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*A REVIEW*

# Weed control in maize with herbicides and its effect on grain yield

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**Abstract :** Competition posed by weeds is a major challenge in crop production as weeds cause severe reduction in yield by competing with crop plants for limited resources like light, space applied nutrients and water also. Several researchers and eminent investigators observed that diverse weed flora causes huge losses in maize yield and if the weeds are not managed at right time then it results in huge yield penalty. Among weed management treatments, hand weeding at 15-21 days after sowing and 30-42 days after sowing and integration of pre-emergence application of atrazine 1.5 kg $ha^{-1}$, pendimethalin at 1.50 kg $ha^{-1}$, pendimethalin + atrazine both at 0.5 kg $ha^{-1}$ as pre-emergence spray, atrazine + alachlor at 0.75 + 1.25 kg $ha^{-1}$, or alachlor at 1.5 kg $ha^{-1}$fb hand weeding at 30 days after sowing and tembotrione 125 g $ha^{-1}$+surfactant applied on 20 DAS were proved more effective. In case of sequential treatments, pre-emergence application of atrazine at 1.25 kg $ha^{-1}$ or pendimethalin at 1.5 kg $ha^{-1}$ fbparaquat at 0.6 kg $ha^{-1}$at 3 weeks after sowing or pre-emergence application of atrazine at 1.0 kg $ha^{-1}$ followed by topramazone at 0.030 kg $ha^{-1}$ at 30 days after sowing gave higher gross returns, net returns and benefit cost ratio, thus proved more economical.

**Key Words :** Herbicide, Losses, Maize,Weeds, Yield

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## INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop and referred as "queen of cereals" around the world due to high productivity among the cereals. In Punjab, maize is mainly grown during the *Kharif* season and was cultivated on 1.08 lakh hectares with a production of 3.95 lakh tonnes and average yield of 3.67 tonnes per hectare (Anonymous, 2022). Maize is a $C_4$ plant which is considered to be energy efficient and has high yield potential which also adds towards its importance in agriculture. It contains10.4% proteins, 4.5% fat, 71.8% starch, 3% fibre along with vitamins and minerals. Its flour is considered a good diet for heart patients due to its low gluten (protein) content. It is also used as green fodder at early stages, baby corn at very early cob stage, green cob at late milk to dough stage, maize grains as pop corn and maize flour for chapatti making. Besides this, crop also provides a good quality feed for piggery, poultry and milch animals. Being a versatile food crop of global importance, it is used as asource of raw material for many industrial products for food, animal feed, poultry

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feed, starchand brewery. Due to its unique photosynthetic mechanism, it produces high biological and grain yield in a short span of time.

In Punjab, the optimum sowing time of *Kharif* maize is from last week of May to end of June. This period is characterized by a high evaporative demand due to high temperature and low relative humidity. Among the various factors responsible for low yields in maize, severe infestation of weeds often inflict huge losses in yield. Due to wider row spacing and co-incidence of crop with rainy season, yield losses in maize ranged from 28-100% attributed to heavy infestation by different weed species and severe crop-weed competition (Patel *et al.,* 2006). The infestation of weeds like *Acrachneracemosa, Brachiariareptans* and *Commelina benghalensis* etc. are increasing day by day in the maize growing belt of the state (Kaur *et al.,* 2016). Worldwide maize production is reduced to about 40% due to competition from weeds, which form an important pest group (Oerke and Dehne, 2004). Control of *Dactyloctenium aegyptium,Cynodon dactylon, Digitaria sanguinalis, Echinocloa*s pp. and *Rottboellia exaltata* as grasses; *Parthenium hysterophorus, Commelina benghalensis, Amaranthus viridis, Euphorbia geniculata, Digeraarvensis* and *Trianthema portulacastrum* as broad leaf weeds and *Cyperus rotundus* as sedges remain a problem for the farmers, especially when too high or too low soil moisture hinders the intercultural operations and scarcity of labour during critical stages of weeding. This weed flora has been traditionally controlled through pre-emergence application of herbicides.

Manual weeding is quite effective but becoming less popular among farmers as it is time consuming, costly and moreover labour is not easily available. Whereas, in absence of manual weeding, farmers in irrigated areas mainly rely on herbicides to control weeds. Herbicide application is cost effective method for controlling weeds in maize. Use of pre-emergence herbicides gets more importance due to their effectiveness at initial stages. Many times due to various constraints at farm level, the application of pre-emergence herbicide is not possible and also continuous use of same herbicide might cause resistance in weeds. Under such situations, the post emergence herbicides are another option. Further, post-emergence herbicides applied at about 40-45 days after sowing help in avoiding the problem of weeds at later stages (Kumar and Angadi, 2014). Sequential use of pre- and post-emergent herbicides at temporal variation may help in avoiding the problem of weeds throughout the maize growth stages.

## RESULTS AND DISCUSSION

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

**Losses caused by weeds in maize:**

Maize is an important cereal grain crop. Among different biotic and abiotic factors responsible for reducing the crop yields, competition posed by weeds has been a major challenge in crop production as weeds cause severe reduction in yield by competing with crop plants for limited resources like light, space applied nutrients and water also. Weeds are the undesirable plants which affect the crop production, both in quality and quantity and also the effective resource utilization by crop plants. Thus, weeds are the plants which do more harm than benefits. Weed control is a major challenge in maize production as weeds can curtail grain yield by 86% (Bijanzadeh and Hossein, 2006). Globally, weed caused 10 per cent losses in agricultural production due to their competitive effect even regular control of weeds in most agricultural systems. Severe infestation due to wider row spacing inflicts huge losses in yield, may be upto 52 per cent in maize (Walia *et al.,* 2005). The extent of losses due to weeds, however, depends upon different weed species associated with crop, severity and critical period of weed infestation as determined by the density, biomass and spatial distribution of weeds in crop field, competitive ability of crop plants including the growth habit, canopy architecture and duration of crop, climatic conditions favouring the growth of weed plants and soil fertility status. Although, maize (*Zea mays* L.) is a vigorous and tall growing crop, but it is susceptible to competition from weeds with losses more than 30 per cent commonly reported. Poor weed control leads to spread of weeds throughout the growing season and causes maize yield loss. Wilson and Westra (1991) observed that delay in controlling weeds till 6 weeks after planting, there was 16 to 28 per cent reduction in maize grain yield. Worldwide maize production is hampered upto 40 per cent by competition from weeds (Oerke and Dehne, 2004). Even small weeds during first week after emergence can reduce the grain yield substantially. Oerke (2005) reported that weed caused 37% loss potential

which is followed by 18% through insect pests, 16% by fungal and bacterial pathogens and 2% by viruses.

Competitive weeds in dense population may reduce crop yield by more than 50 per cent by sharing available nutrients, space, soil moisture and light. Worldwide, weeds caused a significant reduction in yield with mean value of 12.8 per cent even with weed control application and 29.2 per cent under unweeded control in maize (Ngouajiro *et al.,* 2006). The season-long weed competition caused considerable yield losses in maize (Dalley *et al.,* 2006). In another study, weeds reduced maize grain yield by 83 per cent if not managed properly (Usman *et al.,* 2001). Unchecked weed growth in maize causes yield losses even upto 100% (Sharma, 2005). Crop-weed competition may lead to reduction of maize yield upto 86% and of these *Amaranthus*s pp. and other annual grasses reduce yields upto 50% (Grichar and Minton, 2006). Pandey *et al.* (2002) reported 77.4 per cent reduction in grain yield by grasses followed by 44.2 per cent by broad leaf weeds and 38.4 per cent by sedges. Donovan *et al.* (2000) observed that the relative time of crop and weed emergence is the most important factor to determine the crop weed competition. However, different weed species and density may affect the magnitude of yield losses. The weeds emerged at the time of crop emergence will cause more yield losses than those emerged at later stages.

Sharma *et al.* (2000) reported the reduction in grain yield of maize upto 32.4 to 42.3 per cent which may be attributed to severe weed infestation. *Trianthema portulacastrum*, a strong competitor of maize caused substantial yield losses to the extent of 4.2 to 30.2 per cent depending upon intensity of infestation (Saeed *et al.,* 2010). Page and Willenborg (2013) observed that when *Echinochloa crusgalli* germinated after maize emergence then its higher weed density greatly declines the grain yield. Therefore, weed control is an important management approach for maize to ensure optimum grain yield. Yakadri *et al.* (2015) reported 30-93% losses in grain yield of maize due to its wider spacing and initial slow growth. Singh *et al.* (2016) conducted an experiment on maize at Ludhiana and reported that yield attributes characters and yield of maize were decreased due to enhancement in crop-weed interference duration, however the yield was enhanced with long duration of weed free period. They observed significant reduction in grain yield of maize between 30 to 60 days after sowing (DAS).

**Effect of herbicides on weed control and maize yield:**

Salarzai (2001) evaluated various herbicides at Pakistan for controlling weeds in maize and reported that density and dry matter accumulation (DMA) of weeds and different parameters of yield were affected significantly by herbicides. The maximum grain yield (5.16 t $ha^{-1}$) of maize was recorded with the application of Gesaprim 80 WP as compared to 3.12 t $ha^{-1}$ under control treatment and the increase in yield was 54.5 per cent over control. Woldetsadik and Chinawong (2005) investigated that weed population and dry matter production of weeds were effectively suppressed with pre-emergence application of atrazine/ metolachlor at 3.0 kg $ha^{-1}$+ post-emergence application of 2, 4-D at 1.0 kg $ha^{-1}$ and resulted in increased grain yield of maize by 13.4 % over unweeded control. Patel *et al.* (2006) observed that pendimethalin + atrazine both at 0.5 kg $ha^{-1}$ as pre-emergence spray resulted in less density of monocot and dicot weeds at all time intervals and also observed highest yield of maize in comparison to all other treatments. Walia *et al.* (2007) observed that integration of hand weeding with pre-emergence spray of atrazine produced significantly higher grain yield of maize and less dry matter accumulation by weeds over unweeded control. Rao *et al.* (2009) conducted a field experiment in Andhra Pradesh on clay loam soil and observed that atrazine at 1.5 kg $ha^{-1}$ as pre-emergence spray followed by one hand weeding at 30 DAS was found efficient method for weed control in maize.

Barla *et al.* (2016) conducted a field experiment at Ranchi and reported that atrazine + pendimethalin both at 0.50 kg $ha^{-1}$as pre-emergence application was statistically similar to two hand weedings at 20 and 40 days after sowing and recorded significantly less density and DMA of weeds in comparison to weedy check at 30 and 60 days after sowing. This treatment significantly increased the plant height, number of grains per cob, 1000 grain weight as well as 65.6% higher grain yield in comparison to unweeded check (1.309 t $ha^{-1}$) and resulted in consequently higher net returns (Rs. 53492 $ha^{-1}$) and benefit cost ratio (3.57) than rest of the treatments. Kaur *et al.* (2016) laid out a field experiment at Ludhiana to evaluate the efficacy of glyphosate 41% SL against complex weed flora in maize. The treatments consisted of glyphosate 41% SL at 900, 1800 and 3600 g $ha^{-1}$ applied as directed post-emergence, pre-emergence application of atrazine 750 g $ha^{-1}$, post-emergence application of paraquat 24 SL 500 g $ha^{-1}$ and 2,4-D sodium

salt 1000 g $ha^{-1}$, weed free and unweeded control. The results revealed that non-selective herbicides paraquat at 500 g $ha^{-1}$ and glyphosate at 900 and 1800 g $ha^{-1}$as post-emergence directed spray in maize showed effective control of grass and broadleaf weeds during both the years and recorded grain yield statistically similar with pre-emergence application of atrazine 750 g $ha^{-1}$.

Owla *et al.* (2015) conducted a field experiment at Udaipur, to evaluate the effect of fertility levels, nutrient sources and weed control on productivity of quality protein maize. Application of pre-emergence atrazine 0.4 kg + alachlor 2.0 kg $ha^{-1}$ followed by hoeing and weeding resulted in minimum weed density and dry matter of weeds but recorded maximum benefit: cost ratio. Sahoo *et al.* (2016) conducted a field experiment at Dharwad and reported that weed free check recorded higher weed control index (97.26%) than all othermethods of weed control at all the growth stages in maize. However, pre-emergence application of atrazine at 1.0 kg $ha^{-1}$ followed by post-emergence application of glyphosate at 2.5 kg $ha^{-1}$ recorded WCI of 92.12% next to weed free check. Weed free treatment resulted in significantly higher grain yield of 84.59 q $ha^{-1}$, stover yield of 114.10 q $ha^{-1}$ and harvest index of 42.57 per cent. Field trials were conducted at Palampur by Rana *et al.* (2017) to assess the impact of tembotrione on weed parameters, growth and yield of maize. The weed control treatments consisted of tembotrione 100, 125 and 150 g $ha^{-1}$ each applied on 20 and 30 DAS in maize, tembotrione at 125 and 150 g $ha^{-1}$ + surfactant (stefesmero 2.5 ml $l^{-1}$) applied on 20 DAS of maize, atrazine 1000 g $ha^{-1}$ (pre) fb atrazine 750 g $ha^{-1}$ (post), atrazine 1000 + pendimethalin 1000 g $ha^{-1}$ (pre), manual weeding thrice (20, 40 and 60 DAS) and unweeded check. Tembotrione at 125 and 150 g $ha^{-1}$ with surfactant (20 DAS) and at 150 g $ha^{-1}$ without surfactant (30 DAS) effectively reduced the dry weight of *Echinochloacolona, Commelina benghalensis, Polygonumalatum, Ageratum conyzoides* and the combined weight of all weeds. Tembotrione 125 and 150 g $ha^{-1}$ + surfactant (20 DAS) produced significantly higher grain yield of maize followed by tembotrione 150 g $ha^{-1}$ applied on 30 DAS, tembotrione 125 g $ha^{-1}$ applied on 30 DAS and tembotrione 150 g $ha^{-1}$ applied on 20 DAS. Grain yield of maize was negatively correlated with dry weight of *Echinochloa, Commelina, Polygonum, Ageratum* and the combination of all weeds. With every 1g $m^{-2}$ increase in DMA of weeds, the maize grain yield was reduced by 33.7 kg $ha^{-1}$. Tembotrione 150 g $ha^{-1}$+surfactant and tembotrione 125 g $ha^{-1}$+ surfactant applied on 20 DAS and tembotrione 150 g $ha^{-1}$ applied on 30 DAS gave highest weed control efficiency, crop resistance index and efficiency index, but lowest weed index over other treatments. The results indicated that the grain yield of maize was reduced by 63.5% due to continuous growth of weeds. Swetha *et al.* (2015) observed that application of tembotrione at 105 + atrazine at 250 g $ha^{-1}$+stefes mero as post-emergence, atrazine at 1.0 kg $ha^{-1}$ followed by hand weeding at 30 days after sowing and intercropping of maize with cowpea and pendimethalin at 1.0 kg $ha^{-1}$ as pre-emergence reduced the weed density and weed biomass significantly as compared to unweeded control at 20 DAS.

Gul *et al.* (2016) conduced an experiment under temperate Kashmir conditions andthe results revealed that application of atrazine as pre-emergence + one hand weeding at 20 DAS was statistically at par with treatment of atrazine as pre-emergence + isoproturon as post-emergence application treatment and both showed significant increase in all yield attributing parameters in comparison to no weeding and two hand-weeding at 20 and 50 DAS. Pre-emergence application ofatrazine + hand weeding at 20 DAS resulted in maximum grain and stover yield of maize in comparison tohand weeding on 20 and 50 days after sowing and no weeding. Mavunganidze *et al.* (2014) carried out the experiment at Zimbabwe to study influence of tillage methods and weeding treatments on densityof weeds, plant height and maize grain yield. The results showed that weed competition was reduced by tank mix application of atrazine at 1.46 kg $ha^{-1}$+ alachlor at 0.96 kg $ha^{-1}$ treatment as pre-emergence spray. This treatment gave maximum maize grain yield and was on par with alone application of atrazine.

An investigation was carried out by Chopra and Angiras (2008) at Palampur to find out the effect of three tillage methods *viz.,* zero tillage, conventional tillage and raised seed-bed and four weedcontrol treatments (unweeded check, acetachlor 0.75 kg $ha^{-1}$, acetachlor 1.25 kg $ha^{-1}$and atrazine 1.5 kg $ha^{-1}$) on nutrient uptake and productivity of maize. Raised seed-bed method recorded significantly lowerdensity and DMA of weeds. Atrazine 1.5 kg $ha^{-1}$, being statistically similar with acetachlor 1.25 kg $ha^{-1}$, lowered the density and DMA of weeds. In comparison to weedy, atrazine at 1.5 kg $ha^{-1}$ and acetachlor at 1.25 kg $ha^{-1}$, being statistically similar,

significantly enhanced the uptake of N, P and K and the grain yield of maize. Kumar *et al.* (2012) conducted a field experiment at Palampur and tested different treatments combinations consisting tank-mix combinations of pre-emergence application of atrazine and pendimethalin as followed by of 2,4-D and metsulfuron methyl as post emergence sprayalong with hand weeding at 20 and 40 days after sowing and unweeded check in maize. *Commelina benghalensis, Panicum dichotomiflorum*, *Digitaria sanguinalis, Echinochloa colona, Cyperusiria, Ageratum conyzoides* and *Polygonum alatum* were the predominant weed species. Application of pendimethalin at 1.50 kg ha$^{-1}$, atrazine followed by atrazine 0.75 kg ha$^{-1}$, atrazine 0.75/1.0 + pendimethalin 0.75/0.50 followed by metsulfuron methyl 4 g ha$^{-1}$reduced the density of *Echinochloa colona*. Atrazine followed by atrazine effectively controlled the density of *Panicum dichotomiflorum* till 60 days after sowing. Pendimethalin followed by atrazine, atrazine 1.0 + pendimethalin 0.50 followed by 2, 4-D 0.75 kg ha$^{-1}$ and hand weeding at 20 and 40 days after sowing significantly lowered the population of *Commelina benghalensis* till 60 days after sowing. Pendimethalin/ atrazine fb atrazine and atrazine + pendimethalin followed by 2, 4-D/ metsulfuron-methyl reduced density of *Ageratum conyzoides* till 60 days after sowing. Pendimethalin/atrazine followed by atrazine, atrazine + pendimethalin followed by metsulfuron-methyl/2, 4-D and pendimethalin significantly decreased total DMA of weeds. Significantly highest grain yield and net returns was obtained with application of Atrazine 1.0 + pendimethalin 0.50 kg ha$^{-1}$ and atrazine + pendimethalin both at 0.75 kg ha$^{-1}$ followed by 2, 4-D treatments. They observed that grain yield of maize was reduced by 50.3 per cent due to presence of weeds.

Yakadri *et al.* (2015) carried out a field experiment at Andhra Pradesh and revealed that importance value index of 37.64, 32.29, 16.33 and 13.37 was obtained with *Echinochloa colona*, *Panicumrepens*, *Trianthema portulacastrum* and *Digeraarvensis*, respectively. Among weed management treatments, hand weeding at 15-21 days after sowing and 30-42 days after sowing and integration of pre-emergence application of atrazine 1.5 kg ha$^{-1}$, pendimethalin at 1.50 kg ha$^{-1}$, atrazine + alachlor at 0.75 + 1.25 kg ha$^{-1}$, or alachlor at 1.5 kg ha$^{-1}$fb hand weeding at 30 days after sowing were proved more effective. In case of sequential treatments, pre-emergence application of atrazine at 1.25 kg ha$^{-1}$ or pendimethalin at 1.5 kg ha$^{-1}$ fbparaquat at 0.6 kg ha$^{-1}$at 3 weeks after sowing or pre-emergence application of atrazine at 1.0 kg ha$^{-1}$ followed by topramazone at 0.030 kg ha$^{-1}$ at 30 days after sowing gave higher gross returns, net returns and benefit cost ratio, thus proved more economical. Arvadiya *et al.* (2012) conducted a research trail at Navsari to assesed the effect of 3 plant populations *viz.,* 1,11,111, 83,333 and 74,074 plants ha$^{-1}$ and 8 weed control strategies *viz.,* weedy check, weed free check, atrazine 1.0 kg ha$^{-1}$ as pre-emergence, atrazine1.0 kg ha$^{-1}$ as pre-emergence + hand weeding at 40 days after sowing, pendimethalin 1.0 kg ha$^{-1}$ as pre-emergence, pendimethalin 1.0 kg ha$^{-1}$ as pre-emergence + hand weeding at 40 DAS, atrazine 0.50 kg ha$^{-1}$ + pendimethalin 0.25 kg ha$^{-1}$ as pre-emergence and hand weeding at 20 days after sowing + inter culture at 40 days after sowing on weed dynamics and productivity of sweet corn. The predominant weed flora were *Echinochloacrusgalli* and *Cynodondactylon* as monocots; *Cyperusrotundus* as sedges and *Amaranthusviridis, Alternetharasessili, Portulacaoleracea, Digeraarvensis* and *Trianthema* sp. as dicots. Density and DMA of weeds was significantly lowest with a plant population of 1,11,111 plants ha$^{-1}$. Green cob, green fodder yield, net returns and benefit cost ratio was significantly higher with plant population of 1,11,111 plants ha$^{-1}$which was statistically similar with plant population of 83,333 plants ha$^{-1}$. The DMA of weeds (83.47 kg ha$^{-1}$) and weed control efficiency at harvest (90.58 %) were lowest in weed free treatment. Atrazine at 1.0 kg ha$^{-1}$ aspre-emergence + hand weeding at 40 DAS gave maximum net returns (Rs. 88,873 ha$^{-1}$) and benefit cost ratio (6.72) in comparison to other herbicides.

Kaur and Kaur (2019) concluded that post emergence application of tembotrione at 0.088 and 0.110 kg/ha resulted in highest WCE (96.3%) and was effective in lowering weed density and biomass as compared to atrazine at 0.8 and 1.0 kg ha$^{-1}$ as pre-emergence. Tembotrione at 0.088 kg ha$^{-1}$ in combination with paddy straw mulch 9.0 t ha$^{-1}$ recorded significantly lower weed density and dry matter accumulation of all weed species. They observed significant interaction between straw mulch and weed control treatments with respect to grain yield (Table 1). The data showed that tembotrione application at both doses (0.088 and 0.110 kg ha$^{-1}$) and weed free treatments in combination with 9.0 t ha$^{-1}$ mulch produced statistically similar but significantly higher grain yield of maize as compared to

**Table 1: Interactive effect ofstraw mulch application and herbicide use on grain yield (t ha$^{-1}$) of maize**

| Treatments | Ludhiana | | | Gurdaspur | | |
|---|---|---|---|---|---|---|
| | No mulch | PSM 6.25 t ha$^{-1}$ | PSM 9.0 t ha$^{-1}$ | No mulch | PSM 6.25 t ha$^{-1}$ | PSM 9.0 t ha$^{-1}$ |
| Atrazine at 1.0 kg ha$^{-1}$ | 5.31 | 5.65 | 5.91 | 4.86 | 5.28 | 5.66 |
| Atrazine at 0.8 kg ha$^{-1}$ | 4.97 | 5.35 | 5.65 | 4.45 | 4.90 | 5.31 |
| Tembotrione at 0.110 kg ha$^{-1}$ | 5.82 | 6.23 | 6.67 | 5.34 | 5.94 | 6.46 |
| Tembotrione at 0.088 kg ha$^{-1}$ | 5.57 | 6.31 | 6.82 | 5.06 | 6.02 | 6.51 |
| Weed free | 5.83 | 6.31 | 6.82 | 5.32 | 6.07 | 6.51 |
| Unweeded check | 4.39 | 5.02 | 5.43 | 3.90 | 4.53 | 5.01 |
| S.E.± | S=0.03,H= 0.04, S×H=0.08 | | | S=0.03,H= 0.04, S×H=0.07 | | |
| C.D. (P=0.05) | S=0.09, H= 0.13, S×H=0.22 | | | S=0.09,H= 0.12, S×H=0.21 | | |

PSM= Paddy straw mulch, S= Straw mulch treatments, H= Herbicidetreatments, S×H= Interaction between straw mulch and herbicide treatments
(Source: Kaur and Kaur, 2019)

all other treatments combinations and these treatments were followed by tembotrione at 0.088 kg ha$^{-1}$, tembotrione at 0.110 kg ha$^{-1}$and weed free in combination with 6.25 t ha$^{-1}$ mulch.It was interesting to note that tembotrione application at 0.088 kg ha$^{-1}$in combination with 6.25 or 9.0 t ha$^{-1}$ mulch gave significantly higher grain yield than tembotrione at 0.110 kg ha$^{-1}$ without mulch, thus, indicating that this combination helped in reduction of 20% herbicide dose. Application of tembotrione at 0.088 and 0.110kg ha$^{-1}$ recorded statistically similar net returns and benefit cost ratio and both these treatments were significantly better than weed free, atrazine at 0.8 and 1.0 kg ha$^{-1}$and unweeded check. They concluded that for getting higher productivity and profitability from maize,apply tembotrione at 0.088 kg ha$^{-1}$as post-emergence in combination with paddy straw mulch 9.0 t ha$^{-1}$, as this herbicide-mulch combination helped in reduction of 20% dose of herbicide.

## Conclusion:

It may be concluded that diverse weed flora causes huge losses in maize yield. If the weeds are not managed at right time then it results in huge yield penalty. Among weed management treatments, hand weeding at 15-21 days after sowing and 30-42 days after sowing and integration of pre-emergence application of atrazine 1.5 kg ha$^{-1}$, pendimethalin at 1.50 kg ha$^{-1}$, pendimethalin + atrazine both at 0.5 kg ha$^{-1}$ as pre-emergence spray, atrazine + alachlor at 0.75 + 1.25 kg ha$^{-1}$, or alachlor at 1.5 kg ha$^{-1}$fb hand weeding at 30 days after sowing and tembotrione 125 g ha$^{-1}$+surfactant applied on 20 DAS were proved more effective.

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