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Weed dynamics and crop productivity as influenced by different tillage and weed management practices in *kharif* maize (*Zea mays* L.)

Gayatree Mishra, Mahua Banerjee, Ashok Kumar Mohapatra, Binoy Kumar Saren and Budhadeb Duary

Abstract
Results of the experiment revealed that conventional tillage in maize with integrated application of pre emergence herbicide metribuzin @ 200 g ha^{-1} with one hand weeding at 35 DAS in maize proved to be the cost effective option for controlling weeds and enhancing the weed control efficiency. The yield and yield attributing characters like no. of cobs plant^{-1}, no. of rows cob^{-1}, grain and stover yield of maize was remarkably enhanced in integrated application of pre emergence herbicide metribuzin @ 200 g ha^{-1} with one hand weeding at 35 DAS, which was also found on a par with hand weeding practice at 15 and 35 DAS under conventional tilled maize in *kharif* season. The same treatments were found economically viable. Unweeded control resulted with highest weed density, dry weight and lowest weed control efficiency thereby reduction in grain yield.

Keywords: Integrated application, weed control efficiency, production potential, tillage practices

Introduction
Maize being the second most widely grown crop in the world and cultivated in tropics, sub-tropics to temperate climate. Maize with its wide adaptability can be grown with elevation ranging from sea level to up to 3000 m above mean sea level. Currently, nearly 1147.7 MT of maize is being produced together by over 170 countries from an area of 193.7 million ha with an average productivity of 5.75 t ha^{-1} (FAOSTAT, 2020) [6]. It has several types like field corn, sweet corn, baby corn and popcorn. The field corn has several other types like quality protein maize (QPM), waxy maize, high-oil maize etc. The quality protein maize group has better biological value in comparison to traditional maize. It could be used towards nutritional security of poor and undernourished masses. The global consumption pattern of maize towards feed-61%, food-17% and industry-22%. As 83% of maize production in the world is used in feed, starch and bio fuel industries, it has attained a position of industrial crop globally. Myriad uses of Maize, has made it a prime driver of the global agricultural economy and being designated as 'Queen of Cereals' due to its nutritional compositions.
Maize was typically a *kharif* crop of Northern India but with less than half of water requirement is the best substitute to rice to diversify the rice centred cropping system particularly in north western plain zone. While *rabi* maize is cultivated under assured ecosystem, over 80% of *kharif* maize is cultivated as rainfed crop. Both biotic and abiotic stresses under rainfed maize result into lower yield of *kharif* maize. Increasing *kharif* maize productivity will remain key to augment the maize productivity in India.
The low productivity of maize has several reasons. Among these, pest is one of the important one. Estimated total loss due to all pests, insect, disease pathogens, weed etc. amounting Rs. 6,000 crores annually in our country. About 33% of these losses are caused due to weeds alone (Mukherjee, 2004) [8]. Even a conservative estimate of about 10% loss would amount to a loss of food grains valued at approximately US$ 13 billion (Yaduraju, 2012) [17]. It is thus indent that the losses caused by the weeds far exceed the losses from other pests. In India weeds are one of the major biological constraints that limit crop productivity. They compete with crops for natural and applied resources besides being responsible for reducing quantity and quality of agricultural productivity (Rao and Nagamani, 2010, 2013; Rao *et al*., 2015) [11, 13]. Weeds cause yield losses with an average of 12.8 per cent despite weed control applications and 29.2 per cent in case of no weed control worldwide (Dogan *et al*. 2004) [3].

Weed management plays most crucial factor in crop management system to achieve recent food production demands and national zero hunger targets for burgeoning population.

In the intensive food production systems, Tillage plays a vital part in the technological development and evolution of agriculture. The process of Tillage results in well seed bed preparation, conservation of soil and water and also controls weed. Tillage has both beneficial and detrimental effect on soil depending on the methods used. Weeds were more effectively controlled when tillage operations were supplemented by the manual weeding and herbicides. Resistance in weeds against herbicide is developed due to frequent use of the chemical. Weed control by manual method is labour intensive, time consuming and a costly affair. Besides, frequent rainfall during cropping season does not permit manual method at the appropriate time. Thus, to eliminate weed competition from the germination stage of the crop and to reduce the yield losses, tillage and integrated weed control methods has become inevitable.

Now a days application of herbicides has gradually been replacing manual weed control practices. Impact of different tillage practices influences the herbicide effectiveness. Thus weed management would continue to play a key role to meet the growing food demands of increasing population in India. As the weed problems are multi-pronged, a holistic multi-disciplinary integrated approach would be imperative. In this context, different tillage and integrated weed management (IWM) was tested to provide a more sustainable approach to maize production.

Materials and Methods

An experiment was conducted at Experimental Farm, CUTM, Bagusala, Gajapati district of Odisha during *Kharif* 2018 and 2019. The soil of the experimental field was sandy loam in texture with pH of 6.80. The soil is low in organic carbon (0.48%) and available nitrogen (158.83 kg ha^{-1}), medium in available phosphorus (10 kg ha^{-1}) and available potassium (147.67 kg ha^{-1}). The experiment was laid out in a split plot design with having two tillage practice as main plot and eight weed management practices as subplot totalling to sixteen treatments as described in table and replicated thrice. A recommended dose of 150 kg N ha^{-1}, 75 kg P_2O_5 ha^{-1} and 75 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash, respectively. Entire quantity of phosphorus and potassium and half of nitrogen were applied at the time of sowing. Remaining one fourth of N applied at 30 and 45 DAS, respectively through urea. The quality protein maize variety (Vivek QPM-9)) was sown at a row spacing of 60 cm with plant to plant distance of 20 cm. The pre emergence and post emergence herbicides were applied as per the treatments through knap-sack sprayer using a spray volume of 500 l ha^{-1}. The data on dry weight were recorded at 30, 60 DAS and at harvest were subjected to square root transformation $\sqrt{x} + 0.5$ before statistical analysis to normalize their distribution (Panse and Sukhatme, 1978) [10]. Different weed parameters and yield attributes were recorded at different days of maize growth and at the time of maturity.

Results and Discussion

Effect on weeds

All the tillage and weed management practices significantly reduced the weed density and dry weight over weedy check treatment during both years of observations (Table 1).

At 60 DAS, lowest weed density and biomass was recorded with conventional tilled plots (T1), which was significantly lowest compared to zero tilled plots (T2) in both of the year and also in pooled analysis. In general, the weed density becomes higher with minimum tillage than with moderate and intensive tillage systems (Dorado *et al*. 1999) [5]. Donovan and Mc Andrew (2000) [4] also observed that weed seedlings density in the field increased from 31 plants m^{-2} in the intensive tillage system to 315 plants m^{-2} in the zero tillage system.

Among different weed management practices significantly lowest weed density was found in sequential herbicidal treatment (W3) which was found to remain on par with integrated herbicidal treatment (W1) and sequential herbicidal treatment (W4) in the first year. Hand weeding twice at 15 and 35 DAS (W7) recorded lowest total weed density in the second year and was remain on par with treatment W1 & W2. Pooled analysis of two-year data revealed that, the treatment W3 was recorded lowest total weed density and remain at par with treatment such as W1, W4 and W7. Other treatments except W8 were remain intermediate in controlling total weed density. Weedy check (W8) recorded highest total weed density among all other treatments in both first and second year. Hand weeding twice at 15 and 35 DAS (W7) recorded significantly the least biomass of total weeds which found statistically at par with sequential applied herbicidal treatment W3, whereas the integrated weed control treatment W1 also found at par with W3. Other treatments such as W2, W4, W5 & W6 were next in order & intermediate in controlling the biomass of total weeds in first year. In second year similar trend followed as like first year in recording least biomass in W7. In pooled analysis, also the hand weeding twice at 15 and 35 DAS (W7) recorded the least dry weight of total weeds and found stabilizing at par with sequentially applied herbicidal treatment W3. Among different herbicide tested, W3 recorded the least total weed biomass which was followed by W1, W2 and W4. Weedy check (W8) recorded significantly the highest dry weight of total weeds compared to all other treatments during both years and their pooled analysis in *kharif* maize. Combined application of pre emergence herbicide followed by post emergence herbicide or with one hand weeding practice markedly reduced the density as well as dry weight of grasses, sedges and broad leaved weeds compared to other weed management practices. The reduced density of grasses, sedges and broad leaved weeds could be due to more persistence of metribuzin resulting in effective control of weeds in the initial stages and control of late emerged weeds by either one hand weeding or post emergence herbicides. These results are in agreement with those of Madhavi *et al*., 2014 [7] and Singh *et al*., (2015) [15].

The highest weed control efficiency was recorded in conventional tillage practice (T1) at 45 DAS compared to zero tillage practice at. Higher weed control efficiency were observed with conventional tillage in maize crop were during both years and their pooled data due to inversion of soil by conventional tillage resulted in deeper placement of weed seeds which could not emerge, causing a significant reduction in the population of weeds (Vijaymahantesh *et al*., 2013) [16]. Hand weeding twice at 15 and 35 DAS (W7) recorded numerically the highest weed control efficiency at 60 DAS. Among other weed management practices, sequentially applied herbicidal treatment W3 i.e., pre emergence application of metribuzin @ 200 g ha^{-1} at 1 DAS and post emergence application of topramezone @ 35 g ha^{-1} at 35 DAS and integrated application of PE herbicide metribuzin @ 200 g ha^{-1} with one hand weeding (W1) recorded numerically the highest weed control efficiency and closely followed treatment W7. Pre emergence herbicides gave effective control of weeds by inhibiting the germination of the weed seeds and also killing the emerging weeds at the early stages and later weeds effectively controlled by either hand weeding practice or herbicide helps to give through control entire crop growth period (Nadeem *et al*., 2010) [9].

Table 1: Weed density, dry weight and weed control efficiency as influenced by different tillage and weed management practices at 60 DAS in *kharif* maize

Treatments	Weed density (No. m^{-2})			Weed dry weight (g m^{-2})			Weed control efficiency (%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Tillage Practices									
T1: Conventional tillage	*11.85 (146.50)	12.55 (163.84)	12.20 (155.17)	5.44 (40.82)	5.55 (43.22)	5.49 (42.02)	80.16	80.39	80.28
T2: Zero tillage	13.83 (197.25)	13.67 (194.74)	13.75 (196.00)	6.04 (49.67)	6.08 (51.07)	6.06 (50.37)	79.7	80.16	79.93
S.Em ±	0.17	0.16	0.12	0.06	0.06	0.04	-	-	-
CD	0.04	1.00	0.33	0.34	0.34	0.11	-	-	
CV %	6.51	6.16	6.34	5.13	5.10	5.11	-	-	-
Weed management treatments									
W1: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* hand weeding at 35 DAS	11.81 (140.00)	11.66 (136.33)	11.73 (138.17)	4.20 (17.23)	4.22 (17.47)	4.21 (17.35)	92.37	92.71	92.54
W2: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* hand weeding at 35 DAS	12.75 (163.33)	11.99 (144.67)	12.37 (154.00)	4.35 (18.50)	4.26 (17.74)	4.31 (18.12)	91.76	92.57	92.18
W3: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* topramezone @ 35 g ha^{-1} as PoE at 35 DAS	10.88 (120.33)	12.12 (147.90)	11.50 (134.12)	3.83 (14.23)	3.81 (14.07)	3.82 (14.15)	93.69	94.12	93.91
W4: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* topramezone @ 35 g ha^{-1} as PoE at 35 DAS	11.03 (122.67)	12.74 (162.56)	11.89 (142.61)	4.41 (19.08)	4.20 (17.34)	4.30 (18.21)	91.60	92.80	92.22
W5: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* 2,4-D Na salt @ 500 g ha^{-1} as PoE at 35 DAS	12.22 (151.33)	12.87 (166.47)	12.54 (158.90)	5.14 (26.16)	5.31 (27.96)	5.22 (27.06)	88.42	88.33	88.37
W6: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* 2,4-D Na salt @ 500 g ha^{-1} as PoE at 35 DAS	12.43 (156.00)	13.01 (170.15)	12.72 (163.08)	5.43 (29.12)	5.49 (29.75)	5.46 (29.44)	87.09	87.44	87.26
W7: Hand weeding at 15 and 35 DAS	12.57 (158.67)	10.81 (117.33)	11.69 (138.00)	3.57 (12.43)	3.77 (13.96)	3.67 (13.19)	94.52	94.21	94.36
W8: Weedy check	19.03 (362.67)	19.70 (388.88)	19.36 (375.77)	15.00 (225.20)	15.45 (238.87)	15.23 (232.04)	0.00	0.00	0.00
S.Em ±	0.37	0.45	0.29	0.14	0.16	0.11	-	-	-
CD	1.07	1.30	0.82	0.42	0.47	0.31	-	-	-
CV %	7.03	8.39	7.75	6.11	6.50	6.52	-	-	-

[*The data are $\sqrt{X + 0.5}$ transformed. The figures in parentheses are the original values.]
*PE- Pre emergence application, PoE- Post emergence application

Effect on yield attributes and yield of crop

Number of cobs per plant differed significantly with different tillage and weed management practices. Significantly a greater number of cobs per plant observed in conventional tilled treatments (T1) compared to zero tilled treatment (T2) during second year and their pool analysed data except in the first year which was found not significant (Table 2). Among different weed management practices hand weeding twice at 15 and 35 DAS (W7) recorded significantly highest no. of cobs per plant in *kharif* maize during both the years. Integrated practice of pre emergence herbicide with one hand weeding (W1& W2) and sequentially applied herbicidal treatment (W3) were found at par with hand weeding practice (W7) during first year. However, second year and pooled data revealed that integrated practice of metribuzin herbicide as pre-emergence with one hand weeding (W1) was found at par with W7 and other treatments were next in order in recording number of cobs per plant. Number of rows per cob did not significantly influence by different tillage practices. Conventional tillage (CT) numerically resulted in highest number of rows per cob during both years. There was a significant impact of weed management treatments on no. of rows per cob during both years. Highest no. of rows per cob observed in hand weeding (W7) and found at par with integrated practice of pre emergence herbicide with one hand weeding (W1 & W2) during first year. But the second year and pooled analysed data indicates only the W1 remained at par to W7 other treatments W2 and W3 closely followed W7. Significantly lowest no. of rows per cob recorded in weedy check treatment (W8) during the years. This is due to better control of weeds at critical growth phases which enhanced the growth and yield attributes of maize. Razz and Mahmood (2007) [14] observed that chemical weeding at 2-3 leaf stage of weeds + hand weeding at 50 DAS gave promising results of increase in grain and stalk yield by 34 and 33 percent, respectively and higher 1000 grain weight of maize.

Conventional tillage (T1) produced higher and comparable grain and stover yield which is an indication for higher efficiency of deep tillage over a long capacity period (Table 2). Higher grain and stover yield of maize with conventional tillage are highly supported with improved growth and yield attributes (Chopra and Angiras, 2008) [2]. Zero tillage (T2) resulted in minimum grain and stover yield of maize. Reduced crop growth and development increased difficulties in weed management have been cited as the cause for less than desirable or in inconsistent soyabean yield under no tillage management (Yin and Al-kaisi, 2004) [18]. Higher grain and stover yields of maize obtained with hand weeding at 15 and 35 DAS (W7) which was found statistically similar with pre emergence application of metribuzin @ 200g ha^{-1} followed by hand weeding on 35 DAS (W1) was due to efficient control of weeds and increased root growth. Kandasamy and Chandrasekhar (1998) noticed that integrated weed management with pre emergence application of atrazine 0.25 kg ha^{-1} with a follow up hand weeding on 40-50 DAS recorded better weed control with higher yields (3077 kg ha^{-1}) in rainfed maize. Combination of non chemical weed control methods of power tiller drawn sweep weeding followed by hand weeding was found to be an effective and economic method of weed control in rainfed maize (AICRP-WC, 2000).

Table 2: Yield and yield attributes as influenced by different tillage and weed management practices in *kharif* maize

Treatments	No. of cobs plant^{-1}			No. of rows cob^{-1}			Grain yield t ha^{-1}			Stover yield t ha^{-1}		
	2018	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
Tillage Practices												
T1: Conventional tillage	1.40	1.40	1.40	14.53	14.54	14.54	3.66	4.11	3.89	5.21	6.02	5.61
T2: Zero tillage	1.35	1.32	1.34	13.93	13.86	13.89	3.28	3.71	3.50	4.51	5.46	4.99
S.Em ±	0.02	0.01	0.01	0.23	0.23	0.16	0.05	0.05	0.04	0.08	0.12	0.07
CD	NS	0.08	0.03	NS	NS	NS	0.29	0.33	0.11	0.47	NS	0.19
CV %	6.56	5.02	5.68	7.82	8.05	7.94	6.79	6.83	6.82	7.79	10.22	9.32
Weed management treatments												
W1: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* hand weeding at 35 DAS	1.53	1.57	1.55	15.07	15.53	15.30	4.11	4.71	4.41	5.37	6.88	6.12
W2: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* hand weeding at 35 DAS	1.47	1.43	1.45	14.70	14.50	14.60	3.79	4.37	4.08	5.18	6.62	5.90
W3: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* topramezone @ 35 g ha^{-1} as PoE at 35 DAS	1.43	1.37	1.40	14.63	14.47	14.55	3.60	4.40	4.00	4.99	6.31	5.65
W4: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* topramezone @ 35 g ha^{-1} as PoE at 35 DAS	1.37	1.30	1.33	13.93	13.77	13.85	3.46	3.85	3.66	4.73	5.83	5.28
W5: Metribuzin @ 200 g ha^{-1} as PE at 1DAS *fb* 2,4-D Na salt @ 500 g ha^{-1} as PoE at 35 DAS	1.30	1.30	1.30	13.77	13.67	13.72	3.42	3.65	3.54	4.71	5.31	5.01
W6: Oxadiargyl @ 90 g ha^{-1} as PE at 1 DAS *fb* 2,4-D Na salt @ 500 g ha^{-1} as PoE at 35 DAS	1.28	1.27	1.28	13.63	13.63	13.63	3.16	3.53	3.35	4.71	4.88	4.79
W7: Hand weeding at 15 and 35 DAS	1.53	1.60	1.57	15.47	15.83	15.65	4.15	4.75	4.45	5.46	6.56	6.01
W8: Weedy check	1.08	1.05	1.07	12.63	12.20	12.42	2.09	2.02	2.05	3.72	3.54	3.63
S.Em ±	0.05	0.05	0.04	0.29	0.31	0.21	0.15	0.12	0.10	0.18	0.19	0.13
CD	0.14	0.15	0.10	0.84	0.89	0.60	0.43	0.34	0.27	0.52	0.54	0.37
CV %	8.56	9.31	8.94	5.01	5.27	5.14	10.55	7.43	8.95	9.07	7.98	8.48

Conclusion

Tillage and different weed management practices significantly reduced the density, dry weight of weeds and increased the weed control efficiency during two years of observation when compared to weedy check. The conventional tillage reduced the weed density, dry weight and recorded maximum weed control efficiency, yield attributes and yield over zero tillage at 60 days of crop growth. Integrated application of PE herbicide metribuzin @ 200 g ha^{-1} with one hand weeding at 35 DAS (W1) recorded with highest weed control efficiency by reducing the density and dry weight of weeds there by resulted with highest no. of cobs per plant, no. of rows per plant, grain and stover yield, among all other weed management practices. Sequential application PE herbicide metribuzin @ 200 g ha^{-1} *fb* PoE herbicide topramezone @ 35 g ha^{-1} also recorded highest weed control efficiency and being comparable to W1. Although hand weeding (W7) resulted with good control over population, biomass production by weeds and maximum yield and yield attributes but as it is labour intensive and time consuming method not feasible to farmers.

References

1. AICRP – WC. Fourteenth annual progress report 01.01.2000 to 31.12. 2000. All India Coordinated Research Project on Weed Control, Coimbatore centre, Dept of Agronomy, TNAU, Coimbatore, 2000, 21-29.
2. Chopra P, Angiras NN. Effect of tillage and weed management on productivity and nutrient uptake of maize (*Zea mays*). Indian Journal of Agronomy. 2008;53:66-69.
3. Dogan MN, Unay A, Boz O, Albay F, *et al*. Determination of optimum weed control timing in maize (*Zea mays* L.). Turkish Journal of Agronomy. 2004;28:349-354.
4. Donovan JT, McAndrew DW. Effect of tillage on weed populations in continuous barley (*Hordeum vulgare*). Weed Technology. 2000;14:726-733.
5. Dorado J, Del Monte JP, Fando CL, *et al*. Weed seed bank response to crop rotation and tillage in semiarid ecosystems. Weed Science. 1999;47:67-73.
6. FAO. FAOSTAT. Food and Agriculture Organization of the United Nations, 2020. Rome, [Weblink: Italy. http://www.fao.org/faostat/en/ #data/QC]
7. Madhavi M, Ramprakash T, Srinivas A, Yakadri M, *et al*. Topramezone (33.6% SC) + Atrazine (50%) WP tank mix efficacy on maize. Biennial conference on Emerging challenge in weed management Organized by Indian Society of Weed Science. 2014, 15-17, February.
8. Mukherjee D. Weed management in rice. Agriculture Today. 2004;11:26-27.
9. Nadeem MA, Awais M, Ayub M, Tahir M, Maqbool MM, *et al*. Integrated weed management studies for autumn planted maize. Pakistan J Life Soc. Sci. 2010;8(2):98-101.
10. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, 1978, 152.
11. Rao AN, Nagamani A. Integrated Weed Management in

India- Revisited. Indian Journal of Weed Science. 2010;42:1-10.
12. Rao AN, Nagamani A. Eco-efficient weed management approaches for rice in tropical Asia. In: Proceedings 4th Tropical Weed Science Conf. Weed Management and Utilization in the Tropics held during January 23-25, 2013, The Empress Hotel, Chiang Mai, Thailand, 2013, p. 78-87.
13. Rao AN, Wani SP, Ramesha M, Ladha JK, *et al*. Weeds and Weed Management of Rice in Karnataka State, India. Weed Technology. 2015;29(1):1-17.
14. Razz M, Jamil M, Mahmood TZ, *et al*. Yield and yield components of maize as affected by various weed control methods under rainfed conditions of Pakistan. Intl. J Agric. Bio. 2007;09(1):152-155.
15. Singh AK, Parihar CM, Jat SL, Singh B, Sharma S, *et al*. Weed management strategies in maize in maize (*Zea mays*): Effect on weed dynamics, productivity and economics of the maize-wheat (*Triticum aestivum*) cropping system in Indo-gangetic plains. Indian Journal of Agricultural Sciences. 2015;85(1):87-92.
16. Vijaymahantesh, Nanjappa HV, Ramachandrappa BK. Effect of tillage and nutrient management practices on weed dynamics and yield of fingermillet (*Eleusine coracana* L.) under Rainfed Pigeonpea (*Cajanus cajan* L.) fingermillet system in Alfisols of Southern India. African Journal of Agricultural Research. 2013;8(21):2470-2475.
17. Yaduraju NT. Weed management perspectives for India in the changing agriculture scenario in 'the'-country. Pakistan Journal of Weed Science Research. 2012;18:703-710.
18. Yin X, Al-Kaisi MM. Periodic response of soybean yields and economic returns to long-term no-tillage. Agron. J. 2004;96:723-733.