Effect of weed control methods on growth and yield of maize in western zone of Tamil Nadu

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Abstract
Field trials were conducted at Department of Agronomy during rainy (kharif) seasons of 2018 and 2019 at Agricultural College and Research Institute, TNAU, Coimbatore, Tamilnadu, India, to study the effect of different weed management practices on growth, development and yield of maize crop. The experiment was laid out in randomised block design with 10 weed management practices replicated thrice. The results revealed that hand weeding twice at 20 and 40 DAS was significantly superior in recording higher plant height (254.56 cm and 258.2 cm), stem girth (13.68 cm and 13.76 cm plant⁻¹), leaf area index (7.31 and 7.24), chlorophyll index (52.4 and 53.5) and dry matter production (12147 and 12435 kg ha⁻¹) at 90 DAS as compared to other weed management practices and it was found to be at par with PE (pre emergence) atrazine 0.5 kg a.i. ha⁻¹ fb EPOE (early post emergence) tembotrione 122 g a.i. ha⁻¹ and PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹ during 2018 and 2019. Also, hand weeding twice at 20 and 40 DAS, PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹ and PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹ took significantly more number of days for the crop to reach different phenological stages compared to rest of the treatments during both the years of study. Hand weeding twice at 20 and 45 DAS recorded significantly higher grain and stover yield which was comparable with PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹ and PE atrazine a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹. Significantly higher biological yield and harvest index was recorded in hand weeding twice at 20 and 40 DAS which was on par with PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 25.2 g a.i. ha⁻¹ and PE atrazine 0.5 kg a.i. ha⁻¹ fb EPOE tembotrione 122 g a.i. ha⁻¹ during both the years of experimentation.

Keywords: Integrated weed management, maize, growth and yield

Introduction
Globally, maize is the one of the most versatile crop due to its suitability or ability to grow under diversified climatic conditions. It is one of the most important food grain crop which gives higher grain yield and biological yield in a short stipulated period of time. Dass et al. (2008) reported that maize is the basic ingredient in numerous products viz., 49% in poultry feed, 25% in food, 12% in feed for livestock, 12% in starch production and 2% in brewery and seed as equal share. In India, the total area, production and average productivity under maize are 9.2 million hectare, 28.7 million tonnes and 3.12 tonnes ha⁻¹ respectively [1]. In India, weed infestation is severe in maize crop due to various factors which helps in creating congenial conditions for weed growth. Maize crop predominantly grown in monsoon season, along with wider spacing and slow initial crop growth results to greater loss in crop production. Weeds being injurious, harmful and poisonous are a constant trouble for the successful growth and development of the current crop [2] and also succeeding crop in the same field by producing large seed bank in the same soil resulting in continued presence of weed growth in cropped field and reducing the soil fertility and soil moisture [3]. The critical period of CWC (crop weed competition) in maize crop ranges from 1-6 weeks after sowing. During this period (CWC), adopting any weed management practice plays a vital role in increasing the crop production.

Generally, farmers give more importance to manual weeding (cultural practices) and neglect other methods like chemical weed control. In maize, grain yield was significantly improved by chemical weed control methods [4]. Higher production of maize was recorded from the herbicides treated plot [5].
Maize yield generally responded positively to increased weed control \(^{[9]}\). In view of the importance of the weed management problem, the present research was conducted on response of maize crop to herbicides in terms of tolerance and yield.

**Material and Methods**

Field trials were conducted at Agricultural College and Research Institute, TNAU, Coimbatore, Tamilnadu, India during \textit{kharij} season of 2018 and 2019 in a randomized block design with ten treatments replicated thrice. The treatments comprised of 10 weed control methods \textit{viz.}, \textit{W} \textsubscript{1}-\textit{PE} (pre emergence) atrazine 50\% WP at 0.5 kg a.i ha\(^{-1}\) hand weeding (HW) at 20 DAS, \textit{W} \textsubscript{2}-\textit{PE} atrazine 50\% WP at 0.5 kg a.i. ha\(^{-1}\) fb power weeder (PW) at 20 DAS, \textit{W} \textsubscript{3}-\textit{PE} atrazine 50\% WP at 0.5 kg a.i. ha\(^{-1}\) + pendimethalin 30\% EC at 1 kg a.i. ha\(^{-1}\) (Tank mix), \textit{W} \textsubscript{4}-\textit{PE} atrazine 50\% WP at 0.5 kg a.i. ha\(^{-1}\) + pendimethalin 30\% EC at 1 kg a.i. ha\(^{-1}\) (Tank mix) fb HW at 20 DAS, \textit{W} \textsubscript{5}-\textit{EPOE} (early post emergence) topramezone 336 g/l SC at 25.2 g a.i. ha\(^{-1}\) at 20 DAS, \textit{W} \textsubscript{6}-\textit{PE} atrazine 50\% WP at 0.5 kg a.i. ha\(^{-1}\) fb EPOE topramezone 336 g/l SC at 25.2 g a.i. ha\(^{-1}\) at 20 DAS, \textit{W} \textsubscript{7}-\textit{EPOE} tembotrione 420 SC at 122 g a.i. ha\(^{-1}\) at 20 DAS, \textit{W} \textsubscript{8}-\textit{PE} atrazine 50\% WP at 0.5 kg a.i. ha\(^{-1}\) fb EPOE tembotrione 420 SC at 122 g a.i. ha\(^{-1}\) at 20 DAS, \textit{W} \textsubscript{9}-\textit{control} (weedy check) and \textit{W} \textsubscript{10}-hand weeding (HW) twice at 20 and 45 DAS.

Maize cultivar “Maize – COH (M) 6” was dilled at a spacing of 60 cm x 25 cm between rows and plants, respectively, in plots of size 4.8m x 4.6m. Herbicides were sprayed as early post emergence after the emergence of the crop which provided the crop plants with optimum environment to utilize growth resources efficiently resulting in better growth of crop. The reasons for this might be that atrazine functions by binding to the plasto quinine-binding protein in photosynthesis II. Weed death results from starvation and oxidative damage caused by breakdown in the electron transport process. The oxidative damage is accelerated at high light intensity. Significantly lower leaf area index (3.81 and 4.08) and chlorophyll index (40.1 and 39.6) was observed in control at 90 DAS during both the years of experimentation however, it was at par with PE atrazine 0.5 kg a.i ha\(^{-1}\) fb EPOE tembotrione 122 g a.i. ha\(^{-1}\) this could be attributed to better control of weeds in early growth stages of crop which provided the crop plants with optimum environment to utilize growth resources efficiently resulting in better growth of crop.

**Results and Discussion**

**Plant height**

Perusal of the data indicated that weed management practice hand weeding twice at 20 and 40 DAS recorded higher plant height (254.56 cm and 258.20 cm) which was at par with PE atrazine 0.5 kg a.i ha\(^{-1}\) fb EPOE topramezone 25.2 g a.i. ha\(^{-1}\) and PE atrazine 0.5 kg a.i ha\(^{-1}\) fb EPOE tembotrione 122 g a.i. ha\(^{-1}\) (Table 1) at 90 DAS during both the years of 2018 and 2019 experimentation. The height of plant is an important growth character directly linked with the productive potential of plant in terms of yield \(^{[10]}\). Control treatment recorded lower plant height this might be attributed to higher weed densities where the crop weed competition was severe \(^{[11]}\). Among herbicide treatments PE atrazine 0.5 kg a.i ha\(^{-1}\) fb EPOE topramezone 25.2 g a.i. ha\(^{-1}\) (250.13 cm and 250.19 cm) and PE atrazine 0.5 kg a.i ha\(^{-1}\) fb EPOE tembotrione 122 g a.i. ha\(^{-1}\) (248.27 cm and 243.14 cm) produced significantly taller plants than other chemical treatments during both the years of 2018 and 2019 experimentation which were comparable with each other. This was probably due to better weed control with the treatments that enabled lower densities of weeds to compete with crop for growth resources \(^{[12]}\).

**Leaf area index and chlorophyll index**

Results from the study showed that among the herbicide treatments (Table 1 and 2) higher leaf area index (6.94 and 7.16) and chlorophyll index (51.6 and 52.3) was recorded for growth resources. In addition to the presence of biotic and a biotic stresses, plant growth per plot and multiplying by 100 given by \(^{[8]}\). The data obtained in respect of different parameters were analysed statistically by the \(^{[9]}\). The significance of “F” and “t” test was tested at 5\% level of significance.

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Yield
The results of the investigation revealed that the lower grain yield (4387 and 4246 kg ha⁻¹) (Table 3) was found in control treatment during both the years of experimentation. This could be attributed to greater removal of nutrients and moisture by weeds and a severe crop weed competition resulted in poor source and sink development with poor yield components [12, 16]. Among weed control treatments PE atrazine 0.5 kg a.i ha⁻¹ / fb EPOE topramezone 25.2 g a.i. ha⁻¹ recorded higher grain yield (8198 and 8276 kg ha⁻¹ during 2018 and 2019 respectively) however, it was at par with PE atrazine 0.5 kg a.i ha⁻¹ / fb EPOE tembotrione 122 g a.i. ha⁻¹ which could be attributed to improved yield attributes. This improvement in turn was due to higher dry matter production and distribution in different parts, higher LAI [17]. This implies that with effective and efficient weed control, more plant nutrients are made available to the crop for enhanced leaf area formation that increases solar radiation interception thereby favouring better utilization of photosynthesis for higher grain yield. Stover yield was also significantly higher under PE atrazine at 0.5 kg a.i ha⁻¹ / fb EPOE topramezone at 25.2 g a.i. ha⁻¹ and PE atrazine at 0.5 kg a.i ha⁻¹ / fb EPOE tembotrione at 122 g a.i. ha⁻¹ during both the years (14432, 14502 kg ha⁻¹ and 14219, 14393 kg ha⁻¹ in 2018 and 2019, respectively). Higher biological yield and stover yield is the effect of higher plant height, more number of functional leaves and higher dry matter production. This also might be due to suppression of weed growth as well as more availability of plant nutrients to maize which favoured better utilization of photo-assimilates for grain yield formation [10]. Harvest index is defined as a ratio of yield biomass to the total biomass at harvest. During both the years of field trial, various weed management practices did not exert any significant impact on harvest index of maize.

Table 1: Effect of weed management practices on plant height, LAI and stem girth of maize at 90 DAS during kharif 2018 and 2019

| Treatments | Plant height (cm) | LAI | Stem girth (cm) |
|------------|------------------|-----|-----------------|
| W₁: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb HW at 20 DAS | 230.96 | 231.54 | 5.96 | 6.48 | 12.38 | 12.73 |
| W₂: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb power weeder at 20 DAS | 153.05 | 181.29 | 4.56 | 5.73 | 11.09 | 11.05 |
| W₃: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) | 142.5 | 160.07 | 4.25 | 5.25 | 10.95 | 10.98 |
| W₄: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) / fb EPOE tembotrione at 20 DAS | 234.12 | 234.63 | 6.02 | 6.52 | 12.54 | 12.85 |
| W₅: EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 208.63 | 205.78 | 5.91 | 6.39 | 11.92 | 11.98 |
| W₆: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 250.13 | 250.19 | 6.49 | 7.16 | 13.47 | 13.54 |
| W₇: EPOE tembotrione 420 SC at 122 g a.i. ha⁻¹ at 20 DAS | 208.53 | 202.15 | 5.87 | 6.34 | 11.96 | 11.64 |
| W₈: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb EPOE tembotrione 420 SC at 122 g a.i. ha⁻¹ at 20 DAS | 248.27 | 249.87 | 6.89 | 7.02 | 13.39 | 13.46 |
| W₉: Hand weeding twice at 20 and 45 DAS | 254.56 | 258.20 | 7.31 | 7.24 | 13.68 | 13.76 |
| W₁₀: Control | 121.4 | 140.03 | 3.81 | 4.08 | 10.41 | 12.73 |
| CD (P=0.05) | 12.16 | 13.02 | 0.17 | 0.25 | 0.38 | 0.27 |

Table 2: Effect of weed management practices on chlorophyll index and dry matter production (DMP) of maize at 90 DAS during kharif 2018 and 2019

| Treatments | Chlorophyll index | DMP (kg ha⁻¹) |
|------------|-------------------|---------------|
| W₁: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb HW at 20 DAS | 48.6 | 48.9 | 9954 | 9954 |
| W₂: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb power weeder at 20 DAS | 45.2 | 44.7 | 6743 | 6982 |
| W₃: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) | 44.3 | 43.2 | 6589 | 6875 |
| W₄: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) / fb EPOE tembotrione at 20 DAS | 49.1 | 49.6 | 9076 | 10063 |
| W₅: EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 47.8 | 48.1 | 8435 | 9023 |
| W₆: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 51.6 | 52.3 | 12087 | 12286 |
| W₇: EPOE tembotrione 420 SC at 122 g a.i. ha⁻¹ at 20 DAS | 47.5 | 47.8 | 8391 | 8967 |
| W₈: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb EPOE tembotrione 420 SC at 122 g a.i. ha⁻¹ at 20 DAS | 51.2 | 51.9 | 11925 | 12267 |
| W₉: Hand weeding twice at 20 and 45 DAS | 52.4 | 53.5 | 12147 | 12435 |
| W₁₀: Control | 40.1 | 39.6 | 6125 | 6314 |
| SEd | 1.13 | 1.5 | 102.5 | 104.40 |
| CD (P=0.05) | 2.6 | 3.5 | 287 | 261 |

Table 3: Effect of weed management practices on yield of maize during kharif 2018 and 2019

| Treatments | Grain yield (kg ha⁻¹) | Stover yield (kg ha⁻¹) | Harvest index (%) |
|------------|-----------------------|------------------------|-------------------|
| W₁: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb HW at 20 DAS | 7597 | 7796 | 12637 | 12987 | 0.375 | 0.375 |
| W₂: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb power weeder at 20 DAS | 6673 | 6572 | 9976 | 10015 | 0.401 | 0.396 |
| W₃: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) | 6384 | 6324 | 9685 | 9842 | 0.397 | 0.391 |
| W₄: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb pendimethalin 30% EC at 1 kg a.i. ha⁻¹ (Tank mix) / fb EPOE tembotrione at 20 DAS | 7738 | 7856 | 12865 | 13154 | 0.376 | 0.374 |
| W₅: EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 7243 | 7501 | 12036 | 12434 | 0.376 | 0.376 |
| W₆: PE atrazine 50% WP at 0.5 kg a.i. ha⁻¹ / fb EPOE topramezone 336 g/l SC at 25.2 g a.i. ha⁻¹ at 20 DAS | 8198 | 8276 | 14432 | 14502 | 0.362 | 0.363 |
## Conclusion

Various aspects of the present investigation and observation showed that all growth and yield traits were significantly influenced by various weed management practices. Results clearly suggested that PE application of atrazine 50% WP @ 0.5 kg a.i. ha\(^{-1}\) fb EPOE topramezone 336 g/l SC @ 25.2 g a.i. ha\(^{-1}\) at 20 DAS or PE atrazine 50% WP @ 0.5 kg a.i ha\(^{-1}\) fb EPOE tembotrione 420 SC @ 122 g a.i. ha\(^{-1}\) at 20 DAS were the appropriate weed management practices for irrigated maize.

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## References

1. India stat. http://www.indiastat.com. accesses 04 march 2019.
2. Cousens R, Mortimer M. Dynamics of Weed Population. Cambridge University Press, Cambridge 1995, 332 p.
3. Knezevic SZ, Streibig JC, Ritz C. Utilizing R software package for dose–response studies: the concept and data analysis. Weed Technology 2007;21:840-848
4. Rout D, Satyapathy MR. Chemical weed control in rainfed maize (Zea mays). Indian Journal of Agronomy 1996;41(1):51-53.
5. Miller TW, Libby CR. Response of three corn cultivars to several herbicides. Res. Prog. Report. Western Soc. Weed Science 1999, 57-58.
6. Watson DJ. The physiological basis of variation in yield. Advances in Agronomy 1952;4:101-105.
7. Donald CM. In search of yield. Journal of Australian Institute of Agricultural Science 1962;28(3):171-178.
8. Gomez KA, Gomez A. Statistical Procedure for Agricultural Research, 2nd Edn. Wiley Inter Science, New York, USA 1984, 680 pp.
9. Saeed IM, Abbasi K, Kazim M. Response of maize to nitrogen and phosphorus fertilization under agronomic condition of Jammu and Kashmir. Pakistan Journal of Biology 2001;4:949-952.
10. Cochran WG, Cox GM. Planning and analysis of non-experimental studies. In: Proceedings of the Twelfth Conference on the Design of Experiments in Army Research and Testing, ARO-D Report 1967;67(2):319-36.
11. Makinde JO, Ogunbode BA. Evaluation of atrazine plus isoxaflutole (Atoll) mixture for weed control in maize Ghana Journal of Agricultural Science 2007;40:193-198.
12. Naveed M, Ahmad R, Nadeem MA, Nadeem SM, Shahzad K, Anjum MA, et al. Effect of a new post emergence herbicide application in combination with urea on growth yield and weed control in maize Journal of Agriculture and Research 2008;46(2):157-110.
13. Appleby AP, Miller F, Carpy S. Weed control in Ullman’s encyclopedia of industrial chemistry Wiley-VCH 2002. Available: www.weinheim DOI:10.1002/14356007.928-165.
14. Norman JM, Arkebaver TJ. Predicting canopy photosynthesis and light use efficiency from leaf characteristics. In: Model Crop Photosynthesis from Biochemistry to Canopy. [Eds. K.J. Boote and R.S. Loomis]. CSSA Spec. Publ. 19 CSSA, Madison, WI 1991, 75-94.
15. Sinha SP, Prasad SM, Singh SJ, Sinha KK. Integrated weed management in winter maize (Zea mays) in North Bihar. Indian Journal of Weed Science 2003;35(3-4):273-274.
16. Kolage AK, Shinde SH, Bhilare RL. Weed management in kharif maize. Journal of Maharashtra Agriculture University 2004;29(1):110-111.
17. Worku M, Zelleke H. Advances in mproving harvest index and grain yield of maize in Ethiopia. East African Journal of Science 2007;1(2):112-119.