotundus* (m^2) at harvest: The *C. didymus* appeared in all plots of different treatments at lateral stages. This is evident from the data presented in Table 2 that the affect of various weed control treatments on *C. didymus* density was non-significant. The maximum *C. didymus* density (33.33) was recorded in weedy check treatment against the minimum (24) in foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea.

Similarly, data in Table 2 showed also that all weed control treatments significantly reduced density of *C. rotundus* at harvest except application of herbicide alone. The minimum density (52.92% controls) of *C. rotundus* was recorded in plots where foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea was applied and it was statistically at par with (W_2), (W_5) and (W_6). The maximum *C. rotundus* density (28) was recorded in weedy check and was statistically similar to application of herbicides alone.

Dry weight of *T. portulacastrum* and *C. rotundus* (gm^{-2}) 20 and 40 DAS: The significantly maximum dry weight of *T. portulacastrum* (636.6) was recorded in weedy check (Table 3) and was followed by foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea. The significantly minimum dry weight of *T. portulacastrum* (99.68% control) was recorded in manual hoeing. The application of foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea resulted in significantly lower dry weight of *T. portulacastrum* compared with foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone. The *T. portulacastrum* dry weight however, increased at lower herbicide dose along with urea (W_5) and (W_6) compared to foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea.

Similarly, data pertaining to *C. rotundus* dry weight (20 days after spray) given in Table 3 revealed that significantly maximum reduction (84.27%) in *C. rotundus* dry weight was recorded in manual hoeing treatment. The maximum *C. rotundus* dry weight (3.2) was recorded in weedy check plots.

Likewise, data taken 40 days after spray (Table 3) showed that minimum dry weight (76% control) of *C. rotundus* was recorded in plots where foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea was applied which was statistically at par with manual hoeing. The maximum *C. rotundus* dry weight (4.18) was recorded in weedy check plots.

Dry weight of *C. didymus* and *C. rotundus* (gm^{-2}) at harvest: This is evident from the data presented in Table 2 that the effect of various weed control treatments on *C. didymus* dry weight was significant. The maximum *C. didymus* dry weight (24.09) was recorded in weedy check treatment and it was statistically similar to manual hoeing treatment. The minimum *C. didymus* dry weight (8.31) was recorded in foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea plots and it was statistically similar with treatments W3 and W5.

Data in Table 2 showed that dry weight of *C. rotundus* was non-significantly affected by all weed control treatments at harvest. The minimum dry weight (53.67% control) was recorded in plots where foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea was applied which was statistically at par with foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone and foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea. The maximum *C. rotundus* dry weight (9.94) was recorded in weedy check.

Growth and yield parameters: The data regarding growth and yield parameters of maize (Table 4) i.e. plant height (cm), cob length (cm), 100-grain weight (g), biological yield (t ha^{-1}) and grain yield (t ha^{-1}) are discussed below. Data presented in Table 4 indicated that plant height was significantly affected by various weed control practices. The maximum plant height (216.70 cm) was recorded in plots of manual hoeing and it was statistically at par with foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea (213.70) and foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone (212.70). The minimum plant height (195.70) was recorded in weedy check plots.

The data given in Table 4 showed that various weed control treatments significantly affected the cob length. The comparison of individual means revealed that the cob length in treatment foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea was maximum (16.83 cm) which was statistically at par with manual hoeing (16.59). Latter was followed by foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} +3% urea (15.57) which was statistically at par with foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone and foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea. The minimum cob length was recorded in weedy check plots.

Comparison of treatment means (Table 4) showed that the highest 100-grain weight (25.18 g) was recorded in treatment where foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea were applied which was statistically at par with manual hoeing (25.09). It was followed by foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone (23.36) which was statistically at par with foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea (23.02) and foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea (23.18). The significantly minimum 100-grain weight (21.49) was recorded in weedy check treatment.

Various weed control treatments had a significant effect on biological yield of the crop (Table 4). The highest biological yield (18.19 t ha^{-1}) was gained in manual hoeing and it was statistically at par with foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea (17.62). The foramsulfuron + isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea gave (16.24) biological yield which was statistically at par with foramsulfuron + isoxadifen ethyl 1012 g a.i. ha^{-1} + 3% urea and foramsulfuron + isoxadifen ethyl 1125 g a.i. ha^{-1} alone. The significantly minimum biological yield (13.60) was gained in weedy check treatment which was statistically different from remaining weed control practices.

All the weed control treatments significantly increased maize grain yield over weedy check (Table 4). Foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea gave the highest grain yield (5.12 t ha^{-1}) and was statistically similar with manual hoeing. Application of full dose of foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone gave (4.48) grain yield however, it was statistically at par with (4.25) at reduce dose of herbicide foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea indicated that the herbicide dose can be reduced if urea is used as adjuvant to obtain same efficiency. The significantly minimum grain yield (2.82) was recorded in weedy check plots.

The data pertaining to the harvest index revealed that harvest index was significantly affected by various weed control treatments (Table 4). The highest harvest index (29.11%) was obtained where foramusulfuron + isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea was applied. The significantly lowest harvest index was recorded in weedy check treatment (20.19%).

Table 3. Dry weight of *T. portulacastrum, C. rotundus* 20 and 40 DAS as influenced by various weed control treatments.

(Average of 3 replicates)

Treatments	***T. portulacastrum* dry weight 20 DAS ($g\ m^{-2}$)**	***C. rotundus* dry weight 20 DAS ($g\ m^{-2}$)**	***T. portulacastrum* dry weight 40 DAS ($g\ m^{-2}$)**	***C. rotundus* dry weight 40 DAS (gm^{-2})**
Weedy check	636.60 a*	3.20 a	420.70 a	4.18 a
Manual hoeing (2 hoeing)	1.99 f	0.50 c	18.29 f	1.96 cd
Foramsulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone.	323.10 d	3.06 a	85.32 d	3.51 ab
Foramusulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} + 3% urea	245.30 e	2.14 b	69.21 e	1.00 d
Foramsulfuron+isoxadifen-ethyl at 1012 g a.i. ha^{-1} + 3% urea	368.90 c	3.14 a	113.20 c	4.05 a
Foramsulfuron+isoxadifen-ethyl at 900 g a.i. ha^{-1} + 3% urea	502.80 b	2.48 a	160.80 b	2.62 bc
LSD values	21.98	1.018	9.22	1.039

*Any two means sharing same letters did not differ significantly at 5 % level of probability.

Table 4. Plant height, cob length, 100-grain weight, biological yield, grain yield and harvest index at harvest as influenced by various weed control treatments.

(Average of 3 replicates)

Treatments	**Plant height (cm)**	**Cob length (cm)**	**100-grain weight (g)**	**Biological yield ($t\ ha^{-1}$)**	**Grain yield ($t\ ha^{-1}$)**	**Harvest index (%)**
Weedy check	195.70 d*	14.05 c	21.49 c	13.60 d	2.82 d	20.19 c
Manual hoeing (2 hoeing)	216.70 a	16.59 a	25.09 a	18.19 a	5.03 a	27.79 a
Foramsulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} alone.	212.70 abc	15.51 b	23.36 b	15.44 bc	4.48 b	29.04 a
Foramusulfuron+isoxadifen-ethyl at 1125 g a.i. ha^{-1} +3% urea	213.70 ab	16.83 a	25.18 a	17.62 a	5.12 a	29.11 a
Foramsulfuron+isoxadifen-ethyl at 1012 g a.i. ha^{-1} +3% urea	208.00 bc	15.57 b	23.02 b	15.85 c	4.25 bc	26.56 ab
Foramsulfuron+isoxadifen-ethyl at 900 g a.i. ha^{-1} +3% urea	206.00 c	15.47 b	23.18 b	16.24 bc	4.00 c	24.48 b
LSD Values	7.667	0.9418	1.502	1.512	0.3044	3.265

*Any two means sharing same letters did not differ significantly at 5 % level of probability.

Discussion

The lower weed density with addition of urea as an adjuvant in chemical weed control treatments might have been due to increase permeability and more absorption of herbicide by leaves (Rola *et al*., 1999a). These results are also in accordance with those of Khan *et al*., (2002), Fathi *et al*., (2003) and Muhammad & Hassan (2003) who reported that weed number per meter square was highest in weedy check plots and lowest in chemical weed control treatments. Borona *et al*., (2003) also reported that the use of Ammonium nitrate as an adjuvant contributes to improved penetration and enhanced phytotoxicity of nicosulfuron in maize by 5-14% and the weed density can be reduced up to 25%.

Variation in the density of *T. portulacastrum* and C. *rotundus* in different weed control treatments was due to varying effect of herbicides and hoeing on number of weeds. These results are in line with those obtained by Khan *et al*., (2002), Muhammad & Hassan (2003), Gover *et al*., (2003) and Fathi *et al*., (2003) who recorded that weed density was highest in weedy check plots and lowest in chemical weed control treatments.

The maximum dry weight of *T. portulacastrum*, *C. rotundus* and *C. didymus* in weedy check plots was due to more number of weeds and their growth. Decrease in dry weight of these weeds in different weed control treatments was due to less number of weeds. These results corroborate the findings of Anwar-ul-Haq *et al*., (1981), Devender *et al*., (1998), Saini & Angiras (1998) and Saini (2000). Who reported that dry weights of all weed species were significantly reduced under the hand weeding and chemical weed control treatments. Similarly, Sharma & Gautam (2003) and Tanveer *et al*., (2003) reported that weed number and weed fresh weight m^{-2} was highest in weedy check plots and lowest in chemical weed control treatments.

Variations in plant height and cob length of maize could be attributed to varying effect of weed competition (light, moisture and nutrients) offered by different weed densities in different treatments. It is very likely that the maximum plant height and cob length in (W4) was due to less competition of weeds m^{-2}. These results are confirmatory to Shinde *et al*., (2001), Sinha *et al*., (2001) and Khan *et al*., (2002). Who found that use of herbicides to control weeds resulted in increased plant height and cob length.

More 100-grain weight in weed control treatments than weedy check was due to better growth and development of maize plants, which resulted in more seed assimilates. These results are in line with those of El-Bially (1995) who reported that 100-grain weight was greater for the chemical and mechanical weed control treatments than untreated control. Likewise, more biological yield in weed control treatments than weedy check was due to less weed density and better growth and development of maize plants, which resulted in more biomass of maize plants. These results are in close agreement with Sinha *et al*., (2001), Dixit & Gautam (1996) and Shinde *et al*., (2001). Who found that use of herbicides to control weeds resulted in increased plant height, plant population and biological yield.

Highest grain yield was due to more number of grains per cob, grain weight per cob and 100-grain weight compared to weedy check. The efficiency of chemicals and other weed control practices in increasing grain yield had also been demonstrated by Dixit (1995), Shinde *et al*., (2001), Khan *et al*., (2002) and Khan & Haq (2004). Who reported that when herbicides such as Primextra, atrazine and metalochlor were used, the maize yield was increased significantly as compared with an unweeded control. Rola *et al*., (1999b) also reported that the addition of adjuvants enabled the reduction in herbicide concentration by 30-60% in corn without affecting its yield.

These results are in close agreement with Wang (1994), Porwal (1995) and Dixit & Gautam (1996). Who reported that efficiency of maize crop to partition the dry matter into its economic yield was highest in herbicides treated plots.

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