Madras Agric. J., 104 (10-12): 323-326, December 2017

Nutrient Use Efficiencies and Correlation Studies on Rice Fallow Irrigated Maize

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A field experiment was conducted at Agricultural College and Research Institute, TNAU, Madurai during January to April 2017 to investigate the influence of nitrogen fertilization on roots, nutrient uptake and productivity of rice fallow hybrid maize. The experiment was laid out in a randomized block design with three replications. Seven treatments under rice fallow condition with graded levels of N *viz.,* 100(T_1), 125 (T_2), 150 (T_3), 175 (T_4), 200 (T_5), 225 (T_6) and 250 kg ha^{-1} (T_7) were evaluated. Maize hybrid CoMH 6 was used with a recommended spacing of 60 × 25 cm. The grain yield was found to be significantly higher with the application of 250 kg of N ha^{-1}; however, it was found to be comparable with 225 and 200 kg of N ha^{-1}. The fertilizer use efficiencies increased with decreasing levels of N. Positive and significant correlation was observed between different doses of N and LAI, no. of grains cob^{-1}, grain yield and net income. LAI and no. of grains cob^{-1} were also found to have significant positive correlation with yield.

Key words: Hybrid maize, Nitrogen use efficiency, Yield and Correlation.

Maize (*Zea mays L.)* also known as "Queen of cereals" is the most versatile crop with wider adaptability to varied agro-ecologies and has the highest genetic yield potential among the grain crops. As the demand for maize is growing continuously due to its multiple uses for food, feed and industrial sectors, we need to produce more from the same or even less resources. New production technologies offer great promise for increasing the productivity to meet the growing demands. Since there is a limited scope to increase the area under maize cultivation due to competition from other cereals and commercial crops, the only alternative is to increase the productivity through management factors. One such production system is the cultivation of maize in rice fallows. Maize responds well to nitrogen under various edapho-climatic conditions. Nitrogen is the vital plant nutrient determining yield of maize. Its availability in sufficient quantities throughout the growing season is essential for optimum growth. With the advent of new high yielding varieties, hybrids and pressing demand to increase the quality, adequate application of N fertilizer becomes increasingly important. Standardization of N requirement under rice fallow maize cultivation is of paramount importance.

Material and Methods

A field experiment was conducted at Agricultural College and Research Institute, TNAU, Madurai at 9°54' N latitude and 78°54' E longitude and at an altitude of 147 m above mean sea level during January to April 2017 to study the effect of nitrogen fertilization on growth and productivity of rice fallow hybrid maize CoMH 6. The soil of the experimental field was sandy clay loam with low in available N, medium in available P and K. The experiment was laid out in a randomized block design with three replications. Seven treatments with graded levels of N *viz*., 100 (T_1), 125 (T_2), 150 (T_3), 175 (T_4), 200 (T_5), 225 (T_6) and 250 kg ha^{-1} (T_7) were evaluated with a recommended spacing of 60 × 25 cm. Rice crop was raised as bulk without any treatments with normal recommended package of practice during rabi season (2016) after harvest of rice and maize was sown under zero tillage conditions by dibbling two seeds per hill at a depth of 5 cm with the help of pointed bamboo peg. Thinning and gap filling was done with utmost care at 10 DAS by keeping one seedling hill^{-1}. As per the treatment schedule, N was applied in three splits, 25% of N as basal, 50% of N on 25 DAS and the remaining 25% on 45 DAS as top dressing. The full dose 75 kg each of P and K were applied as basal for all the treatments. Nitrogen levels of 0, 25, 50 and 75 kg ha^{-1} were maintained adjacent to the experimental field. The crop was maintained by adopting recommended package of practices. Need based plant protection measures were taken up during crop growth period. The biometric observations on grain yield was recorded and analyzed as per standard statistical procedures and the nutrient use efficiencies were worked out using following formula and correlation made.

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Results and Discussion

Growth attributes

Plant growth is a mirror for utilization of the available resources like soil, water, space and light *etc.,* by the crop and it provides an index to productivity of the crop. In the present study, favorable influence of growth attributes was observed in each

Table 1. Effect of N application on growth attributes

Treatments (kg of N ha^{-1})	Plant Height (cm)		LAI		DMP(kg/ha^{-1})	
	60 DAS	80 DAS	60 DAS	80 DAS	60 DAS	80 DAS
100	162.28	179.77	2.20	3.54	3246	5518
125	166.17	183.27	2.41	4.24	3478	5912
150	167.80	184.13	3.07	4.36	3793	6449
175	172.77	185.73	3.30	4.80	3985	6775
200	174.13	188.47	3.56	5.09	4160	7071
225	177.53	191.00	3.65	5.16	4308	7324
250	181.05	193.73	3.73	5.33	4394	7469
SEd	6.217	7.257	0.102	0.146	137.3	215.0
CD(P=0.05)	13.070	15.160	0.214	0.306	286.8	449.3

unit increment in nitrogen levels (Table 1). The tallest plants, highest LAI and maximum DMP were recorded by the application of 250 kg N ha^{-1} at both the stages of observation which were comparable with next lower doses of 225 and 200 kg N ha^{-1}. Such increase in growth attributes was mainly due to the enhanced availability of nutrients in soil by the application of higher doses of nitrogen. Significant increase in plant height of maize was attributed to the increased cell division and cell enlargement by nitrogen fertilization as reported by Prihar and Stewart (1991). Increase in plant height due to more N may also be attributed to better vegetative development that resulted in increased mutual shading and internodal extension.

Table 2. Effect of nitrogen application on grain yield and nutrient use efficiencies

Treatments (kg of N ha^{-1})	Grain yield (kg. ha^{-1})	AUE (kg grain kg^{-1} N applied)	NUE (kg grain kg^{-1} nitrogen applied)	AR (kg of NU/ kg^{-1} of nitrogen applied)	NP (kg ha^{-1} day^{-1})	ENUE (kg Rs^{-1})
100	5092	21.82	50.92	15.58	3.28	4.13
125	5396	19.89	43.17	13.50	3.31	3.50
150	5634	18.16	37.56	12.99	3.24	3.05
175	5807	16.55	33.18	13.53	2.92	2.69
200	6002	15.46	30.01	13.59	2.73	2.43
225	6029	13.86	26.80	12.26	2.79	2.17
250	6085	12.70	24.34	11.79	2.69	1.97
SEd	**97.5**	-	-	-	-	-
CD(P=0.05)	**199.1**	-	-	-	-	-

Table 3. Correlation studies in rice fallow hybrid maize

Correlation	Equation	R2 value
N doses with LAI	y = 0.0113x + 2.6607	R^2 = 0.9293
N doses with no. of grains cob-1	y = 0.8069x + 310.9	R^2 = 0.9497
N doses with grain yield	y = 6.59x + 4567.5	R^2 = 0.9239
N doses with net income	y = 88.879x + 31138	R^2 = 0.8907
LAI with grain yield	y = 576.94x + 3040.4	R^2 = 0.9804
No. of grains cob-1 with grain yield	y = -0.0226x2 + 28.227x - 2384.3	R^2 = 0.9886

The larger canopy development under the application of optimum dose of nitrogen might have increased the interception, absorption and utilization of radiant energy which resulted an increased LAI. Adequate supply of nitrogen might have helped the maize plants to increase their growth which in turn put forth more photosynthetic surface, thus contributed to more dry matter accumulation**.** Improved growth attributes by the application of higher doses of nitrogen observed in the present study was in accordance with the findings of Sreelatha *et al.* (2012) and Venkata Rao *et al*. (2014) in rice fallow maize.

Grain yield

Application of different doses of nitrogen profoundly influenced the grain yield of maize (Table 2). Yield is the manifestation of yield attributing characters and largely governed by source (photosynthesis)

and sink (grain) relationship, as it directly related to nitrogen. The results clearly indicated that the grain yield increased progressively with the graded level

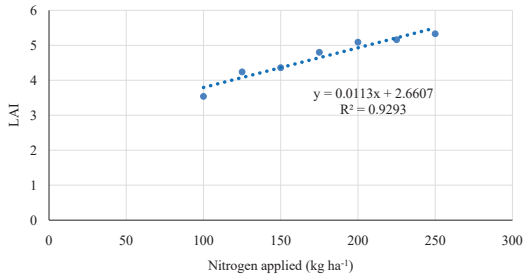

Fig 1. Correlation of N doses with leaf area index (80 DAS)

of nitrogen and it was found to significantly higher with the application of 250 kg N ha^{-1}. However, 225 and 200 kg of N ha^{-1} were also found to be on par. The rate of increase in grain yield was found to

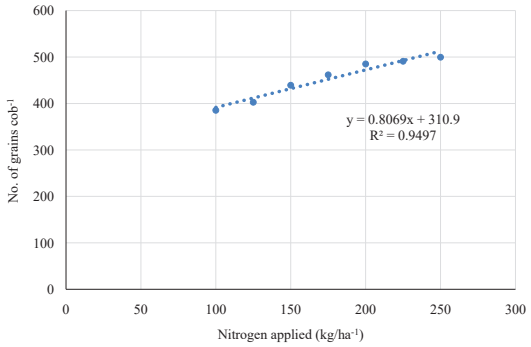

Fig 2. Correlation of N doses with number of grains per cob

increase with the increase in N levels. The higher yield under higher doses of nitrogen application might be due to the corresponding increase in growth and yield attributes as evident from the observation. Positive and significant improvement in LAI and DMP

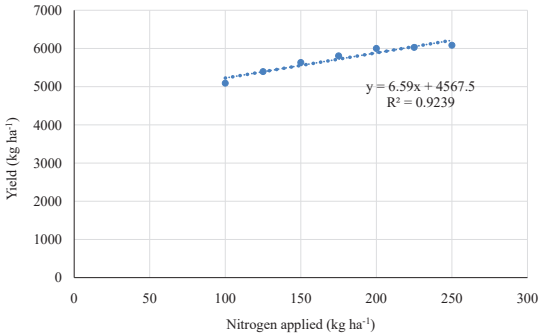

Fig 3. Correlation of N doses with grain yield

along with increased nutrient uptake might have reflected in enhanced grain yield. Overall improvement in crop growth also might have enabled the plant to absorb more nutrients and moisture, empowering the plant to manufacture more quantities of photosynthates and accumulating them in sink. The observation are in conformity with the findings of Bharathi *et al.* (2010) and Reddy *et al.* (2010).

Fertilizer use efficiency studies

Agronomic efficiency and NUE are the measures of utilization of applied nitrogen for crop growth and economic yield. This could be improved by an appropriate crop management practice. All the

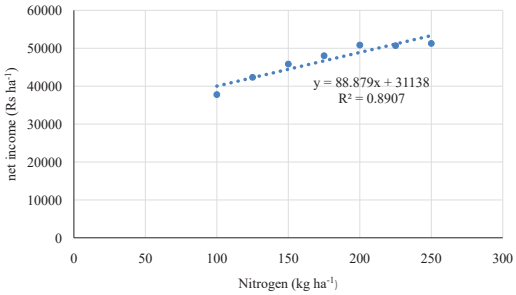

Fig 4. Correlation of N doses with net income

fertilizer use efficiency indices *viz.,* AE, NUE, AR, and ENUE followed a reverse trend of increase in nitrogen application with decreasing values except NP (Table

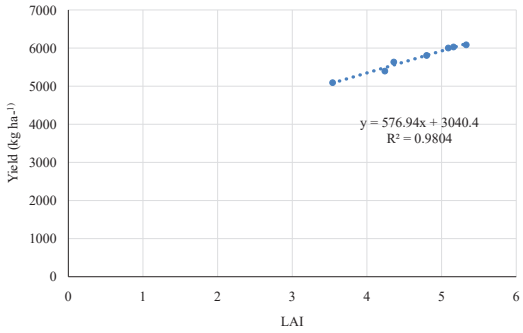

Fig 5. Correlation of LAI with grain yield

2). All the indices recorded higher values with the application of lower dose of N at the rate of 100 kg ha^{-1} and the least value was recorded at higher dose of 250 kg of N ha^{-1}. This can be ascribed to the levels of availability of soil nitrogen, resulting in higher N uptake inturn decreasing the fertilizer use efficiencies studied. Moreover, the small variation in the yield obtained with different N levels presumably might have evened out the fertilizer use efficiency values. These results are in accordance with the findings of Srinivasa Rao (2010), Ali Reze and Raouf (2012), Hafiz Mohkum *et al.* (2012) and Raouf *et al.* (2016), who observed greater NUE with lower doses of N application.

Correlation studies

The final yield of maize is the cumulative effect of growth and yield attributes and such of those treatments which manipulate the favorable parameters could results in the positive relationship with higher yield. The relationship between LAI, number of grains cob^{-1}, grain yield and net income were correlated with the different doses of N applied (Fig 1, Fig 2, Fig 3 and Fig 4). In addition, LAI and number of grains cob^{-1} were also correlated with the grain yield (Fig 5 and Fig 6).The results of the present study (Table 3) revealed that the correlation between LAI, number of

grains cob^{-1}, grain yield and net income were significant and positively correlated with different N doses applied. The correlation between LAI and number of grains cob^{-1} with grain yield were also found

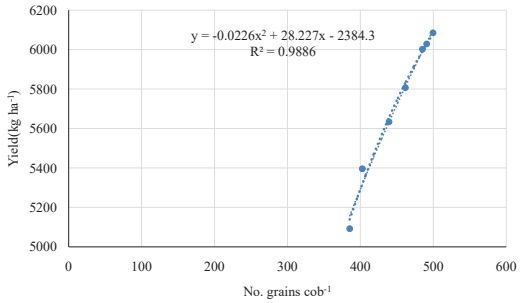

Fig 6. Correlation of number of grains per cob with grain yield

to be significant and positive. These results are in line with the findings of Sadek *et al.* (2006), Pearl (2012) and Garba *et al.* (2015) (yield attributes with yield), Khazaie *et al.* (2010) (number of grains cob^{-1} with yield), Inamullah *et al.* (2011) (number of grains per cob and yield with different doses of nitrogen).

Conclusion

The perceptible effect of higher dose of nitrogen application in promoting the growth, physiological and yield parameters of the crop had definite say on the final grain yield of hybrid maize and stover yield. The higher dose of N 250 kg N ha^{-1} enhanced the grain and stover yield of maize significantly which was comparable with immediate lower doses of 225 kg ha^{-1} and 200 kg ha^{-1}. Nutrient use efficiencies showed a declining trend with increasing level of nitrogen application. Among the different doses of nitrogen applied, 100 kg ha^{-1} recorded higher nutrient use efficiencies which was also comparable next higher dose of 125 kg ha^{-1}. Correlation analysis showed a positive and highly significant correlation of LAI, number of grains cob^{-1}, grain yield, net income with different doses of nitrogen applied and LAI, number of grains cob^{-1} with grain yield.

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Received : November 16, 2017; Revised : December 20, 2017; Accepted : December 28, 2017