International Journal of Environment and Climate Change

Volume 14, Issue 7, Page 296-307, 2024; Article no.IJECC.119471
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Influence of Different Tillage Practices, Irrigation and Nitrogen Levels on Yield and Economics of Rice Fallow Maize

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijecc/2024/v14i74271

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/119471

Original Research Article

Received: 01/05/2024
Accepted: 02/07/2024
Published: 04/07/2024

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Cite as: *Harshitha, Ganta, G. Sreenivas, N. Mahesh, K. Chandrashekhar, Anima Biswal, and P. Srikanth. 2024. "Influence of Different Tillage Practices, Irrigation and Nitrogen Levels on Yield and Economics of Rice Fallow Maize". International Journal of Environment and Climate Change 14 (7):296-307. https://doi.org/10.9734/ijecc/2024/v14i74271.*

ABSTRACT

This experiment was conducted to study the effect of different tillage practices, irrigation schedules and nitrogen levels on the grain yield, stalk yield, harvest index and economics of *rabi* maize in rice fallows. The design selected for this study was Split- split plot design. This experiment was conducted at Regional Agricultural Research Station farm, Polasa, Jagtial during *rabi* 2022 and 2023. The experiment was laid out in split- split plot design with twelve treatment combinations which are replicated thrice. The treatments are two main plots: T_1- Zero tillage, T_2- Conventional tillage (cultivator twice *fb* rotovator twice); three sub plots: I_1- 60% ASM, I_2- 40% ASM and I_3- Irrigation at six critical stages; and two sub-sub plot treatments: N_1- 100% RDN and N_2- 120% RDN. Results indicated that higher grain yield, stalk yield, gross returns, net returns and B-C ratio were higher in conventional tillage among the two tillage practices, in I_3 treatment among the three irrigation schedules and in N_2 (120% RDN) among the two nitrogen levels. The lowest values were recorded with zero tillage, I_2 treatment and N_1 (100% RDN). Harvest index was significantly effected by tillage practices but it is non-significant with irrigation schedules and nitrogen levels.

Keywords: Economics; harvest index; irrigation; maize; nitrogen; tillage; yield.

1. INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat, popularly called as the queen of cereals, grown in diverse climatic conditions in India. It is a major cereal crop for livestock feed, fuel, fodder and human nutrition across the world. Globally, 1214.47 million metric tons of maize is produced which is consumed mostly as feed (61%), food (17%), and industrial raw material (22%). In India, 35.5 million metric tons of maize is produced from 10.4 million hectares area with a productivity of 3.41 t ha^{-1}. Though rainy (*kharif*) season maize accounts for 83% of the total maize-growing areas in India, the productivity is very low (2,706 kg ha^{-1}) in comparison to the winter (*rabi*) maize productivity of 4,436 kg ha^{-1} (iimr.icar.gov.in/india-maize scenario). This low productivity of rainy season maize is due to the different types of stresses. In Telangana maize is grown in an area of 5.48 lakh acres with production of 28.80 lakh tons and productivity of 3174 kg ha^{-1}, respectively [1]. Maize plays a significant role in animal feed and human nutrition, as the main source of both energy and protein [2-5].

Conservation agriculture (CA) is considered as a viable option for sustainable intensification of rice-based cropping systems for profitable production. Conservation tillage is defined as a tillage system in which at least 30% of crop residues are left in the field and is an important conservation practice to reduce soil erosion. In recent years farmer are shifting towards no-tillage systems for growing second crop in rice fallows aimed at reducing and/or reverting many negative effects of conventional farming practices such as soil erosion and decline in soil organic matter. Also, to reduce soil compaction, water loss, soil physical degradation and fuel use. Tillage operation is also concerned in many ways with the adjustment of the soil moisture content to meet the needs of the crop [6]. Tillage operation and soil disturbance results in an increased soil aeration, residue decomposition, organic N mineralization, and the availability of N for plant use. In contrast, zero tillage can cause minimal soil disturbance and increase the buildup of surface residue, which may increase both N immobilization and N losses by leaching and denitrification [7].

Maize is very sensitive to water and other environmental stresses, particularly one week before flowering to two weeks after flowering. Further the water stress occurring at different crop developmental stages could potentially limit biomass accumulation and consequently reduce grain yield of the maize crop. The adoption of appropriate irrigation scheduling practices could lead to increased yields and greater profit for farmers, significant water savings, reduced environmental impacts of irrigation and improved sustainability of irrigated agriculture [8]. Irrigation scheduling is an important irrigation management issues for maximizing production efficiency. It involves determining the proper amount and timing of water applications throughout the growing season.

Out of the three major nutrients (NPK), application of nitrogen fertilizer brings out yield increment in maize. Maize being an important cereal, requires huge quantities of nitrogen due to its high yield potential. Time-specific nitrogen applications are aimed to provide maize with nutrients when needed, in other case its deficiency can cause inevitable yield-loss. Nitrogen fertilization plays a significant role in improving soil fertility and increasing crop productivity. Moreover, N fertilization contributes to increase soil residual N contents. Several factors including tillage intensity, crop rotation and irrigation often influenced soil N cycling [9].

2. MATERIALS AND METHODS

The present experiment was conducted at Regional Agricultural Research Station farm, Polasa, Jagtial duing *Rabi* 2022 and 2023. It is geographically situated between 18º49¹40¹¹ N latitude, 78º56¹45¹¹ E longitude and at an altitude of 243.4 m above mean sea level and falls under Northern Telangana Agro-Climatic Zone. The soil of experimental plot was sandy loamy and slightly alkaline (pH 7.42), with available nitrogen (150.2 kg ha^{-1}), phosphorus (48.6 kg ha^{-1}) and potassium (403 kg ha^{-1}) contents. The total rainfall received during the crop growth period was 24.8 mm in 1 rainy day during *rabi* 2022 and 3.5 mm during *rabi* 2023. To conduct the experiment ‘‘Identification of agronomic strategies under different tillage practices to enhance yield for *rabi* maize in rice fallows at mandal level using RS and DSSAT Model” split-split plot design was used with two main plot, three sub plot and two sub-sub plot treatments which are replicated thrice. The experimental field was laid out in 36 unit plots, each plot measuring 30 m^2 (6.0m x 5.0m). There were ten rows of maize crop in each plot and twenty-five plants in each row. One row of crop from both sides of length and also both sides of breadth were left as guard rows. The net plot consisted of eight rows with twenty-three plants per row (4.8m x 4.6m). Seeds of maize variety DHM-117 were sown with the seed rate of 20 kg ha^{-1} (83333 plants ha^{-1}), and spacing of 60 cm between the rows and 20 cm between the plants.

For the tillage practices as main plot treatments, no field preparation was done for zero tillage treatment (T_1) plots and in the conventional tillage treatment (T_2) plots, field was ploughed twice with tractor drawn cultivator followed by two runs of tractor drawn rotovator. Individual plots were laid out manually and levelled. For sub plot treatments (irrigation schedules) crop was irrigated after sowing for better germination and crop stand. Thereafter crop was irrigated according the treatment schedules based on different depletion levels. The treatments were I_1: Irrigation at 60%, I_2: Irrigation at 40% ASM and I_3: Irrigation at 6 critical stages (sixth leaf, crop development, tasselling and silking, grain filling, soft dough and hard dough stage). For sub-sub plot treatments, recommended dose of fertilizer i.e. 100 % RDN (240:80:80 kg ha^{-1} N: P_2O_5: K_2O) was applied to N_1 treatment plots and 120 % RDN (288:80:80 kg ha^{-1} N: P_2O_5: K_2O) was applied to N_2 treatment plots. Urea, SSP, MOP were used as the source of nutrients. Entire dosage of phosphorus, half dose of potassium and ¼ th dose of the nitrogen was applied as basal application at the time of sowing. Half of the nitrogen dose was top dressed as band placement at 6 th leaf stage of the crop. The remaining ¼ th dose of nitrogen and half dose of potassium was applied at the silking stage.

Timely recommended plant protection measures for maize were followed to save the crop from pests and diseases. The maize crop was harvested manually. Different growth and yield components were recorded periodically. Data obtained from various parameters under study were analysed by the method of analysis of variance (ANOVA) as described by Gomez and Gomez [10]. The level of significance used in the “F” test was given at 5 per cent.

The prices of the inputs prevailed in local market during experimentation were considered for working out the cost of cultivation of Maize. The gross returns were calculated using the yield of maize and the market price of the produce at the time of marketing. The net returns per hectare were calculated by deducting the cost of cultivation per hectare from the gross returns per hectare.

$$\text{Net monetary return} = \text{Gross monetary return} - \text{Total cost of cultivation} \quad (1)$$

Benefit cost ratio was worked out for each treatment by using the formula given by Subba Reddy and Raghu ram [11].

$$\text{Benefit cost ratio} = \text{Gross returns (₹ ha}^{-1}) \,/\, \text{Cost of cultivation (₹ ha}^{-1}) \quad (2)$$

- * Market price of maize grain is Rs. 1962 per quintal in *rabi* 2022 and Rs. 2090 per quintal in *rabi* 2023. Price of maize stover is Rs. 100 per quintal during both seasons.

3. RESULTS AND DISCUSSION

3.1 Grain Yield (kg ha^{-1})

Grain yield (kg ha^{-1}) of rice fallow maize was significantly influenced by different agronomic practices (Table 1). Influence of tillage practices on grain yield was significant during both 2022 and 2023. Conventional tillage practice has recorded significantly higher grain yield compared to zero tillage practice. The yield recorded in conventional tillage was 7316 and 7982 kg ha^{-1} and that of zero tillage was 5575 and 6128 kg ha^{-1} during 2022 and 2023 respectively. The lower grain yield of maize in zero tillage is be due to the greater immobilization of nitrogen and leaching of NO_3 causing lower availability for corn growth which subsequently reduced grain yield compared with conventional tillage Thomas et al. [12] Jones et al. [13] noted that the primary factor that's causing increase in yield in conventional tillage is increase in soil moisture in the root zone. The lower grain yield with zero tillage probably resulted from the slow early crop growth compared with the conventional tillage system [14].

Influence of irrigation schedules on grain yield has shown a significant effect during both 2022 and 2023 (Table 1). It was recorded higher in I_3 treatment where irrigation was scheduled at six critical stages (6802 and 7349 kg ha^{-1}), followed by I_1 (60 % ASM) and the lowest yield was recorded in I_2 (40 % ASM) which is 6054 and 6639 kg ha^{-1} during 2022 and 2023 respectively. Increased number of irrigations has increased the photosynthetic efficiency and uptake of nutrients from soil which resulted in increase in the production of more number of grains along with improving the test weight. This avoided the growth of crop in stressed conditions which lead to the increased grain yield when crop is irrigated at critical stages. Gouranga Kar and Ashwani Kumar [15] reported the similar results on increase of yield with increased number of irrigations.

Influence of nitrogen dosages on grain yield was significant during 2022 and 2023 seasons (Table 1). N_2 (120% RDN) has recorded significantly higher stalk yield compared to N_1 (100% RDN). The yield recorded was 6622 and 7250 kg ha^{-1} in N_2 treatment which are significantly higher than N_1 (6270 and 6860 kg ha^{-1}) during 2022 and 2023 respectively. As there are nitrogen losses due to immobilisation of nitrogen in rice fallows, maize requires a higher dosage of nitrogen to improve the yield. Hence, the application of 120 % RDN has balanced the deficiency of nitrogen required for crop growth and resulted in increase of the grain yield. Similar evidences were reported by Malla reddy et al. [16] and Khalid Usman et al. [17].

During the both years of experimentation (2022 and 2023), the interaction effect of irrigation and nitrogen on grain yield was found significant (Table 4 and 5). Among the different levels of irrigation and nitrogen levels, the combination of I_3 treatment (irrigation at critical stages) with N_2 (120% RDN) has shown the highest grain yield of 7357 and 8035 kg ha^{-1} during 2022 and 2023 respectively. All the other two- way interactions and three-way interaction was found to be non-significant during both years. Water and nitrogen are the two major factors that are required to achieve higher yield potential of maize. Hence, optimization of these inputs provides better conditions for growth and development of crop. Efficient utilization of applied nitrogen depends upon the presence of adequate moisture content in the root zone. Under optimum soil moisture conditions grain yield has shown an increase with increase in nitrogen dosage. Whereas when the crop is under moisture stress, the increase in nitrogen has resulted in decrease of grain yield because of the decrease in biomass accumulation. Pandey et al. [18] has conducted an experiment on effect of different doses of nitrogen in maize crop under deficit irrigation conditions and reported that the greatest reduction in yield per 100 mm of deficit irrigation was with the application of 160 kg ha^{-1} of nitrogen and the least reduction in grain yield was with zero N treatment.

3.2 Stalk Yield (kg ha^{-1})

Stalk yield (kg ha^{-1}) of rice fallow maize was significantly influenced by different agronomic practices and the results are presented in Table 1. Impact of tillage practices on stalk yield was significant during both 2022 and 2023. Conventional tillage practice has recorded significantly higher stalk yield compared to zero tillage practice. The yield recorded in conventional tillage was 9040 and 9497 kg ha^{-1} and that of zero tillage was 7387 and 7811 kg ha^{-1} during 2022 and 2023 respectively. Lower stalk yield under zero tillage was due to poor uptake of nutrients from soil by the plant due to lesser root growth which is caused by the compaction of soil. Improved soil aeration in conventional tillage has increased the emergence percentage of maize along with plant height and photosynthetic area which resulted in higher stalk yield. These results align with the findings of Weisskopf and Anken [19] in fodder maize.

Table 1. Grain yield, stalk yield and harvest index as influenced by different agronomic practices in rice fallow maize

Treatment	Grain yield (kg ha^{-1})		Stalk yield (kg ha^{-1})		Harvest index (%)	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**
Tillage practices						
T_1: Zero tillage	5575	6128	7387	7811	42.9	43.9
T_2: Conventional tillage	7316	7982	9040	9497	44.7	45.6
SEm±	60	53	42	46	0.29	0.12
CD (P=0.05)	371	329	261	281	1.74	0.75
Irrigation schedules						
I_1: 60 % ASM	6481	7086	8250	8684	43.8	44.8
I_2: 40 % ASM	6054	6639	7840	8264	43.4	44.4
I_3: At critical stages	6802	7439	8550	9014	44.2	45.1
SEm±	74	66	66	85	0.38	0.31
CD (P=0.05)	240	214	215	277	NS	NS
Nitrogen levels						
N_1: 100% RDN	6270	6860	8042	8460	43.7	44.7
N_2: 120% RDN	6622	7250	8385	8848	43.9	44.9
SEm±	51	50	45	57	0.24	0.20
CD (P=0.05)	157	153	139	175	NS	NS
Interaction	S	S	S	S	NS	NS

Table 2. Interaction effect of different agronomic practices on grain and stalk yield (kg ha^{-1}) in rice fallow maize during *rabi*, 2022

	Grain yield			Stalk yield		
I*N	**N_1**	**N_2**	**Mean**	**N_1**	**N_2**	**Mean**
I_1	5989	6973	6481	7778	8722	8250
I_2	6572	5535	6054	8331	7349	7840
I_3	6248	7357	6802	8018	9084	8550
Mean	6270	6622		8042	8385	
	SEm±	**CD (P=0.05)**		**SEm±**	**CD (P=0.05)**	
Factor(T)	60	371		42	261	
Factor(I)	74	240		66	215	
T X I	104	NS		93	NS	
Factor(N)	51	157		45	139	
T X N	72	NS		64	NS	
I X N	88	271		78	241	
T X I X N	124	NS		110	NS	

Table 3. Interaction effect of different agronomic practices on grain and stalk yield (kg ha^{-1}) in rice fallow maize during *rabi*, 2023

	Grain yield			Stalk yield		
I*N	**N_1**	**N_2**	**Mean**	**N_1**	**N_2**	**Mean**
I_1	6552	7621	7086	8152	9216	8684
I_2	7186	6091	6639	8786	7742	8264
I_3	6844	8035	7439	8443	9585	9014
Mean	6860	7250		8460	8848	
	SEm±	**CD (P=0.05)**		**SEm±**	**CD (P=0.05)**	
Factor(T)	53	329		46	281	
Factor(I)	66	214		85	277	
T X I	93	NS		120	NS	
Factor(N)	50	153		57	175	
T X N	70	NS		80	NS	
I X N	86	265		98	302	
T X I X N	122	NS		139	NS	

I_1: 60 % ASM, I_2: 40 % ASM, I_3: At critical stages, N_1: 100% RDN, N_2: 120% RDN

Table 4. Influence of different agronomic practices on the cost of cultivation and gross returns of rice fallow maize

Treatment	Cost of cultivation (₹ ha^{-1})			Gross returns (₹ ha^{-1})		
	2022	2023	Mean	2022	2023	Mean
Tillage practices						
T_1: Zero tillage	43567	43067	43317	116774	135879	126326
T_2: Conventional tillage	52911	52411	52661	152579	176317	164448
SEm±	-	-	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-
Irrigation schedules						
I_1: 60 % ASM	48739	48239	48489	135404	156787	146095
I_2: 40 % ASM	46739	46239	46489	126616	147014	136815
I_3: At critical stages	49239	48739	48989	142009	164494	153251
SEm±	-	-	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-
Nitrogen levels						
N_1: 100% RDN	48102	47602	47852	131054	151841	141447
N_2: 120% RDN	48376	47876	48126	138299	160355	149327
SEm±	-	-	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-

Table 5. Influence of different agronomic practices on the net returns and B-C Ratio of rice fallow maize

Treatment	Net returns (₹ ha^{-1})			B-C Ratio		
	2022	2023	Mean	2022	2023	Mean
Tillage practices						
T_1: Zero tillage	73207	92812	83009	2.68	3.15	2.91
T_2: Conventional tillage	99668	123906	111787	2.88	3.36	3.12
SEm±	1165	1152	-	0.02	0.03	-
CD (P=0.05)	7089	7008	-	0.15	0.15	-
Irrigation schedules						
I_1: 60 % ASM	86665	108548	97606	2.77	3.24	3.01
I_2: 40 % ASM	79877	100775	90326	2.70	3.17	2.93
I_3: At critical stages	92770	115755	100564	2.88	3.37	3.13
SEm±	1427	1392	-	0.02	0.02	-

Treatment	Net returns (₹ ha^{-1})			B-C Ratio		
	2022	**2023**	**Mean**	**2022**	**2023**	**Mean**
CD (P=0.05)	4654	4539	-	0.06	0.06	-
Nitrogen levels						
N_1: 100% RDN	82952	104239	93595	2.72	3.18	2.95
N_2: 120% RDN	89923	112479	101201	2.84	3.33	3.08
SEm±	998	1053	-	0.02	0.02	-
CD (P=0.05)	3075	3244	-	0.07	0.06	-

All 2 - way and 3 - way interactions are Non-significant

Impact of irrigation schedules on stalk yield has shown a significant effect during both 2022 and 2023 (Table 1). It was recorded higher in I_3 treatment where irrigation was scheduled at six critical stages (8550 and 9014 kg ha^{-1}), followed by I_1 (60 % ASM) and the lowest yield was recorded in I_2 (40 % ASM) which is 7840 and 8264 kg ha^{-1} during 2022 and 2023 respectively. Higher stalk yield occurred with irrigation at critical stages (I_3) is due to frequent irrigations which provided adequate moisture at top layers of soil where most of the maize roots were spread, preventing the crop from the moisture stress. Padmaj et al. [20] studied the irrigation schedules and reported the similar results in maize.

Influence of nitrogen dosages on stalk yield was significant during 2022 and 2023 seasons (Table 1). N_2 (120% RDN) has recorded significantly higher stalk yield compared to N_1 (100% RDN). The yield recorded was 8385 and 8848 kg ha^{-1} in N_2 treatment which are significantly higher than N_1 (8042 and 8460 kg ha^{-1}) during 2022 and 2023 respectively. Higher nitrogen dosage results in production of larger and robust stalks. Nitrogen is a vital element which plays a major role in carbohydrate metabolism, that facilitates the conversion of sugars which are produced during photosynthesis into structural components of the plant *viz.,* cellulose and hemicellulose, which constitute to a major portion of vegetative biomass resulting in higher stalk yield. Similar results were reported by Malla reddy et al. [15].

During the both years of experimentation (2022 and 2023), the interaction effect of irrigation and nitrogen on stalk yield was found significant (Table 4 and 5). Among the different levels of irrigation and nitrogen levels, the combination of I_3 treatment (irrigation at critical stages) with N_2 (120% RDN) has shown the highest stalk yield of 9084 and 9585 kg ha^{-1} during 2022 and 2023 respectively. All the other two- way interactions and three-way interaction was found to be non-significant during both years. The increase in stover yield in treatments with adequate moisture and higher nitrogen dosage is due to the combined effect on nutrient uptake from the soil. More uptake of nutrients has resulted in more biomass in I_3 and I_1 treatments, whereas negative trend is observed when higher nitrogen doses are applied in moisture stress conditions (I_2). Similar results were documented by Kumari et al. [21].

3.3 Harvest Index (%)

The results of Harvest index (%) of rice fallow maize as influenced by different agronomic practices are presented in Table 1. Influence of tillage practices on Harvest index was significant during both 2022 and 2023. Conventional tillage practice has recorded significantly higher harvest index compared to zero tillage practice. The HI recorded in conventional tillage was 44.7 and 45.6 % and that of zero tillage was 42.9 and 43.9 % during 2022 and 2023 respectively. These reports are in line with the findings of Muhammad Iqbal et al. (2013).

Influence of irrigation schedules on the harvest index has shown a non-significant effect during both 2022 and 2023. HI was recorded higher in I_3 treatment where irrigation was scheduled at six critical stages which is on par with I_1 (60 % ASM) and I_2 (40 % ASM) treatments.

Influence of nitrogen dosages on harvest index was significant during 2022 and 2023 seasons. N_2 (120% RDN) has recorded significantly higher HI compared to N_1 (100% RDN). The HI recorded was 43.9 and 44.9 % in N_2 treatment which are significantly higher than N_1 (43.7 and 44.7 %) during 2022 and 2023 respectively. The interaction effects of tillage practices, irrigation schedules and nitrogen levels were found to be non-significant regarding harvest index of maize during both years of the experimentation (*rabi* 2022 and 2023). Similar results were documented by Khalid Usman et al. (2013).

3.4 Economics

3.4.1 Cost of cultivation (₹ ha^{-1})

Influence of different agronomic practices on the cost of cultivation (1) of rice fallow maize was presented in Table 4. Among the two tillage practices, conventional tillage practice has recorded a higher cost of cultivation compared to zero tillage practice. The cost of cultivation for conventional tillage was Rs. 52911 and 52411 and that of zero tillage was Rs. 43567 and 43067 during 2022 and 2023 because zero tillage crop requires less number of labor, low fuel expenses and less seed requirement. Among the three irrigation schedules the higher cost of cultivation was in I_3 treatment where irrigation was scheduled at six critical stages (Rs. 49239 and 48739) which is followed by I_1 (60 % ASM) with Rs. 48739 and 48239 and the least cost of cultivation is in I_2 (40 % ASM) treatment with Rs.

46739 and 46239 during 2022 and 2023 respectively. Among the two nitrogen levels, the higher cost of cultivation was in N_2 (120% RDN) compared to N_1 (100% RDN). The COC was Rs. 48376 and 47876 in N_2 treatment which is higher than N_1 (Rs. 48102 and 47602) during 2022 and 2023 respectively. Similar results were reported by Visalakshi and Sireesha [22].

3.4.2 Gross returns (₹ ha^{-1})

Influence of different agronomic practices on the Gross returns of rice fallow maize was presented in Table 4. Among the two tillage practices, conventional tillage practice has recorded a higher Gross returns compared to zero tillage practice. The Gross returns for conventional tillage was Rs. 152579 and 176317 and that of zero tillage was Rs. 116774 and 135879 during 2022 and 2023 respectively. Among the three irrigation schedules the higher Gross returns was in I_3 treatment where irrigation was scheduled at six critical stages (Rs. 142009 and 164494) which is followed by I_1 (60 % ASM) with Rs. 135404 and 156787 and the least gross returns is in I_2 (40 % ASM) treatment with Rs. 126616 and 147014 during 2022 and 2023 respectively. Among the two nitrogen levels, the higher Gross returns was in N_2 (120% RDN) compared to N_1 (100% RDN). The returns were Rs. 138299 and 160355 in N_2 treatment which is higher than N_1 (Rs. 131054 and 151841) during 2022 and 2023 respectively. These results were in line with Leela Rani and Yakadri [23].

3.4.3 Net returns (₹ ha^{-1})

Influence of different agronomic practices on the Net returns of rice fallow maize was presented in Table 4. Among the two tillage practices, conventional tillage practice has recorded higher net returns compared to zero tillage practice. The Net returns for conventional tillage was Rs. 99668 and 123906 and that of zero tillage was Rs. 73207 and 92812 during 2022 and 2023 respectively. Among the three irrigation schedules the higher net returns was in I_3 treatment where irrigation was scheduled at six critical stages (Rs. 92770 and 115755) which is followed by I_1 (60 % ASM) with Rs. 86665 and 108548 and the least net returns is in I_2 (40 % ASM) treatment with Rs. 79877 and 100775 during 2022 and 2023 respectively. Among the two nitrogen levels, the higher net returns was in N_2 (120% RDN) compared to N_1 (100% RDN). The returns were Rs. 89923 and 112479 in N_2 treatment which is higher than N_1 (Rs. 82952 and 104239) during 2022 and 2023 respectively. The reason for this is because the benefits of no-till agriculture do not appear in the first season. It takes more seasons in order to obtain results that are better than traditional agriculture.

3.4.4 B-C ratio

Influence of different agronomic practices on B-C Ratio (2) of rice fallow maize was presented in Table 4. Data revealed that the influence of tillage practices on B-C ratio was significant during both 2022 and 2023. Conventional tillage practice has recorded significantly higher B-C ratio (2.88 and 3.36) compared to zero tillage practice (2.68 and 3.15) during 2022 and 2023 respectively. Data revealed that the influence of irrigation schedules on B-C ratio has shown a significant effect during both 2022 and 2023. B-C ratio was higher in I_3 treatment where irrigation was scheduled at six critical stages (2.88 and 3.37), followed by I_1 (60 % ASM) and the lowest no. of grains was recorded in I_2 (40 % ASM) which is 2.70 and 3.17 during 2022 and 2023 respectively. Data revealed that the influence of nitrogen dosages on B-C ratio was significant during 2022 and 2023 seasons. N_2 (120% RDN) has recorded significantly higher B-C ratio which is 2.84 and 3.33 compared to N_1 (100% RDN) 2.72 and 3.18 during 2022 and 2023 respectively.

4. CONCLUSION

Grain yield, stalk yield and HI were significantly influenced by tillage practices and highest values were recorded in conventional tillage practice. Irrigation schedules has shown a significant effect on grain and stalk yield but shown a non-significant effect on harvest index. Highest grain and stalk yield were recorded when irrigation was scheduled at six critical stages of maize. Nitrogen schedules also shown a significant effect on grain and stalk yield but shown a non-significant effect on harvest index. Highest grain and stalk yield were recorded when 120% RDN was applied. Similarly, highest values of cost of cultivation, gross returns, net returns and B-C ratio were recorded in conventional tillage, irrigation at critical stages and 120% RDN during both seasons (*Rabi* 2022 and 2023).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119471