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Influence of integrated nutrient management practices for growth and yield attributes on irrigated transplanted ragi

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Abstract
The field experiment was conducted in a farmer's field at salangapalayam village, Bhavani block of Erode district to study the effect of integrated nutrient management practices for yield maximization in irrigated transplanted ragi. The experimental plots were laid out in a randomized block design (RBD) with nine treatments and three replications. Among the various treatments implemented in this study, application of 100% RDF (60:30:30 kg of NPK ha^{-1}) + Soil application of Micronutrient mixture @ 12.5 kg ha^{-1} (T_3) excelled over all other treatments and recorded higher values for the growth attributes *viz*., plant height (93.82 cm), leaf area index (4.43), days to fifty percent flowering (57 DAT), root length (14.70cm), root volume (36.52 cc), and dry matter production (8249.00 kg ha^{-1}) and yield attributes *viz*., number of tillers m^{-2} (120.33), length of earhead (8.75), number of earheads m^{-2} (114.02), number of fingers $earhead^{-1}$ (11.21), grain yield (3660 kg ha^{-1}) and straw yield (5616.72 kg ha^{-1}). Hence application of 100% RDF (60:30:30 kg of NPK ha^{-1}) + Soil application of Micronutrient mixture @ 12.5 kg ha^{-1} (T_3) was noticed as a viable practice for achieving higher productivity and profitability in irrigated transplanted ragi.

Keywords: Nutrient management practices, growth, yield attributes, irrigated transplanted ragi

Introduction
Millets are popularly known as Nutri cereals as they are rich in vitamins and minerals as it provide most of the nutrients. As a result of declining millets production and consumption, there is a gradual decrease in protein, fibre and iodine content in women and children. Besides providing nutritional security, they also help in preventing malnutrition. Finger millet (*Eleusine coracana* L. Gaertn.) popularly known as Ragi and African millet ranks first in area and production among the small millets in the world. Ragi accounts for about 85% of production among the various minor millets cultivated in India (Sakamma *et al*., 2018) [11]. In India, Ragi is cultivated in an area of 11.9 lakh hectares with a production of 19.8 lakh tonnes and a productivity of 1662 kg ha^{-1}. In Tamil Nadu, it is cultivated in the area of 0.78 lakh hectares with the production of 2.56 lakh tones and productivity of 1966 kg ha^{-1} (Agricultural Statistics at a Glance, 2020) [1]. According to FAO, the projections indicate that world food demand may increase by 70 percent by 2050. In order to meet out this demand we have to increase the yield traits with better agronomical practices such as high yielding varieties, proper weeding, providing timely irrigation, good nutrient management practices are being followed. Among them, integrated nutrient management is one of the best ways to enhance the productivity of ragi.
Micronutrients are used in small quantities but they are as important as macronutrients in respect of their functions in plants. Furthermore, they help to increase the efficiency of macronutrients. They play an essential role in improving the growth, yield and quality of many crops. Micronutrients play an important role in the enzymic activities and various metabolic processes of the plant (Vijayakumar *et al.*, 2020) [14]. Seaweed extracts may improve crop growth through certain mechanisms, that is the provision of phytohormones and these include vigorous growth, higher yield, increased nutrient uptake, and more resistance to biotic and abiotic stresses (Karthikeyan and Shanmugan, 2016) [5]. Humic acid improves the physical, chemical and biological properties of soils (Mikkelsen, 2005) [7]. Humic acid-based fertilizers increase crop yield (Mohamed *et al.*, 2009) [8], stimulate plant enzymes, hormones and improve soil fertility in an ecologically and environmentally benign manner (Mart, 2007) [6]. Although research work on inorganic fertilizers and organic manures on ragi are in plenty, the

combined application of inorganic fertilizers and organic manures along with micronutrients, seaweed extract granules, and humic acid granules on irrigated ragi is almost very meagre. Hence the present experiment was conducted to study the influence of integrated nutrient management practices for growth and yield attributes on irrigated transplanted ragi.

Materials and Methods

A Field experiment was conducted in a farmer's field at Salangapalayam village, Bhavani block of Erode district from April to July 2021 to study the influence of integrated nutrient management practices for growth and yield attributes on irrigated transplanted ragi. The experimental field was geographically located at 11.42º N latitude and 77.57º E longitude at an altitude of 196 meters above mean sea level. The weekly mean maximum temperature ranged from 26.57 °C to 34.85 °C with a mean of 30.71 °C and the weekly minimum mean temperature ranged from 20.14 °C to 26.28 ºC with a mean of 23.21 °C. The relative humidity ranged from 83.57 to 63.05 percent with a mean of 73.31 percent. The total rainfall received during the cropping period is 430.5 mm. The Soil of the experimental field was sandy clay loam soil. The available soil nitrogen, phosphorus and potassium were 186.73, 10.49 and 148.2 kg ha^{-1} respectively. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments *viz*., T_1 - Control (without any fertilizers), T_2- 100% RDF (60:30:30 kg NPK ha^{-1}), T_3 - 100% RDF + soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_4- 100% RDF + soil application of Humic acid @ 25 kg ha^{-1}, T_5- 100% RDF + soil application of Seaweed extract @ 25 kg ha^{-1}, T_6 - 75% RDF (45.0:22.5:22.5 kg NPK ha^{-1}), T_7 - 75% RDF + soil application of Micronutrient mixture (TN grade XI) @ 12.5 kg ha^{-1}, T_8 - 75% RDF + soil application of Humic acid @ 25 kg ha^{-1}, T_9 - 75% RDF+ Soil application of Seaweed extract @ 25 kg ha^{-1}. The Finger millet variety ATL 1 was chosen for the study. The biometric observations were taken at critical stages of the crop.

Results and Discussion

Growth attributes

Application of integrated nutrient management practices significantly influenced the growth attributes of ragi (Table 1). Application of 100% RDF (60:30:30 kg of NPK ha^{-1}) + Soil application of Micronutrient mixture @ 12.5 kg ha^{-1} (T_3) recorded higher growth attributes *viz*., plant height (93.82cm), leaf area index (4.43), days to fifty percent flowering (57 DAT), root length (14.70 cm), root volume (36.52 cc), and dry matter production (8249.00 kg ha^{-1}). The least values for growth attributes were recorded under the control (T_1). This might be due to the influence of integrated nutrient management practices for growth and yield attributes on irrigated transplanted ragi. This could be due to optimum and sustained availability of micronutrients along with macronutrients because micronutrients help the plant to observe macronutrients during the entire growth phase of the crop being the supply of nutrients through the soil. This conforms with the findings of Chang *et al*. (2005) [16].

The reason for maximum heights of the crop might be due to the increased availability of nutrients in the soil through mineralization of organic sources which could have triggered cell elongation and multiplication resulting in the higher growth rate of shoots. Sunitha *et al.* (2004) [13], Narolia *et al.* (2009) [10], and Giribabu *et al.* (2010) [4]. An increase in LAI by micronutrient mixture application might be due to an increase in tryptophan amino acid and indole acetic acid hormone which was two main factors in leaf area expansion as elucidated by Mohsin *et al*. (2014) [9]. The applied nutrients by their effect on the metabolism of the cell promoted the meristematic activity of the crop and its better uptake would have resulted in increased dry matter accumulation as explained by Elayaraja and Singaravel (2010) [3].

Table 1: Influence of integrated nutrient management practices for growth attributes on irrigated transplanted ragi.

Treatments	Plant height (cm) at harvest	LAI	Root length	Root volume	DMP at harvest (kg ha^{-1})
T_1	72.60	2.01	9.10	30.53	2849.00
T_2	87.96	3.33	11.88	33.26	6762.00
T_3	93.82	4.43	14.70	36.52	8249.00
T_4	91.98	4.04	13.87	35.05	7680.00
T_5	91.38	3.96	13.77	34.90	7502.00
T_6	83.79	2.35	9.86	31.44	5968.00
T_7	89.58	3.61	12.83	34.15	7168.00
T_8	86.18	2.95	10.96	32.35	6432.00
T_9	85.44	2.90	10.81	32.29	6290.00
SEm±	0.56	0.08	0.22	0.12	79.67
CD (p=0 .05)	1.68	0.26	0.68	0.34	240.89

Yield attributes and yield

Yield attributes and yield of ragi was significantly increased with influence of integrated nutrient management practices (Table 2). Among various treatments tried Application of 100% RDF (60:30:30 kg of NPK ha^{-1}) + Soil application of Micronutrient mixture @ 12.5 kg ha^{-1} (T_3) recorded higher number of tillers (120.33), length of earhead (8.75), number of fingers $earhead^{-1}$ (11.21), test weight (2.92), grain yield (3660 kg ha^{-1}) and straw yield (5616.72 kg ha^{-1}). The least values for yield attributes and yield were recorded under the control (T_1).

Table 2: Influence of integrated nutrient management practices for growth attributes on irrigated transplanted ragi.

Treatments	Yield attributes				Yield	
	No. of. tillers m^{-2}	Length of earhead	No. of fingers $earhead^{-1}$	Test weight (g)	Grain yield	Straw yield
T_1	80.78	5.01	7.73	2.84	986	2124.39
T_2	96.88	6.90	9.44	2.89	2765	4859.65
T_3	120.33	8.75	11.21	2.92	3660	5616.72
T_4	113.28	8.23	10.78	2.91	3103	5408.72
T_5	111.23	8.11	10.57	2.90	3021	5275.91
T_6	82.44	5.56	8.29	2.85	2406	4334.39
T_7	103.98	7.46	9.96	2.88	2895	5069.91
T_8	89.04	6.25	8.85	2.87	2625	4648.24
T_9	87.79	6.20	8.74	2.86	2546	4554.03
SEm±	2.12	0.15	0.15	0.02	38.62	59.84
CD (p=0 .05)	6.40	0.46	0.46	NS	117.00	180.97

Anther and pollen grain development in micronutrients applied plants were largely increased, possibly as a result of increased levels of IAA and proteins and enhanced plant growth by increased photosynthetic translocation through vascular bundles of petioles, causing growth and reproductive tissue development, the micronutrient acted as a catalyst in the uptake and use of certain other macronutrients Arif *et al*. (2012) [2]. Thus, the micronutrient application method led to greater availability of Zn and B to the plants, which increased their metabolic efficiency and ultimately led to increased vegetative growth and the number of effective tillers. These results were in agreement with the reports of Singh *et al*. (2015) [12]. Grain yield was the ultimate end product of many yield contributing components and physiological and morphological processes that took place in plants during growth and development. The conjunctive use of organic and inorganic sources had a beneficial effect on the physiological process of plant metabolism and growth, thereby leading to higher grain yield. The easy availability of N due to mineralization of organics influenced the shoot and root growth favouring the absorption of other nutrients. The results conformed with the findings of Yakadri and Reddy (2009) [15].

Conclusion

From the present study, it can be concluded that influence of integrated nutrient management practices and Application of 100% RDF (60:30:30 kg of NPK ha^{-1}) + Soil application of Micronutrient mixture @ 12.5 kg ha^{-1} (T_3) remarkably increased the growth and yield attributes of irrigated transplanted ragi.

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