The Pharma Innovation Journal 2023; 12(6): 384-386

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 384-386

www.thepharmajournal.com
Received: 08-03-2023
Accepted: 12-04-2023

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Effect of ecological intensification practices on growth and yield of rice

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Abstract
A field experiment entitled "Studies on ecological intensification in rice (Oryza sativa L.)" was conducted on sandy loam soil at experimental farm of TCA, Dholi (Dr. Rajendra Prasad Central Agricultural University, Pusa) (Samastipur), Bihar during kharif season, 2019. The soil of the experiment field was calcareous in nature containing 32.3% free $CaCO_3$, sandy loam in texture and alkaline in reaction with a pH of 8.21. It was moderately fertile being low in organic carbon (0.41%) and available nitrogen (184 kg N/ha) and also low in available phosphorus (10.23 kg P/ha) and potassium (103.21 kg K/ha). The experiment was conducted in randomised block design (factorial) which was replicated thrice taking the variety Rajendra Bhagavati as a test crop. The factors under study comprised of different ecological intensification practices and farmers practices: Farmers practices, Ecological intensification, E.I. minus tillage practices, E.I. minus nutrient management, E.I. minus planting density, E.I. minus water management, E.I. minus weed management and E.I. minus insect and disease management. Standard package and practices of crop management were followed. Phosphorus and potassium fertilizers were applied as basal whereas urea was applied as per treatment in three split doses as basal (50%), active tillering (25%) and panicle initiation (25%). The experimental findings revealed that Ecological intensification had a profound influence on growth parameters, yield attributes, yield, nutrient uptake and economics of rice. Significantly higher values of growth parameters (tillers m-2 and dry matter production) were observed in rice. As a result, treatment T2 produced tallest plants at all the growth stages. However, T8 treatment found at par with the T2 treatment in all the growth stages. Most of the yield attributes (grains panicle-1 and test wt.), yield (grain and straw) Thus, it can be inferred that the ecological intensification practices is beneficial for higher productivity, reduced fertilizer use and improved soil fertility.

Keywords: Ecological intensification, SSNM and farmers practices

Introduction
Agriculture is facing more challenges to enhance the production of rice and build-up the sustainability in rice ecosystem. Presently, climate change and shifting monsoon pattern creating the problem in crop production as they affect water supply and demand. One of the ways to overcome the challenges for rice yield sustainability is a set of principles grouped together under the umbrella term **"**Ecological intensification". "Ecological intensification involves using ecological processes more intensively in a sustainable manner. The aim to use land, water, biodiversity and nutrients more ecologically efficiently and in ways that minimize negative environmental impacts. Soil conservation tillage practices and sensible crop rotation with residue retention, mulching and some other agronomic practices, increasing yield and decreasing soil degradation and nutrient losses and also reduce cultivation cost, enhancement in resource use efficiency, productivity and soil health. The Food and Agriculture Organization recently defined ecological intensification (sustainable intensification) within the framework of organic agriculture as maximization of primary production per unit area without compromising the ability of the system to sustain its productive capacity".
In India continues follow the rice-wheat cropping system in arable areas that encourage the problem of multi-nutrient deficiency and decreasing the nutrient supply capacity of soil so that at present reduce the uses natural resources and maintaining the soil health, needs to be properly managed to meet fertility requirements of the crops, the most important consideration lies in the application rate, time and sources. Rice crop tolerates from several limitations in production and most important among them is the struggle through weeds. Weed management is essentially the most important feature in successful cultivation of rice. Weeds are widely regarded as pests of great agricultural menace as they pose serious problems by causing severe

competition with crop plants for moisture, nutrients and solar energy and space. So weeds bring heavy reductions in growth and yield of crop. Transplanting is the main crop establishment practice in lowland ecosystem. There are many advantages of transplanting in rice which makes it the most efficient method of rice cultivation over other methods. First being, transplanted rice is capable of yielding 30% more than the broadcasted rice. Also, the transplanted rice competes better with weeds as compared to direct seeded rice. Rice is conventionally grown under flooded condition that is decrease the water use efficiency, creating the problem of water logging condition and disturbed the soil health. Increasing use of ground water for rice cultivation has lead to decline in water table resulting in water scarcity and increased cost for pumping of water. Optimal plant spacing ensures the plants to grow properly both in their above ground and underground parts through effective utilization of solar radiation and nutrients and also, reduce the incidence of insect-pest and disease. At ideal plant spacing less weed incidence will be observed than closer or wider spacing.

Materials and Method

A field experiment was carried out during the summer (*kharif*) seasons of 2019-20 at research farm field in TCA, Dholi, under Dr. RPCAU, Pusa, Samastipur (Bihar). The experiment was executed in random block design with three replications having net plot size of 4.20 m x 4.40 m. The experiment consists of following treatments Farmers practices (FP), Ecological intensification, E.I. minus tillage practices, E.I. minus Nutrient management, E.I. minus planting density, E.I. minus water management, E.I. minus weed management and E.I. minus weed management. Rice variety '*Rajendra Bhagwati'* were transplanted in 4th week of July and harvested in second week of November. Rice was sown in 20 cm spacing from row to row and plant to plant distance of 15 cm were maintained by thinning and gap filling at 15 days after transplanting. The recommended dose of fertilizers (120:60:40 NPK Kg/ha) for farmers practices and 110:35:58 NPK Kg/ha for ecological intensification practices. Half of nitrogen and full dose of phosphorous and potassium were applied at the time of sowing according to the treatment in each plot. However, remaining nitrogen was top dressed in two equal splits i.e. 25 percent at during active tillering and 25 percent N during stage of panicle initiation.

Result and Discussion

Growth attributing characters

Maximum plant height was observed with ecological intensification treatment. It was probably because, with best tillage, nutrient, water and weed management practices. This provided favourable conditions for crop growth that resulted in higher plant height because of well chance for more use of nutrients, moisture, space and sun light to the crop. Ashraf *et al*., 2014 [1] and Chapagain *et al.* 2009 [2] also confirmed same result The minimum plant height was recorded in treatment - farmer's practices at all growth stages. This might be due to more number of weeds which compete with the crop plant for nutrients, water, light and space and exerted high degree of competition with crop plants resulted in reduced plant height Maximum number of tillers per hill noted at different growth stages in ecological intensification treatment and it was found at par with treatments- EI minus insect & pest management than farmers practices because of appropriate nutrient level, water regime and weed control methods that nutrient creation increase cell division, moisture level and reduced weed environment for crop plants to grow in congenial conditions and proper consumption of all the growth factors resulting in better tillering. Guanghou, *et al*, 2005) [4]

Yield attributing characters

Yield attributing characters are mainly dependent on the different growth characters. The increasing effect of different yield related attributes is ultimately reflected in the yield of crop.

The data pertaining to No. of grains per panicle and 1000-grain weight was recorded maximum in Ecological intensification showed superiority over farmers practices. This might be owing to better availability of plant nutrients, better growth and development of the plant, higher photosynthetic rate and better translocation to photosynthates to sink.

Ecological intensification practices were found significantly influence on grain yield. Higher grain yield was recorded with ecological intensification which might be the results of higher yield related attributes such as no. of panicles per m^2, length of panicle, grains per panicle and test weight. Among different treatments ecological intensification recorded maximum grain yield that significantly surpassed over E.I. minus nutrient management and farmers practices. This might be due to many factor during crop management like optimum quantity of nutrient, proper plant spacing, optimum moisture level, lesser weed population and good crop protection measures that creates favourable plant environment, lesser crop-weed competitions which led to higher growth, higher dry matter production, better yield characters, lesser weed dry biomass and density, hence more economic yield than other treatments. (Saharawat *et al* 2010, Chowdhury, *et al* 2012 and Yadav, *et al*. 2017) [5, 13, 6]

The maximum straw yield was recorded in ecological intensification treatment but it was found statically at par with E.I. minus insect and disease management and both these treatments significantly surpassed over E.I. minus nutrient management and farmers practices.

Harvest index being a genetic character, was non-significantly affected by various treatments. The efficiency of crop production which indicates the critical partitioning of dry biomass in grain and vegetative parts is measure by harvest index and it was effected by the amount of assimilates translocation to the panicle throughout grain filling which, in turn, depends on yield capacity of the conducting tissues etc. Among the treatments, higher value of harvest index was recorded in E.I. minus nutrient management but was found at par with the ecological intensification treatments and significantly higher than E.I. minus tillage practices The increase in harvest index was probably due to higher grain yield.

Table 1: growth parameter *viz*., Plant height, No. of tillers and yield attribute *viz*., No. of grains/panicles and Test wt. are affected by Ecological intensification practices.

Treatment	Plant height at harvest(cm)	No. of tillers/ M^2	No. of grains/panicles	Test weight(g)
Farmers practices	98.23	246.48	77.67	19.97
Ecological intensification (E.I.)	110.12	263.08	93.67	20.99
E.I. minus tillage practices	105.52	257.57	88.00	20.88
E.I. minus Nutrient management	98.84	249.25	84.67	20.59
E.I. minus planting density	104.93	254.10	86.00	20.82
E.I. minus water management	101.07	252.37	83.33	20.77
E.I. minus weed management	102.63	250.98	81.67	20.63
E.I. minus weed management	107.12	261.73	89.33	20.86
SEm±	1.19	2.00	1.28	0.20
LSD (p= 0.05%)	3.67	6.20	3.96	NS

Table 2: Grain Yield, Straw Yield Harvest Index and are affected by Ecological intensification practices

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
Farmers practices	40.33	53.87	42.78
Ecological intensification (E.I.)	47.43	62.73	43.05
E.I. minus tillage practices	42.50	59.17	41.79
E.I. minus Nutrient management	41.17	54.33	43.11
E.I. minus planting density	42.37	58.50	41.97
E.I. minus water management	42.23	57.23	42.44
E.I. minus weed management	41.80	55.83	42.78
E.I. minus weed management	44.87	61.06	42.32
SEm±	0.78	0.58	0.56
LSD (p= 0.05%)	2.42	1.79	NS

Conclusion

On the basis of research finding Ecological intensification recorded maximum at all the parameter *viz*., plant height, and no. of tillers dry matter accumulation, yield attributes, grain yield and harvest index in respect to farmers practices and others.

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