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Productivity of Maize as Influenced by Different Weed Management Practices under Conservation Agriculture in East and South Eastern Zone of Odisha

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ABSTRACT

A field experiment entitled "Weed management in maize under conservation tillage" was conducted during *rabi* season of 2020-21 and 2021-22 at AICRP on Weed Management Block, Central Farm, OUAT, Bhubaneswar. The experiment was laid out in a split plot design with three replications. The soil of the experimental site was sandy loam in texture with pH 5.6, bulk density (B.D) 1.5 Mg/m3, organic carbon 6.3g/kg, available nitrogen 218.28 kg/ha, phosphorus 21.36 kg/ha and potassium 127.28 kg/ha. The maize hybrid "Nilesh hybrid" was grown as the test crop. In total 13 different types of weeds infested the maize crop field. The most problematic grass, sedge and broadleaved weeds found in the plot were *Eleusine indica* (10.55%), *Cyperus iria* (5.34%) and *Spilanthes acmella* (29.25%), Conventional tillage recorded lowest weed density (56.55no./m^2), weed dry weight (17.22g/m^2). Among the tillage practices, conventional tillage was the best treatment but was at par with zero tillage + mulching. Conventional tillage recorded lowest weed density (56.55no./m^2),weed dry weight (17.22g/m^2), lowest weed control efficiency (64.29%) and highest weed index (8.27%) and grain yield of 5354 kg/ha and stover yield of 8731 kg/ha. Among weed management methods, pre-emergence application of pendimethalin 1kg/ha (2DAS) recorded lowest weed density (63.19no./m^2), weed dry weight (14.87g/m^2) and highest weed control efficiency (83.29%) and grain yield (5522 kg/ha) and stover yield of 8915 kg/ha. But grain yield was at par with post-emergence application of tembotrione 120g/ha and pendimethalin 1kg/ha (2 DAS). Zero tillage + mulching resulted in highest net return (Rs 62305/ha) and B:C ratio (2.19). Application of pendimethalin 1kg/ha (2DAS) also resulted in the highest gross return of Rs 119352/ha, net return of Rs 80662/ha and B:C ratio of 3.08. Zero tillage with rice straw mulching 5t/ha (ZT+M) and pre-emergence application of the herbicide pendimethalin 1 kg/ha was found to be the best treatment with high grain yield, highest B:C ratio. Hence, zero tillage practice along with rice straw mulching 5t/ha and pre emergence application of herbicide pendimethalin 1kg/ha proved to be the best treatment and the practices can be advocated for growing *rabi* maize in East and South Eastern Coastal Plain Zone of Odisha.

Keywords Pendimethalin, Tembotrione, Zero tillage, Maize, Weed management.

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INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat, extensively cultivated across the world and utilized as a main source of nutrition in many poor nations. The crop may be used in a variety of cropping systems due to its flexibility and high production potential. In several regions of Asia, the growing demand for maize is fast changing agricultural methods Yakadri *et al.* (2015).

Protecting maize against weeds, pests, and diseases is critical in order to avoid significant losses in maize output and quality. Weed control is typically the most critical, as weed interference is a serious problem with corn, especially early in the growing season because of its sluggish growth rate and greater row spacing. Depending on the kind of weed flora and their intensity, stage, character, and length of agricultural weed competition, yield losses range from 28 to 93%. Triveni *et al.* (2017). Weed depletes the soil of 30-40% of the applied nutrients. They obstruct the efficient use of fertilizer by agricultural crops, because weeds consume a significant amount of the fertilizer applied to the soil. Weeds were the most prominent biological production limitations that limited maize output among the other production constraints. Weed infestation is the most important of the biotic variables that cause reduced maize grain production. Weeds, the most important pest group of this crop, have hindered maize output by up to 40% worldwide. Over the last 50–60 years, repeated conventional tillage combined with other poor land-use practices has resulted in widespread soil deterioration, with most soils losing up to half of their natural organic matter content and fauna Malik *et al.* (2006).

The use of a single tillage method may reduce production, but a mix of tillage, mulching, and weed control measures will impact maize growth and yield. Manjith Kumar and Angadi (2016). Zero tillage is one of the better alternatives for reducing the issues connected with poor land-use practices to some extent. However, in order to improve system sustainability and resource efficiency, a sequence of zero and conventional choices must be defined for each agricultural, soil, and microclimatic condition. Zero tillage enhances the soil's physico - chemical and biological-characteristics while lowering production costs. Bisen and Singh (2008) and Jha *et al*. (2011). Traditional tillage affects soil physicochemical qualities such as soil structure, porosity, water retention, and organic carbon content, lowering maize yields; however, conservation tillage methods enhance soil attributes significantly, increasing crop yields. Meena *et al.* (2015).

Basing on the above facts a field experiment was conducted to test performance of maize under different tillage systems in Odisha when different herbicides are taken as weed control measures and to study the weed dynamics and crop productivity under zero tillage and residue management practices.

MATERIALS AND METHODS

A field experiment entitled, "Weed management in maize under conservation tillage" was conducted at the AICRP on Weed Management Block, Central Farm, Department of Agronomy, Odisha University of Agriculture and Technology, Bhubaneswar during the *rabi* season of 2020-21 and 2021-22.The soil of the experimental field was sandy loam in texture, acidic in reaction, medium in available nitrogen, available phosphorus and available potassium. The mean maximum / minimum temperatures during the cropping season of 1st and 2nd year were 31.0^{o}C /17.9^{o}C and 31.6^{o}C /17.1^{o}C respectively. Total rainfall of 253.3mm and 267.4mm were received during the crop growing seasons of both the years respectively. The mean relative humidity for morning/afternoon were 92.8 / 47.2 % and 92.4 /47.8% respectively. Similarly, the mean bright sunshine hours were 5.8 and 5.9 hr/day in both the seasons of crop growth respectively. In general all the weather parameters were suitable for successful growth of the maize crop. A combination of T_1-Conventional tillage (CT), T_2-zero tillage + mulching paddy straw 5t/ha (ZT+M), T_3-zero tillage with dibbling (ZT) and four different weed management practices were viz.,W_1- pendimethalin (pre-emergence 1 kg/ha), W_2- tembotrione (post-emergence 120 g/ha), W_3- Manual weeding and W_4- Weedy check were taken for study.

Table 1. Effect of tillage and weed management practices on total population of weed (no./m^2) in maize.

Treatments	30 DAS	60 DAS	At harvest
Main plot (Tillage)			
T_1-Conventional tillage (CT)	75.04	56.55	74.62
T_2-Zero tillage + Mulching (ZT+M) (paddy straw @ 5t/ha)	95.44	83.72	91.32
T_3-Zero tillage (ZT) (dibbling)	114.58	106.66	103.63
SEm ±	0.92	0.85	0.41
CD (P=0.05)	3.60	3.32	1.61
Sub plot (Weed Management)			
W_1-Pendimethalin (pre-emergence 1 kg/ha)	83.91	63.19	73.37
W_2-Tembotrione (post-emergence 120 g/ha)	90.63	73.14	75.32
W_3-Manual weeding	99.04	82.34	79.11
W_4-Weedy check	106.51	110.57	131.61
SEm ±	0.64	1.52	1.78
CD (P=0.05)	1.90	4.53	5.29

RESULTS AND DISCUSSION

Weed density

The weed density decreased up to 60 DAS in T_1 (conventional tillage) and T_2 (zero tillage + mulching) and thereafter increased up to harvest. In zero tillage, weed density decreased till harvest. At all the stages of growth; zero tillage produced maximum weed density and conventional tillage the minimum weed density. At 60 DAS, the weed density was the highest (106.66/m^2) and significantly higher in zero tillage as compared to T_1 and T_2.The improvement in density of weeds under continuous zero tillage in maize might be due to higher deposition of weed seeds in the upper layer of soil (0–10 cm) with no disturbance of the top soil. However, under continuous conventional tillage lower grassy weed density could be ascribed to comparatively less number of seeds of this category on top 0–10 cm layer of soil due to burying of seed into deeper layer and killing of newly emerged weeds with repeated tillage operations. Similar finding are reported by (Mahajan *et al.* 2002).

In weed management practices, the weed density increased up to 60 DAS in W_1 and W_2 and thereafter it decreased. However, it decreased till harvest with manual weeding. On the contrary, it increased up to harvest under weedy check where no weed management practice was adopted. Maximum weed density was recorded in weedy check (106.51, 110.57, 131.61/m^2 at 30 DAS, 60 DAS and at harvest, respectively) at all the stages of growth (Table 1). At each stage of growth, the weed density was the least when pre-emergence application of pendimethalin (W_1) was done to control weeds. Similar results were reported by Shrivasthav *et al*. (2015).

Weed control efficiency (WCE %) and weed index (WI)

Weed control efficiency was highest in zero tillage + mulching (71.24%) followed by conventional tillage (69.22%) and zero tillage (64.29%). Weed control efficiency was maximum (82.39%) when pendimethalin was applied to control the weeds followed by the use of tembotrione (72.64%) and manual weeding (64.64%).Highest weed index was observed in conventional tillage (8.27%) followed by zero tillage (6.9%). However, the weed index was least in zero tillage + mulching plots (6.19%). The weed index was highest with weedy check (26.71%) followed by manual weeding (8.16%). The weed index was minimum (3.61%) when tembotrione was used to control weeds (Table 2).

Grain yield

Maximum grain yield was recorded from conventional tillage T_1 (5354.33 kg/ha) which was statistically at

Table 2. Effect of tillage and weed management practices on Weed control efficiency (WCE) and weed index (WI) of maize at 60 DAS.

Treatments	Weed control efficiency (%)	Weed index (%)
T_1-Conventional tillage (CT)	69.22	8.27
T_2-Zero tillage + Mulching (ZT+M) (paddy straw @5t/ha)	71.24	6.19
T_3-Zero tillage (ZT)	64.29	6.90
W_1-Pendimethalin (pre-emergence @1kg/ha)	82.39	-
W_2-Tembotrione (post-emergence @120g/ha)	72.64	3.61
W_3-Manual weeding	64.64	8.16
W_4-Weedy check	-	26.71

Table 3. Effect of tillage and weed management practices on grain yield (kg/ha), stover yield of maize.

Treatments	Grain yield (kg/ha)	Stover yield (kg/ha)
T_1-Conventional tillage (CT)	5354.33	8730.50
T_2-Zero tillage + Mulching (ZT+M) (paddy straw @5t/ha)	5292.33	8677.92
T_3-Zero tillage (ZT) (dibbling)	4727.75	8024.00
SEm ±	64.95	58.97
CD (P=0.05)	254.96	231.46
W_1-Pendimethalin (pre-emergence @ 1kg/ha)	5521.78	8915.22
W_2-Tembotrione (post-emergence@ 120g/ha)	5318.33	8778.56
W_3-Manual weeding	5072.44	8470.78
W_4-Weedy check	4586.67	7745.33
SEm ±	83.74	30.90
CD (P=0.05)	248.76	91.80

Table 4. Effect of tillage and weed management practices on economics of maize.

Treatments	Cost of culivation (Rs)	Gross-return (Rs)	Net re-turn (Rs)	B:C
Main plot (Tillage)				
T_1-Conventional tillage (CT)	56800	115818	59018	2.04
T_2-Zerotillage + Mulching (ZT+M) (paddy straw @5t/ha)	52220	114525	62305	2.19
T_3-Zero tillage (ZT) (dibbling)	48000	102579	54579	2.14
Subplot (weed management)				
W_1-Pendimethalin (pre-emergence @1kg/ha)	38690	119352	80662	3.08
W_2-Tembotrione (post-emergence @120g/ha)	40500	115146	74646	2.84
W_3-Manual weeding	40630	109914	69284	2.71
W_4-Weedycheck	37200	99479	62279	2.67

par with zero tillage + mulching T_2 (5292.33kg/ha). Maize crop grown with only zero tillage produced the least yield (4727.75 kg/ha) (Table 3). Highest grain yield was obtained from W_1 (5521.78kg/ha) when pendimethalin was used as pre-emergence application to control weeds which was statistically at par with use of tembotrione W_2 (5318.33kg/ha). However, the least grain yield was obtained under weedy check plot W_4 (4586.67kg/ha), where weed control was not done (Table 3). When weed growth is reduced the crop plant has better growth and yield. Similar results were supported by Mitra *et al.* (2018).

Stover yield

The stover yield is presented in the Table 3. Maximum stover yield was recorded from conventional tillage (8730.50 kg/ha) which was statistically at par with T_2 (8677.92 kg/ha). Maize crop grown with zero tillage produced the least yield (4727.75 kg/ha). Maximum stover yield was obtained from W_1 treatment (8915.22 kg/ha) which was superior over other weed management practices. Stover yield was least in weedy check with stover yield of only7745.3 kg/ha.

Economics

Production economics is the main deciding factor for adoption of a technology by the farmers. New technology aims at reducing the cost of cultivation with increasing yield, more net return and higher B:C ratio (Table 4). Maximum cost of cultivation was recorded with conventional tillage (Rs 56800) fb zero tillage+ mulching (Rs 52220) and zero tillage (Rs 48000).The gross return was highest when maize was grown with conventional tillage (Rs 115818) followed by zero tillage+ mulching (Rs 114525) and only zero tillage (Rs 102579). The net returns were highest when maize was grown with zero tillage with mulching (Rs 62305). Highest benefit cost ratio (2.19) was reported from plots where maize was grown in zero tillage + mulching. B:C was least (2.04) in conventional tillage. A similar finding was also supported by Stanzen *et al.* (2016).

In weed management practice, cost of cultivation was maximum with hand weeding (Rs 40630) fb use of tembotrione (Rs 40500) fb pendimethalin (Rs 38690) and minimum in weedy check (Rs37200). The gross return was highest when pendimethalin (Rs119352) was used to control weeds, but was lowest in weedy check (Rs 99479). In weed management practice use of pendimethalin (Rs 80662) to control weeds recorded highest net returns. The net returns were minimum in weedy check (Rs 62279). In weed management practices, highest B:C was recorded in plots where pendimethalin (3.09) was used to control

weeds. Least B:C was reported from where weedy check plot (2.67).Similar findings were supported by Triveni *et al.* (2017) and Mitra *et al*.(2018).

CONCLUSION

It was revealed from the effect of tillage and weed management practices on grain yield of maize that maximum grain yield was produced from the conventional tillage and pre-emergence application of herbicide pendimethalin 1kg/ha but was at par with the zero tillage + mulching along with pendimethalin application or post emergence tembotrione herbicide application. However, keeping in view the economics of maize production (B:C), zero tillage with rice straw mulching (5t/ha) along with pre-emergence application of the herbicide pendimethalin 1kg /ha was found to be the best treatment with grain yield of 5641.67kg/ha and the highest B:C ratio. Hence, zero tillage practice along with rice straw mulching (5t/ha) and pre-emergence application of herbicide pendimethalin 1kg/ha proved to be the best treatment and a better option for growing *rabi* maize under East and South Eastern Coastal Plain Zone of Odisha.

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