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Growth, yield, weed control efficiency and economics of sweet corn as influenced by integrated weed management practices under varying tillage practices

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Abstract

A field experiment entitled “Integrated weed management in sweet corn under different tillage practices” was conducted during rabi season of 2021-22 at Agronomy Main Research Farm, Department of Agronomy, College of Agriculture, OUAT, Bhubaneswar. The experiment was laid out in a strip plot design with three replications. Three tillage treatments were assigned to the main plot viz., T₁-conventional tillage (CT), T₂-zero tillage by dibbling (ZT) and T₃- zero tillage+mulching with paddy straw @5 t/ha (ZT+M) and four weed management practices viz., W₁- Pendimethalin and atrazine @0.5 kg/ha (Pre-emergence), W₂-Pendimethalin and atrazine @0.5 kg/ha (Pre-emergence) fb one manual weeding 30 DAS, W₃-Manual weeding at 30 DAS and W₄-Weedy check. 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 6.3 g/kg, available nitrogen 218.32 kg/ha, phosphorus 21.31 kg/ha and potassium 127.29 kg/ha. The sweet corn variety “Sugar 75” was grown as the test crop. Among the tillage practices, zero tillage +mulching was the best treatment. Among the weed management methods Pendimethalin and atrazine @0.5 kg /ha (Pre-emergence) fb one manual weeding 30 DAS was found to be the best. It recorded lowest weed density (46.81 no./m²). The interaction plot zero tillage+ mulching supplemented with Pendimethalin and atrazine @0.5 kg/ha (Pre-emergence) fb one manual weeding 30 DAS had the least weed density at 60 DAS (39.08 no/m²), least weed dry weight (19.3 g/m² at 60 DAS), highest weed control efficiency (66.1% at harvest. It also resulted in better plant characters such as plant height (179.0 cm), LAI of 4.98 at 60 DAS, fresh cob yield of 18.20 t/ha and green fodder yield of 31 t/ha. Zero tillage practice along with rice straw mulching @5 t/ha and pre emergence application of herbicide Pendimethalin and atrazine @ 0.5 kg/ha fb one manual weeding 30 DAS resulted in highest net return of Rs 176000/ha and maximum B:C ratio (3.01), hence proved as the best treatment among all.

Keywords: Sweet corn, integrated weed management, zero tillage, mulching

Introduction

Maize (*Zea mays* L.), the queen of cereals also known as corn is the third most important cereal crop after rice and wheat. Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice. In addition to being consumed directly by humans (often in the form of masa), maize is also used for ethanol, animal feed and other products, such as corn starch and corn syrup. The six major types of maize are dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn. Sugar-rich varieties called sweet corn are usually grown for human consumption as kernels, while field corn varieties are used for animal feed, various corn-based human food uses (including grinding into cornmeal or masa, pressing into corn oil, fermentation and distillation into alcoholic beverages like bourbon whiskey), and as feeds stocks for the chemical industry. Maize is also used in making ethanol and other biofuels and is the most adaptable crop, being produced in over 166 nations across the world in tropical, subtropical, and temperate climates from sea level to 3000 meters above sea level. After rice and wheat, maize is the third most significant crop for human consumption, accounting for almost 9% of India's food basket and 5% of the world's dietary energy supply. Its output has grown more than 12 times since 1950-51, from 1.73 million tonnes to 21.73 million tonnes in 2010-11, and it now covers 8.55 million hectares with a mean yield of 2.54 tons/hectare.

Despite the fact that 75% of maize land is rain fed and minimal input, and is subject to the whims of the monsoon, this performance is extraordinary. In India, maize consumption is expected to continue to rise due to rising demand in the poultry and cattle industries, as well as a growing non-vegetarian population and changing eating preferences. In the face of rising demand, increasing maize production in the future years across all growing regions in India would be a major challenge in the age of climate change. Maize is cultivated in Odisha in around 2.52 lakh hectares of land. Odisha is not a traditional maize growing state in the country, but it has recently caught up in cereal farming. Odisha has a total area under maize of 0.56 lakh hectares, with an average output and productivity of 0.11 million tonnes and 1.9 tonnes per hectare, respectively. It is mostly produced in Odisha's southern regions during the kharif season to meet the needs of the state's agro-based businesses and even neighbouring states. Sweet corn (*Zea mays* convar. *saccharata* var. *rugosa*, also called, sugar corn and pole corn, is a special type of maize with a high sugar content. It also serves as a raw material for deriving large number of industrial products such as starch syrup, dextrose and dextrin etc. Thus sweet corn with varied uses has a great potential in export as well as domestic market. Sweet corn matures early and green ears can be harvested in 75-80 days after planting. The left over stalk can serve as useful fodder for the livestock. Thus it can fit easily in multiple or inter cropping systems. The critical period of crop-weed competition and weed threshold are two important aspects in a weed management programme. The critical period may be defined as the time period after crop emergence during which crop must be kept weed-free to prevent yield losses, described as losses greater than 5% in earlier studies. Likewise, weed threshold, defined as the weed density above an acceptable count, provides an opportunity to decide the right time to take appropriate control measures to avoid yield loss. Maize is traditionally seeded by seed drill after 2-3 tillage operations. Growing these crops traditionally has been a time-consuming, expensive, and arduous process. Conventional tillage techniques increase the cost of energy and labour in the agricultural production system, resulting in poorer economic returns. The absence of appropriate moisture in the seed zone is a key limitation for growing crops in water scarcity areas. Straw mulching is one of the most significant techniques for reducing soil erosion, increasing in situ soil moisture conservation, and increasing crop production. Maize is produced by hand dibbling following rigorous 5-6 tillage operations, which delays maize seeding by as least 2- 3 weeks in a normal rice-maize system. The frequency of recurrent tillage operations raises both cost of cultivation and amount of gasoline consumed. Dibbling necessitates a considerable amount of labour, which raises the expense of cultivation even more. New agronomic management methods based on conservation agriculture (CA) offer a solution to these problems. CA has tremendous potential for different farms and agro-ecological systems, but small landholders are likely to need it the most. Direct seeded maize in no-till/strip till/permanent beds is an alternative option that may be planted in a single pass using automated precision planting. Zero- tillage technology has become a huge success story, and it appears to

be one of the finest technologies developed since the green revolution. Basing on the above facts the present field experiment was designed to test performance of maize under different tillage systems when different herbicides in combination with manual weeding are taken as weed control measures.

Materials and Methods

A field experiment was conducted at the Agronomy Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar during the *rabi* season of 2021 -22. 3.3 Soil characteristics of the site Prior to the start of experiment (*rabi*, 2021- 2022) three composite soil samples were collected (0- 15 cm) from each replications and were air dried, ground, passed through 2 mm sieve and analyzed for their physico-chemical properties by the standard methods. It was revealed from the data that soil of the experimental field was sandy loam in texture, slightly acidic (5.65) in reaction, medium in available nitrogen(218.32kg/ha), available phosphorus(21.31kg/ha) and available potassium(127.29kg/ha). The sweetcorn variety Sugar 75 was sown on 21 st November in rows, 50 cm apart (row spacing) at plant to plant distance of 30 cm with the seed rate of 12 kg/ha. Zero tillage with raised seed bed sowing was done with power tiller drawn zero till maize planter. All the plots were supplied with uniform application of 120 kg nitrogen, 60 kg phosphorus and 60 kg potassium through urea (46% N), single super phosphate (16% P₂O₅) and muricate of potash (60% K₂ O), respectively. Half nitrogen and full dose of phosphorus and potassium was applied as basal dose and remaining half of nitrogen was applied in two equal splits at knee-high and pre-tasselling stages. The basal dose of fertilizer in zero tillage plots and in zero tillage + mulching was drilled with zero tillage maize planter drill, while in conventional tillage plots basal dose was placed below the seed in the open furrows made by hand operated plough. The two splits of nitrogen were given by placing fertilizer by the sides of maize rows avoiding direct contact with plants. The maize crop was harvested at the time when cob sheath turned brown and the grains were hard. The harvesting was done manually by picking the cobs from the plants of each net plot separately by leaving one row on borders and 20 cm from each side of the plot. The harvesting was done on 12th February, 2022 Weed control efficiency of different treatments was worked out at maximum weed dry matter as per the formula.

$$WCE (\%) = (W_c - W_t) / W_c \times 100$$

Where, W_c - Weed dry weight (g/m²) in control plot
 W_t - Weed dry weight (g/m²) in treated plot

The data obtained on various characters were analysed statistically by following standard analysis of variance technique (ANOVA) for strip plot design (Gomez and Gomez, 1984) [7]. The treatment variations were tested for significance by F- test. The standard error of mean and critical difference at % probability level were calculated to interpreted the results.

Table 1: Effect of tillage and integrated weed management practices on growth, yield attributes and WCE (%) of sweet corn

Treatments	Max plant height at harvest(cm)	Max LAI at 60 DAS	Max dry matter accumulation at harvest(g/plant)	Cob length (cm)	Cob girth (cm)	Rows/cob	Weed Control Efficiency (WCE) %
Tillage practices							
T ₁ -conventional tillage (CT)	173.4	4.28	196.41	20.38	14.38	14.4	31.4
T ₂ -Zero tillage (ZT)	171.1	4.39	213.84	20.61	15.05	14.6	34.4
T ₃ -zero tillage+mulching (ZT+M)	174.2	4.57	225.48	21.42	15.10	14.9	33.4
S.Em+ _—	0.18	0.02	0.547	0.12	0.11	0.56	-
CD(p=0.05)	0.42	0.08	1.948	0.46	0.41	NS	-
Weed management practices							
W1-Pendimethalin (pre) @0.5 kg/ha+ Atrazine (pre) @0.5 kg/ha+Atrazine (pre) @0.5 kg/ha	176.8	4.85	230.82	21.04	15.08	14.6	34.7
W2-Atrazine@0.5 kg/ha+pendimethalin @0.5 kg/ha fb 1 manual weeding at 30 DAS	179.0	4.98	243.99	21.36	15.19	14.7	64.4
W3-1 Manual weeding 30 DAS	175.2	4.80	202.29	20.07	15.02	14.6	33.2
W4- Weedy check	161.5	2.99	151.54	16.50	12.69	14.4	0.00
S.Em+ _—	0.61	0.02	0.52	0.14	0.11	0.14	-
CD(p=0.05)	1.81	0.05	1.56	0.41	0.34	0.42	-

Table 2: Effect of tillage and weed management practices on cob yield, green fodder and economics of sweetcorn

Treatments	Fresh kernel yield (t/ha)	Fresh cob yield(t/ha)	Green fodder yield (t/ha)	Harvest index (%)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
Tillage practices							
T ₁ -conventional tillage (CT)	6.13	12.18	24.42	34.97	137012	124800	1.75
T ₂ -Zero tillage (ZT)	6.58	13.23	25.32	36.19	144912	132250	2.06
T ₃ -zero tillage+mulching (ZT+M)	7.01	14.85	25.87	36.47	113275	141500	2.18
S.Em+ _—	0.156	0.352	0.581	0.022			
CD(p=0.05)	0.46	0.95	1.66	0.66			
Weed management practices							
W1-Pendimethalin (pre) @0.5 kg/ha+ Atrazine(pre) @0.5 kg/ha+Atrazine (pre) @0.5 kg/ha	7.80	16.71	28.46	36.90	184733	167166	2.51
W2-Atrazine @0.5 kg/ha +pendimethalin @0.5 kg/ha fb 1 manual weeding at 30 DAS	8.25	17.88	29.96	37.37	145523	174266	2.66
W3-1 Manual weeding 30 DAS	6.30	12.70	25.83	32.96	139916	127000	1.18
W4- Weedy check	3.04	6.30	16.56	21.56	71250	71250	0.99
S.Em+ _—	0.166	0.372	0.581	0.024			
CD(p=0.05)	0.49	1.11	1.72	0.07			

Results and Discussion

Growth parameters

The plant height of maize increased rapidly up to 60 DAS and there after increased gradually till harvest. Maximum plant height was noticed under conventional tillage (173.4cm at harvest) and among weed treatments plant height was maximum in plots treated with pendimethalin and atrazine followed by 1 manual weeding 30 DAS (179.0 cm at harvest). 7. The plant dry matter increased rapidly up to 60 DAS and there after increased gradually up to harvest. At harvest, maximum dry matter production (225.48 g/plant) was recorded in zero tillage with mulching practice. Minimum dry matter accumulation (196.41 g/plant) was found with conventional tillage. At harvest, maximum dry matter accumulation (261.60 g/plant) was obtained when pendimethalin with atrazine followed by one hand weeding was used to control weeds. However, dry matter accumulation in maize was the least (151.54 g/plant) under weedy check (W4). 8. Plant growth parameters like LAI and number of functional green leaves were significantly affected by the treatments. The LAI increased robustly up to 60 DAS and there after decreased up to harvest. Maximum LAI (4.57) was recorded at 60 DAS when sweet corn was grown in zero tillage with mulching. Maximum LAI (4.98) was recorded when pendimethalin along with atrazine as pre emergence application

77 followed by 1 manual weeding was used to control weeds in sweet corn. The number of green leaves per plant at 90 DAS was found maximum with ZT+mulching(15.10) but statistically at par with the leaf number in ZT(15.05) and least in conventional tillage (14.85).In weed management practice, more number of leaves per plant were recorded with application of atrazine and pendimethalin fb one manual weeding 30 DAS, W2(15.67) but was at par with W1(15.25) followed by W3(14.73) and least in weedy check(11.53) 9. Highest cob yield was obtained from W2(17.88t/ha) when pendamethalin along with atrazine was used as pre-emergence application fb one manual weeding 30DAS to control weeds followed by W1, application of atrazine and pendimethalin (16.71/ha). However, the least grain yield was obtained under weedy check plot, W4(6.30t/ha) where weed control was not done (Table-1).

Yield and yield attributing characters

maximum cob length (21.42 cm) was registered from the treatment T₃ and minimum in T₁ (conventional tillage) which is 20.38 Maximum cob length was recorded from W2 (21.36 cm) which was statistically at par with W1(21.04 cm). Maximum cob girth was recorded from ZT+M (15.10 cm) but was statistically at par with zero tillage and minimum in conventional tillage. Cob girth was maximum (15.19 cm) from W2 but W1 and W3

are statistically at par. Maximum no. of rows/cob was observed in T_1 (14.9) but was statistically on a par with T_2 treatment (14.6) and minimum in T_1 (14.4). Maximum grain yield was recorded from ZT+M, T_3 (7.01 t/ha) followed by zero tillage (6.58t/ha) which was statistically at par with conventional tillage, T_1 (6.13/ha). Highest grain yield was obtained from W2 (8.25 t/ha) when Pendimethalin along with atrazine is was used as pre-emergence application fb 1 manual weeding at 30DAS to control weeds and the least grain yield was obtained under weedy check plot W4 (3.04t/ha), where weed control was not done. Maximum fresh cob yield was obtained from ZT+M (14.15 t/ha) in tillage practices followed by T_2 (ZT) 13.22t/ha and T_1 (CT) 12.41t/ha. Among the weed management practices highest yield was in W2 (17.30t/ha) followed by W1 (16.71t/ha) and W3 (12.7t/ha) respectively and least in W4 (6.3t/ha). Maximum grain fodder yield was recorded from ZT+M (24.42t/ha) and minimum from conventional tillage (24.42t/ha) which is statistically at par with T_2 (25.32t/ha). Among the weed management practices W2 produced the highest yield (29.96t/ha) followed by W1 (28.46) and W3 (25.83) respectively and least in W4 (16.56) (Table-2)

Economics

The net return and B:C ratio (2.18) were highest in T_3 -zero tillage+mulching (ZT+M). Similarly, among the weed management practices, spraying with Atrazine@0.5 kg/ha+pendimethalin@0.5 kg/ha fb 1 manual weeding at 30DAS recorded maximum net return and B:C ratio (2.66).

Conclusion

It was revealed from the interaction effect of tillage and weed management practices on yield of sweet corn that maximum cob yield of 18.2t/ha was produced from the interaction plot having combined effect of Zero Tillage+Mulching supplemented with pre emergence application of herbicide Pendimethalin @0.5 kg/ha and atrazine@0.5 kg/ha fb 1 manual weeding 30 DAS, followed by the cob yield 17.6t/ha obtained from zero tillage and mulching with atrazine@0.5 kg/ha and Pendimethalin@ 0.5 kg/ha, and 17.5 t/ha obtained from zero tillage with the pre emergence application of the herbicide Pendimethalin @0.5 kg/ha and atrazine@0.5 kg/ha fb 1 manual weeding 30 DAS. However, keeping in view, the economics of maize production (B:C), zero tillage with rice straw mulching (5 t/ha) i.e., ZT+M and pre emergence application of the herbicide Pendimethalin @0.5 kg/ha and atrazine @0.5 kg/ha fb 1 manual weeding 30 DAS was found to be the best treatment with cob and green fodder yield with the highest B:C ratio. Zero tillage with mulching also had favourable effect on soil micro organisms. Hence, zero tillage practice along with rice straw mulching (5 t/ha) and pre emergence application of herbicide Pendimethalin @0.5 kg/ha and atrazine@0.5 kg/ha fb 1 manual weeding 30 DAS 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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