

Advanced Weed Management Approaches And Their Impact on Yield, Economic Benefits And Weed Control Efficiency In Irrigated Hybrid Maize

Dr. P.Thukkaiyannan¹

Associate Professor (Agronomy)

ICAR-Krishi Vigyan Kendra, Pongalur ,Tiruppur, Tamilnadu, India

Abstract- A study was conducted on “Optimizing the pre emergence herbicide and time of post emergence weed management practice in irrigated maize” at Maize Research Station, Vagaraiduring 2017-18, 2018-19 and 2019-20 to optimize the pre-emergence herbicide dose of atrazine 0.5 kg/ha, 0.75 kg/ha and 1.0 kg/ha in experiment I and along with recommended dose of pre-emergence herbicide of atrazine @ 0.25 kg/ha and optimize the time and method of post emergence weed management in maize viz., hand weeding, early post emergence herbicide application, post emergence herbicide application and mechanical weeding in various time in experiment II. After 2 years of study, the best performed treatments from experiment I and II were combined and tested in 3rd year. The result of the experiment revealed that a significant higher grain yield (9,251 kg/ha) was recorded in the application of atrazine @ 1.0 kg/ha as pre-emergence and followed by spraying of tembotrione @ 120 g a.i./ha at 15 DAS than control and recommended practice. The highest net returns of Rs.1,17,864/- per hectare and BCR of 3.04 in application of atrazine @ 1.0 kg/ha followed by tembotrione @ 120 g a.i./ha at 15 DAS. Total weed population was significantly lesser in atrazine 1.0 kg/ha (PE) fb mechanical weeding at 25 DAS) at 15 DAS followed by application of atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) at 25 DAS and atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS at 50 DAS (12.7 nos./m² at 15 DAS, 11.0 nos./m² at 25 DAS and 10.7 nos./m² at 50 DAS). The total weed dry weight was also significantly lesser (5.7 g/m² and 5.0 g/m²) in T9 (atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) at 15 DAS and at 25 DAS. Whereas at 50 DAS, the significant lesser total weed dry weight (5.2 g/m²) was found in atrazine application @ 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS. The WCE was significantly higher (83.7 %) when atrazine applied @ 1.0 kg/ha (PE) fb mechanical weeding at 25 DAS in 15 DAS and at 25 DAS, followed by application of atrazine @ 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) (90.5 %). At 50 DAS, the WCE was significantly higher (85.9 %) in the treatment which applied with atrazine @ 0.75 kg/ha (PE) fb One hand weeding at 30-35 DAS.

Keywords- Herbicide optimization, Maize, Grain yield, pre-emergence, post emergence, weed control efficiency

I. INTRODUCTION

Maize (*Zea mays L.*) is the second most important cereal crop in the world in terms of total food production. It is grown for fodder as well as for grain. The grains of maize are used in a variety of ways by the human beings. Recently, with the release of improved cultivars and hybrids, the grain yield has been increased but still the maize crop faced many problems. Weeds are one of the most important factors in maize production. They cause important yield losses worldwide with an average of 12.8 % despite weed control applications and 29.2 % in the case of no weed control (Oerke and Steiner, 1996). Therefore weed control is an important management practice for maize production that should be carried out to ensure optimum grain yield.

The review on herbicides controlling broad leaved, grasses and sedges said that the higher dose of (1.0 kg/ha) Atrazine recorded higher 100 grain weight (33.8 g) and grain yield (Kamble Anand Shankar *et al.*, 2015). Pre emergence application of Atrazine @ 1.0 kg/ha and Pendimethalin @ 1.0 kg/ha followed by one hand weeding was found the most effective weed management treatment in controlling complex weed flora and getting highest yield of Maize (DMR Annual Report 2013-14). These studies are also evidenced in the sequential application of Atrazine 0.75 kg/ha fb 2, 4-D 1.00 kg/ha or mechanical weeding alone or application of Atrazine 1.00 kg/ha alone at both the doses recorded the higher grain yield. Sequential application of Atrazine 0.75 kg/ha fb 2,4D 1.00 kg/ha is on par with weed free treatment (Shantveerayya Hawaldar and Agasimani, 2012). In maize crop application of Atrazine @ 0.25 kg/ha (Crop Production Guide) with one hand weeding at 25 DAS or application of post emergence herbicide at 25 DAS is very difficult to effectively control weeds. The broad leaved weeds like *Trianthem portulacastrum* (Saranai in Tamil language) will grow faster than the maize crop in the early stage and grass

like *Dactyloctenium aegyptium* (Crow foot grass) will farm mat like structure are shown less effect for post emergence herbicides at 25 DAS.

II. MATERIALS AND METHODS

This experiment was conducted in two phases in a same time as experiment I and experiment II. Experiment I comprised of pre-emergence herbicide atrazine in various doses viz., 0.25 kg a.i./ha, 0.50 kg a.i./ha, 0.75 kg a.i./ha and 1.0 kg a.i./ha and hand weeding twice at 20 days after sowing and 40 days after sowing. All these herbicide doses and manual weeding was compared with unweeded check. Simultaneously, experiment II comprised of early post emergence herbicide 2,4-D @ 1.0 kg a.i./ha, tembotrione @ 120 g a.i./ha and halosulfuron ethyl @ 60 g a.i./ha at 15 days after sowing and 25 days after sowing. Another post weed management practice of mechanical weeding and existing recommended weed management practice of atrazine @ 0.25 kg a.i./ha followed by one hand weeding at 35 days after sowing. All these weed management methods were compared with unweeded check. The hybrid chosen was TNAU Maize hybrid Co 6. Statistical design was Randomized Block Design with four replications in Experiment I and three replications in Experiment II. The plot size formed in I year was 4.2 m X 3.0 m with the spacing of 60 cm X 25 cm, in year II, the plot size of 3.6 m X 3.0 m and the spacing of 60 cm X 25 cm.

The study was consolidated after two years data and better performed treatments were combined and formed a new set of treatments as unweeded check, atrazine @ 0.25 kg/ha (PE) fb 1 hand weeding at 30-35 DAS (Rec.), atrazine @ 0.25 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS, atrazine @ 0.25 kg/ha (PE) fb mechanical weeding at 25 DAS, atrazine @ 0.75 kg/ha (PE) fb 1 hand weeding at 30-35 DAS, atrazine @ 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS, atrazine @ 0.75 kg/ha (PE) fb mechanical weeding at 25 DAS, atrazine @ 1.00 kg/ha (PE) fb 1 hand weeding at 30-35 DAS, atrazine @ 1.00 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS and atrazine @ 1.00 kg/ha (PE) fb mechanical weeding at 25 DAS. The variety chosen was TNAU Maize hybrid Co 6 in statistical design of RBD with three replications. The plot size made to 5.0 m X 4.0 m and taken up the sowing with the spacing of 60 cm X 25 cm.

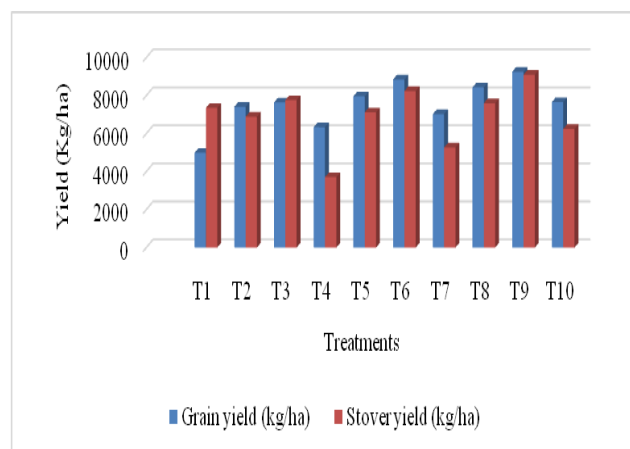
Results and discussions of pre and post emergence weed management methods

Result of yield and economics

Effect of pre and post emergence herbicides on hybrid maize with various doses and methods had a positive

impact on grain yield and stover yield. A significant higher grain yield (9,251 kg/ha) was recorded in the application of atrazine @ 1.0 kg/ha as pre emergence and followed by spraying of tembotrione @ 120 g a.i./ha at 15 DAS (T₉). This was followed by T₆ (atrazine 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) and T₈ (atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS (Rec.) i.e. 8,847 kg/ha and 8,428 kg/ha respectively. It was clearly shown that the unweeded check resulted poor and significantly lesser grain yield. This result was supported with the findings of increased grain yield in maize under spraying of atrazine as pre-emergence herbicide by (Larbi *et al*, 2013) which was substantiating the findings of Rout and Satapathy (1996). A similar result was also obtained by Sandhya Rani *et al*, (2022).

Fig. 1. Optimization of pre emergence and time of post emergence weed management methods on yield in hybrid maize



As the highest yield attributes, kernel and stover yield of maize was recorded with hand weeding twice at 15 and 30 DAS, which was however, comparable with application of atrazine 1.0 kg ha⁻¹ as PE fb topramezone 30 g ha⁻¹ as PoE. This might be due to reduced competition between the crop and weeds for the existing resources throughout the crop growing period enabling the crop for maximum utilization of nutrients, moisture, light and space, which enhanced the vegetative and reproductive potential of the crop that reflected in the form of higher kernel and Stover yield of maize as also noted by Parameswari *et al.*, (2017).

The highest benefit cost ratio was calculated (Rs.1,17,864/- per hectare) in application of atrazine @ 1.0 kg/ha followed by tembotrione @ 120 g a.i./ha at 15 DAS (T₉), which was followed by T₆ (atrazine 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) and T₈ (atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS (Rec.)) treatments (Rs. 1,10,113/- and Rs. 1,01,204/- respectively).

The benefit cost ratio was also in the same trend as that of net returns. The highest BCR was registered in T₉, followed by T₆ and T₈ treatments (3.04 followed by 2.91 and 2.73 respectively).

Table 1. Optimization of pre emergence and time of post emergence weed management methods on yield and economics in hybrid maize

Treatments	Gra n yiel d (kg/ ha)	Stov er yiel d (kg/ ha)	Net retu rns (Rs./ ha)	BC R
T ₁ -Unweeded check	4985	7350	4358 1	1.83
T ₂ -Atrazine 0.25 kg/ha (PE) fb One hand weeding at 30-35 DAS (Rec.)	7406	6882	8240 1	2.42
T ₃ -Atrazine 0.25 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	7635	7755	8804 5	2.54
T ₄ -Atrazine 0.25 kg/ha (PE) fb Mechanical weeding at 25 DAS	6334	3704	6415 7	2.17
T ₅ -Atrazine 0.75 kg/ha (PE) fb One hand weeding at 30-35 DAS	7960	7112	9244 9	2.58
T ₆ -Atrazine 0.75 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	8847	8238	1101 13	2.91
T ₇ -Atrazine 0.75 kg/ha (PE) fb Mechanical weeding at 25 DAS	7019	5267	7731 2	2.40
T ₈ -Atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS	8428	7597	1012 04	2.73
T ₉ -Atrazine 1.0 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	9251	9094	1178 64	3.04
T ₁₀ -Atrazine 1.0 kg/ha (PE) fb Mechanical weeding at 25 DAS	7657	6243	8946 0	2.62
SEd	910	743	-	-
CD (p=0.05)	1912	1561	-	-

Results on weed observation

Total weed population and total weed dry weight

The total weed population and total weed dry weight in a square meter observed area was pooled and calculated. A significant difference was found in weed population and total weed dry weight. Significantly lesser total weed population was recorded in T₁₀ (atrazine 1.0 kg/ha (PE) fb mechanical weeding at 25 DAS) at 15 DAS, T₉ (atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) at 25 DAS and T₈ (atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS) at 50 DAS. (12.7 nos./m² at 15 DAS, 11.0 nos./m² at 25 DAS and 10.7 nos./m² at 50 DAS). The total weed population was significantly higher in unweeded check (T₁) (78.3 nos./m² at 15 DAS, 116.7 nos./m² at 25 DAS and 92.3 nos./m² at 50 DAS).

The total weed dry weight was significantly lesser (5.7 g/m² and 5.0 g/m²) in T₉ (atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) at 15 DAS and at 25 DAS. Whereas at 50 DAS, the significant lesser total weed dry weight (5.2 g/m²) was found in T₈ (atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS). As in the case of total weed population, the total weed dry weight was also higher in unweeded check (T₁) (40.1 g/m², 56.0 g/m² and 44.8 g/m²). Pre followed by post emergence herbicide application of herbicides might have resulted ineffective control of weeds during the initial and later stages of crop growth and was equally effective to that of hand weeding twice as accordance with the earlier reports of Puscalet *et al.*, (2018). Similar results of reduced density and dry weight of weeds with sequential application of herbicides were reported by Dharamet *et al.*, (2018) and Sandeep *et al.*, (2018). The total weeds count and biomass was significantly higher with weedy check (T₁₀), than rest of all the weed management practices performed.

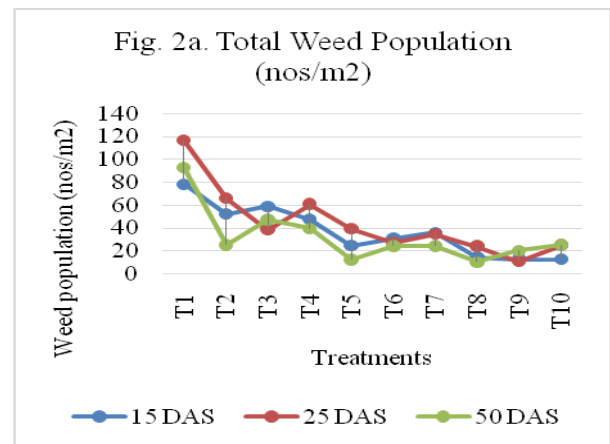
The weed control efficiency of the experiment showed that at 15 DAS, the WCE was significantly higher (83.7 %) in T₁₀ (atrazine 1.0 kg/ha (PE) fb mechanical weeding at 25 DAS) and at 25 DAS, it was higher (90.5 %) in T₉ (atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS) and at 50 DAS, the WCE was significantly higher (85.9 %) in T₅ (atrazine 0.75 kg/ha (PE) fb One hand weeding at 30-35 DAS (Rec.)) treatments. It was supported with the evidence from the findings of Suman Kantwaet *et al.*, (2020) noted that weed control efficiency was recorded under treatment weedy check (0.0%). Except T₁ (unweeded check), a comparatively lesser weed control efficiency was recorded in atrazine 0.25 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS at 15 DAS and at 50 DAS and WCE was significantly lesser in atrazine 0.25 kg/ha (PE) fb one hand weeding at 30-35 DAS (Rec.) at 25 DAS. Manual weeding maintained its supremacy over chemical control in limiting the weed load (weed density as well as their biomass) in maize crop reported by Barlaet *et al.*, 2016. Among all the herbicidal weed control

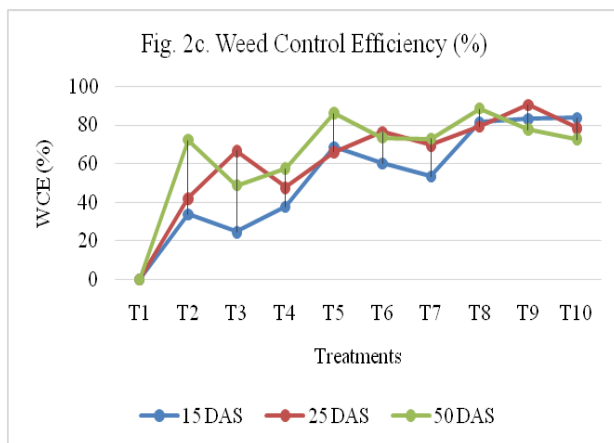
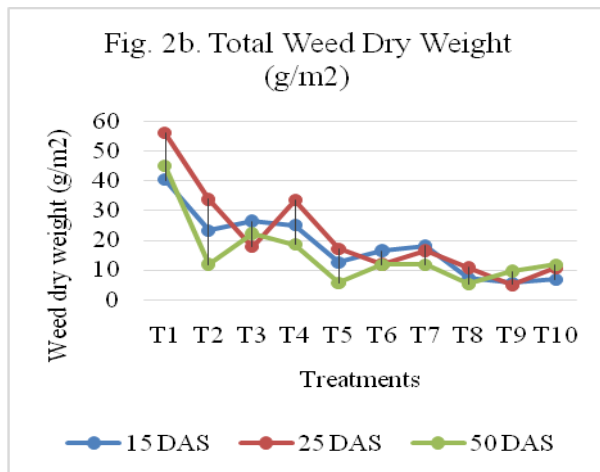
treatments, alone and combined application (with atrazine) of topramezone and tembotrione was found the most effective in order to reduce the density and dry matter of weeds at all stages compared to other treatments. This might be due to post-emergence application of topramezone and tembotrione controlled majority of weeds. The results are in close agreement with the findings of Swetha *et al.*, 2015 and Damalaset *et al.*, (2018).

Table 2. Optimization of pre emergence and time of post emergence weed management methods on total weed dynamics and weed control efficiency in hybrid maize

Treatments	Total weed Population (no/m ²)			Total weed dry weight (g/m ²)			Weed control Efficiency (%)		
	1 5 D A S	2 5 D A S	5 0 D A S	1 5 D A S	2 5 D A S	5 0 D A S	1 5 D A S	2 5 D A S	5 0 D A S
T ₁ -Unweeded check	7 8. 3	1 1 6. 7	9 2. 3	4 0. 1	5 6. 0	4 4. 8	0 0 0	0 0 0	0 0 0
T ₂ -Atrazine 0.25 kg/ha (PE) fb One hand weeding at 30-35 DAS (Rec.)	5 2. 3	6 6. 3	2 5. 7	2 3. 1	3 3. 7	1 1. 8	3 3. 8	4 1. 9	7 2. 1
T ₃ -Atrazine 0.25 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	5 9. 0	3 9. 0	4 7. 3	2 6. 4	1 7. 8	2 2. 2	2 4. 5	6 6. 6	4 8. 7
T ₄ -Atrazine 0.25 kg/ha (PE) fb Mechanical weeding at 25 DAS	4 7. 7	6 1. 0	3 9. 7	2 4. 9	3 3. 5	1 8. 4	3 7. 7	4 7. 5	5 7. 3
T ₅ -Atrazine 0.75 kg/ha (PE) fb One hand weeding at 30-35 DAS	2 4. 7	3 9. 3	1 2. 7	1 2. 5	1 7. 1	5 5 7	6 8. 7	6 6. 0	8 5. 9
T ₆ -Atrazine 0.75 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	3 1. 3	2 7. 3	2 4. 7	1 6. 4	1 1. 9	1 1. 7	6 0. 0	7 6. 3	7 3. 3

T ₇ -Atrazine 0.75 kg/ha (PE) fb Mechanical weeding at 25 DAS	3 6. 0	3 5. 0	2 4. 7	1 8. 0	1 6. 6	1 1. 7	5 3. 3	6 9. 5	7 2. 9
T ₈ -Atrazine 1.0 kg/ha (PE) fb One hand weeding at 30-35 DAS	1 4. 3	2 4. 3	1 0. 7	7. 2 7	1 0. 8	5. 2 4	8 1. 4	7 9. 4	8 8. 4
T ₉ -Atrazine 1.0 kg/ha (PE) fb Tembotrione @ 120 g a.i./ha at 15 DAS	1 3. 0	1 1. 0	2 0. 7	5. 7 0	5. 0 7	9. 5 1	8 3. 5	9 0. 5	7 7. 5
T ₁₀ -Atrazine 1.0 kg/ha (PE) fb Mechanical weeding at 25 DAS	1 2. 7	2 5. 0	2 5. 3	6. 7 7	1 0. 7	1 1. 7	8 3. 7	7 8. 5	7 2. 6
SEd	0. 5 1	0. 4 6	0. 5 2	0. 4 0	0. 3 9	0. 3 3	0. 6 0	0. 4 5	0. 2 9
CD (p=0.05)	1. 0 8	0. 9 7	1. 0 9	0. 8 4	0. 8 2	0. 7 0	1. 2 5	0. 9 4	0. 6 1





III. CONCLUSION

Study on optimizing the pre emergence herbicide and time of post emergence weed management practice in irrigated maize was conducted at Southern Agro-climatic zone of Tamilnadu (Maize Research Station, Vagarai) during the year 2017 to 2019 and it was concluded that significant higher grain yield was recorded in the application of atrazine @ 1.0 kg/ha as pre-emergence and followed by spraying of tembotrione @ 120 g a.i./ha at 15 DAS which was followed by application of atrazine 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS. The highest benefit cost ratio was calculated in application of atrazine @ 1.0 kg/ha followed by tembotrione @ 120 g a.i./ha at 15 DAS, which was followed by application of atrazine 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS). The highest BCR was registered in application of atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS, followed by atrazine 0.75 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS. The WCE was significantly higher in atrazine 1.0 kg/ha (PE) fb mechanical weeding at 25 DAS in 15 DAS and at 25 DAS, it was higher in atrazine 1.0 kg/ha (PE) fb tembotrione @ 120 g a.i./ha at 15 DAS and at 50 DAS, the WCE was significantly higher in atrazine 0.75 kg/ha (PE) fb one hand weeding at 30-35 DAS.

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REFERENCES

- [1] Barla, S., Upasani, R.R., Puran, A.N., Thakur, R., 2016. Weed management in maize. Indian Journal of Weed Science. 48(1): 67–69.
- [2] Damalas, C.A., Gitsopoulos, T.K., Koutroubas, S.D., Alexoudis, C., Georgoulas, I., 2018. Weed control and selectivity in maize (*Zea mays*L.) with tembotrione mixtures. International Journal of Pest Management. 64(1): 11–18.
- [3] Dharam, B.Y., Ashok, Y., Punia, S.S. and Anil, D. 2018. Tembotrione for PoE control of complex weed flora in maize. Indian Journal of Weed Science. 50: 133-136.
- [4] DMR (2014) Annual Report 2013-14. Directorate of Maize Research, Pusa Campus, New Delhi – 110012. pp 98.
- [5] Kamble Anand Shankar, L.N., Yogeesh, S.M., Prashanth, A.S., Channabasavanna, Channagoudar, R.F. 2015. Effect of weed management practices on weed growth and yield of maize. Int. J. Sci. Environ. Tech. 4(6):1540-1545.
- [6] Larbi E., Ofosu-Anim, J., Norman, J.C., Anim-Okyere, S. and Danso, F. 2013. Growth and yield of maize (*Zea mays* L.) in response to herbicide application in the coastal savannah ecozone of Ghana. Net Journal of Agricultural Science. 1(3): 81-86.
- [7] Oerke, E.C. and Steiner, U. 1996. Abschätzung der Ertragsverluste im Maisanbau. In: Ertragsverluste und Pflanzenschutz – Die Anbausituation für die wirtschaftlich wichtigsten Kulturpflanzen-. German Phytomedical Society Series, Band. 6: 63-79, Eugen Ulmer Verlag, Stuttgart.
- [8] Parameswari, Y.S., Srinivas, A. and Ram Prakash, T. 2017. Productivity and economics of rice (*Oryza sativa*)-zero till maize (*Zea mays*) as affected by rice establishment methods and weed management practices. International Journal of Current Microbiology and Applied Sciences. 6: 945-952.
- [9] Pusal, S., Buddhadeb, D. and Raghavendra, S. 2018. Tank mix application of tembotrione and atrazine to reduce weed growth and increase productivity of maize. Indian Journal of Weed Science. 50: 305-308.
- [10] Rout D, Satapathy MR, 1996. Chemical weed control in rainfed maize (*Zea mays*). Indian J Agron. 41: 51-53.
- [11] Sandeep, R., Dhindwal, A.S. and Punia, S.S. 2018. Response of furrow irrigated raised bed planted maize

- (Zea mays) to different moisture regimes and herbicides treatments under semi-arid conditions. *Indian Journal of Agricultural Sciences*. 88: 354-360.
- [12] Sandhya Rani, B., V. Chandrika, G. Prabhakara Reddy¹, P. Sudhakar², K.V. Nagamadhuri, G. KarunaSagar. 2022. Weed Dynamics and Nutrient Uptake of Maize as Influenced by Different Weed Management Practices. *Indian Journal of Agricultural Research*. 56 (3): 283-289.
- [13] ShantveerayyaHawaldar, C. and Agasimani, A. 2012. Effect of herbicides on weed control and productivity of maize (*Zea mays* L.). *Karnataka Journal of Agricultural Sciences*. 25 (1): 137-139.
- [14] Suman Kantwa, Jadon, C. K.,Tetarwal,J. P.,Baldev Ram, Kantwa, S. R. and Yadav,R. K.2020. Effect of Weed Management Practices on Weed Dynamics, Yield Attributes and Yield of Maize. *International Journal of Bio-resource and Stress Management*. 11(5):488-493.
- [15] Swetha, K., Madhavi, M., Pratibha, G., Ramprakash, T., 2015. Weed management with new generations' herbicides in maize. *Indian Journal of Weed Science*. 47(4): 432-433.