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P Supriya
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

A Sundari
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

S Kalaisudarson
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Corresponding Author:
P Supriya
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Effect of weed management practices on weed observations, yield and economics of irrigated maize

P Supriya, A Sundari and S Kalaisudarson

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Abstract
A field experiment was carried out during the *kharif*, 2021 (July - October) to evaluate the effect of weed management practices on weed dynamics and yield of irrigated maize and to work out the economics of different weed management practices in irrigated maize. The experiment was conducted in randomized block design with nine treatments and replicated thrice. The treatments includes T_1 - Unweeded control, T_2 - Twice hand weeding on 20 and 40 DAS, T_3 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS, T_4 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + one hand weeding on 30 DAS, T_5 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Post emergence Tembotrione 34.4% SC @ 100 g ha^{-1} on 21 DAS, T_6 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Intercrop with black gram, T_7 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Mulching with sugarcane trash on 21 DAS, T_8 - Intercropping alone and T_9 - Mulching alone on 21 DAS. The least weed biomass, highest yield parameters with maximum net return and B:C ratio observed in the application of pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram(T_6). The results of the study showed to be efficient and economically feasible technology to manage the weeds and to realize better returns from the irrigated hybrid maize.

Keywords: Intercrop, oxyfluorfen, tembotrione, yield, economics, B:C ratio, mulching and weed management.

1. Introduction
Maize (*Zea mays* L.) is most important cereal crop for food and nutritional security. It is considered as "Queen of cereals" because of the highest yield potential among cereals and wider adaptability to different soil and climatic conditions (Parihar *et al.*, 2018) [9]. Maize is generally known as the Indian corn or simply corn and it is a worldwide cultivated cereal crop in a wide range of climatic condition. Comparing the world's production potential of maize, the low productivity of maize in India was attributed to several reasons. Among these weeds are the major problem; it will reduce the crop productivity. Weeds are omnipresent and substantially reduce the yield and quality of crops. A wider row spacing and sowing of the crop with onset of monsoon provides a favourable environment for growth of problematic weeds. Almost all type of weeds *viz.*, grassy, broad leaved weeds and sedges infest the maize field with an extent of yield loss varies from 30-40 per cent (Mundra *et al.*, 2002) [6]. Weeds reduce the crop yield because they compete with the crop plants for nutrients, water, space and light. Weeds also impede with the crop harvesting and intensify the cost of production (Amir Khatam *et al.*, 2013) [1]. Neelam Sharma and Manisha Rayamajhi (2022) [7] reported that the total losses in maize yield due to competition from weeds are estimated to be around 37 per cent globally. Reports concluded that weed infestation is the major cause for such maize yield reduction that has been estimated approximately 20 to 80 per cent in contrast to other causes. Maize based intercropping system is very important to provide effective and acceptable weed control for realizing high production (Shah *et al.*, 2011) [13]. In a recent overview of benefits of intercropping, intercrops were found to suppress weeds more than either of the sole crops in 86 per cent of the cases (Stomph *et al.*, 2020) [15]. Maize-legume intercropping system, besides increasing productivity and profitability also improves soil health, conserves soil moisture and increases total out turn (Padhi and Panigrahi (2006) [8]. This study was chosen to the how different weed management practices on weed observations, yield and economics on irrigated maize.

2. Materials and Methods

Field experiment was conducted during the *kharif* (July - Oct), 2021 in farmer field, Daniyancheruvu village, Anantapur district, Andhra pradesh to evaluate the chemical and cultural weed management practices on maize. The experimental site geographically located at 14º 08' N latitude and 78º 33' E longitude at an altitude of 2.79 m above mean sea level. The weather of Daniyanicheruvuvu is moderately warm with hot summer months. The soil of the experimental field is clay loam in texture with a pH of 7.7 and EC 0.45 dSm^{-1}. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium. The maize hybrid - Kaveri 25K55 was sown at 20 kg ha^{-1} with the spacing of 60X20 cm and for intercrop black gram variety - TU 40 was chosen for the study of the experiment. The crop was grown with recommended package of practices except the weed management. Nine treatments comprising unweeded control, twice hand weeding on 20 and 40 DAS, pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS, pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + one hand weeding on 30 DAS, pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + post emergence tembotrione 34.4% SC @ 100 g ha^{-1} on 21 DAS, pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram, Pre emergence oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + mulching with sugarcane trash on 21 DAS, intercropping alone, mulching alone on 21 DAS and their combination were tried in randomized block design with three replication with plot size 5X4 m. The pre emergence herbicide oxyfluorfen was sprayed on 3 DAS and the post emergence herbicide tembotrione was sprayed on 21 DAS with 500 liters of water ha^{-1} through knapsack spryer fitted with flood jet nozzle separately in specified plots as per the treatments. Black gram (TU-40) was intercropped with maize in between two maize rows as per the treatment schedule with seed to seed distance of 10 cm. Mulching with the sugarcane trash in between the rows of maize was done on 21 DAS as per the treatment schedule. Weed biomass were recorded on 30 and 60 DAS. The yield parameters yield and economics were recorded in respective treatments. The cost of cultivation was calculated by taking current market prices of inputs while monetary return was obtained by multiplying grain yield with market price of grain and stover. The benefit:cost (B:C) ratio was calculated by dividing the net returns by cost of cultivation. The critical difference at 5 per cent level of profitability was calculated for testing the significance of difference between any two means where ever 'F' test was significant.

3. Results and Discussion

The weed species recorded in the experimental field are *Cynodon dactylon, Cyperus rotundus, Trianthema portulacastrum, Phyllanthus niruri* and *Cleome viscosa*. All the weed control treatment showed significant influence on the population of these weeds, because of sporadic occurrence and lesser adaptability other weeds not significantly influenced by the treatments. Pre emergence oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram was on par with twice hand weeding on 20 and 40 DAS and followed by pre emergence oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + post emergence tembotrione @ 100 g ha^{-1} on 21 DAS and registered the least amount of weed biomass, highest grain yield, stover yield (Table.1) and economics unrivaled over the treatments (Table.2).

The pre emergence application of oxyfluorfen and intercrop with black gram control all type of weeds because this may be due to oxyfluorfen reduce the enzyme activity in seed to suppress the weed seed germination in the soil. Oxyfluorfen is a diphenyl - ether herbicide structurally related to lactofen, fomesafen, acifluorfen. This herbicide is used for broad spectrum pre- and post-emergence control of annual broadleaf and grassy weeds in field crops. By forming a chemical barrier on the soil surface, oxyfluorfen affects the plants at emergence. This is because of the length of oxyfluorfen soil half-life, this barrier may last upto three months (USEPA 2007). The intercropping increases the spatial diversification of crops, resulting in competitive interactions with weeds and also controls weeds by shading more significantly compared with mono cropping. This result was similar with Seemantini Nadiger *et al.* (2013) [12] and weeding twice which efficiently removing the all types of weeds. This result was similar with Vinaya Lakshmi and Martin Luther (2017) [18]. This was followed by pre emergence oxyfluorfen and post emergence tembotrione because tembotrione(2-[2-chloro-4-(methylsulfonyl)-3[(2,2,2trifluroethoxy)methyl]benzoyl]-1,3-cyclohexanaedione) triketone group herbicide. This will inhibit of the enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD) broad leaved and grassy annual weeds. As a result showed that formation of carotenoids is disrupted. The chlorophyll formation stopped and remaining will reduced. The plant parts then will and development of over necrosis before they finally die and this process is fast, as the herbicide excerts its full effect within few days. Similar result was also reported by Santel (2009) [11]. The heavy weed growth resulted in unweeded control resulted the highest weed count and weed biomass. This result was similar with the findings of Singh *et al.* (2017) [14] and Sandhya Rani (2021) [10].

Pre emergence oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram recorded significantly the highest yield and yield attributes *viz.*, cob length, cob diameter, number of grains per cob, hundred grain weight, grain yield and stover yield. The results confirm with the findings of Ishaq Rahimi *et al.* (2017) [4] and Caihong Yang *et al.* (2018) [2]. The highest maize equivalent yield (MEY) obtained with pre emergence herbicide oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram compared to intercropping alone. The results confirm the findings of Choudary *et al.* (2014) [3]. Intercropping with legumes caused the wide range of microbes of plant rhizosphere to mobilize the inherent P and K and nutrients increasing their availability and uptake by plants which resulted more favorable environment for growth and development of crop plants. The unweeded control (T_1) recorded significantly the lowest yield and yield attributes *viz.*, cob length, cob diameter, number of grains per cob, hundred grain weight, grain yield and stover yield. This may due to severe weed competition for light, space, water, nutrients, through out the crop growth period.

Table 1: Effect of weed biomass and yield of maize as influenced by weed management practices.

Treatments	Weed biomass on 60 DAS (g m^{-2})	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Maize equivalent yield (kg ha^{-1})
T_1	175.20	3558	5584	3558
T_2	19.40	6104	8752	6104
T_3	62.14	4783	7054	4783
T_4	44.20	5125	7489	5125
T_5	33.40	5780	8331	5780
T_6	15.80	6289	8947	8115
T_7	40.00	5449	7913	5449
T_8	90.97	4437	6613	5914
T_9	99.20	4076	6176	4076
SEm ±	1.33	96.22	132.88	-
CD(P = 0.05)	4.02	290.95	401.80	-

T_1 - Unweeded control, T_2 - Twice hand weeding on 20 and 40 DAS, T_3 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS, T_4 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + one hand weeding on 30 DAS, T_5 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Post emergence Tembotrione 34.4% SC @ 100 g ha^{-1} on 21 DAS, T_6 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Intercrop with black gram, T_7 - Pre emergence Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} on 3 DAS + Mulching with sugarcane trash on 21 DAS, T_8 - Intercropping alone and T_9 - Mulching alone on 21 DAS.

Table 2: Economics of maize as influenced by weed management practices.

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C Ratio
T_1	49934	87418	37488	1.75
T_2	55010	146244	91214	2.65
T_3	51540	117063	65523	2.27
T_4	54073	125364	71291	2.31
T_5	55441	141271	85830	2.54
T_6	57024	153594	96570	2.69
T_7	57417	133240	75823	2.32
T_8	55428	108664	53236	1.96
T_9	55820	99924	44104	1.79

Considering the economics of different weed control measures it was observed that pre emergence oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram (T_6) involving initial cost of Rs. 57024 ha^{-1} resulted in attractive returns. The highest gross income (Rs. 153594 ha^{-1}), net income (Rs. 96570 ha^{-1}) B:C ratio (2.69) was recorded in that pre emergence Oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram. The lowest initial cost (Rs. 49934 ha^{-1}), gross income (Rs. 87418 ha^{-1}), net income (Rs. 37488 ha^{-1}) B:C ratio (1.75) was recorded in the unweeded control (T_1). The above result is line with the findings of (Sundari *et al.*,2019) [16].

4. Conclusion

Based on the results of the present study, pre emergence oxyflurofen @ 0.2 kg ha^{-1} on 3 DAS + intercrop with black gram (T_6) showed to be efficient and economically feasible technology to manage the weeds and to realize better returns from the irrigated hybrid maize.

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