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RESEARCH ARTICLE

Impact of foliar nutrient application on growth and yield of drip fertigated aerobic rice

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Abstract

A field experiment was conducted at Agricultural College and Research Institute, Madurai during 2022 to study the effect of supplemental nutrition on different varieties under drip fertigated aerobic rice (*Oryza sativa* L.). The experiment was laid out in a split plot design with twelve treatment combinations and three replications. The treatment consisted of two varieties such as CO-54 and ADT-53 as the main factor and the sub-plot treatments included foliar application of 1% urea + 2% diammonium phosphate (DAP) + 1% potassium chloride at panicle initiation (PI) and 10 days later (F_1), foliar application of 0.5% zinc sulphate and 1% ferrous sulphate at tillering and PI stages (F_2), foliar application of 2% mono ammonium phosphate (MAP) + 1% potassium chloride at heading and grain filling stages (F_3), foliar application of 1.5% fermented egg extract at tillering, PI and flowering stage (F_4), foliar application of 1% ferrous sulphate at 25-30 days after sowing (DAS) (F_5) and control - No spray (F_6). The results of the study indicated that rice variety CO-54 coupled with application of recommended dose of fertilizers (RDF) of nitrogen (N), phosphorus (P) and potassium (K) through drip fertigation along with foliar application of 1% urea + 2% DAP + 1% potassium chloride at panicle initiation and 10 days later registered higher values for yield traits, total yield and zinc (Zn) and iron (Fe) partitioning of aerobic rice.

Keywords

aerobic rice; drip fertigation; grain yield; straw yield; supplemental nutrition

Introduction

Aerobic rice is a water-saving technology designed to address the water crisis in tropical to subtropical agricultural regions where rice is the staple food crop. The water requirement for aerobic rice is approximately 450-650 mm, significantly lower than that of lowland irrigated rice. This makes aerobic rice a feasible option in water-scarce conditions. The aerobic rice production system eliminates continuous seepage and percolation losses, significantly reduces evaporation due to the absence of standing water at any stage of cropping period and effectively utilizes rainfall, thereby enhancing water productivity (1). The major constraint in aerobic rice production includes the limited availability of drought-tolerant, high-yielding varieties, weed dominance and nematode infestations and deficiencies of micronutrients such as Fe and Zn during the early vegetative stage. Both macronutrients and micronutrients are essential for plant nutrition and their deficiency can lead to declining rice productivity. Even in minimal amounts, micronutrients enhance macronutrients availability, supporting crop growth and yield. Emerging technologies play a crucial role in increasing rice production to meet the food demands of the growing population, which is rising at an annual rate of 1.32% (2).

The cultivation of aerobic rice under drip irrigation has resulted in higher water productivity. A key advantage of micro-irrigation is its ability to apply small amounts of water at frequent intervals, allowing for precise soil moisture management throughout part or all of the growing season. This method minimizes soil moisture deficits and prevents excess rainwater retention (3). The performance of rice under drip irrigation was studied and reported that the highest WUE was found under drip irrigation treatment, which was 1.52 to 2.12 times higher than flood irrigation (4). The soil application of RDF combined with micronutrients mixture (MMS) at 12.5 kg ha^{-1} during sowing, along with a foliar application of micronutrients mixture (MMF) at 1% at 20 and 40 DAS, resulted in significantly higher grain yield and improved micronutrients content in post-harvest soil when compared to other treatments (5). In raised beds, foliar fertilization has been found to produce more tillers than standard planting. This may be due to an increase in macro- and micronutrients levels in the leaves, enhancing the net photosynthetic rate of treated rice plants and leading to greater plant height (6). Considering these findings, the present study was designed to examine the effect of drip fertigation and supplemental foliar nutrition on rice yield, nutrient uptake and partitioning.

Materials and Methods

The experiment was conducted in field No. 46 at 'C' block of central farm, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India. The study area is located at 9° 96' N latitude and 78° 20' E longitude with an elevation of 140 m above mean sea level. It falls within the southern agro-climatic zone of Tamil Nadu. The experiment was conducted during the *rabi* season of 2022, using the rice varieties CO-54 and ADT-53. The soil of experimental field is sandy clay loam in texture. Before the experiment, a composite soil sample was collected from five different places at a depth of 0-15 cm and the soil had a bulk density of 1.45 mg m^{-3}. And contained 236 kg ha^{-1} of available nitrogen, 16.4 kg ha^{-1} of available phosphorus and 364 kg ha^{-1} of available potassium. Micronutrient analysis showed that available iron and zinc concentrations of 4.50 mg kg^{-1} and 1.94 mg kg^{-1}, respectively. The soil had a pH of 7.04, an electrical conductivity (EC) of 0.32 dS $m^{-1}$and organic carbon content of 0.39 g kg^{-1}, indicating a low organic matter status. These properties provide essential insights into the soil quality and its potential for sustainable agricultural productivity. The field experiment followed a split plot design, with two rice varieties as the main plot and six foliar nutrition treatments as subplots replicated three times (Table 1). Seeds were dibbled in raised beds at a spacing of 20 × 10 cm, accommodating four rows per bed. Soaking irrigation applied immediately after sowing, followed by life-saving irrigation was given on the third day. Subsequent irrigation was provided every three days based on 125% pan evaporation (PE) data form the meteorological observatory at AC & RI, Madurai. The recommended fertilizer dose of 150:50:50 kg ha^{-1} ($N:P_2O_5:K_2O$) was applied using urea (46%), single super phosphate (SSP, 16% P_2O_5) and sulphate of potash (50% K_2O). The entire phosphorous dose (SSP) was applied as a basal application, while nitrogen and potassium were applied in four splits: 20% at 15 DAS, 30% at tillering and PI stage and 20% at flowering, all through fertigation. For weed management, pendimethalin at 30 EC was applied at 0.75 kg ha^{-1}as a pre-emergence herbicide at 3 DAS. Hand weeding was performed at 25 and 45 DAS to maintain a weed -free field. Gap filling was carried out on the 7th DAS using sprouted seeds in areas where initial germination had failed. All other cultural practices for aerobic rice cultivation, apart from foliar application treatments, were followed as per the Crop Production Guide (2020) of Tamil Nadu Agricultural University.

Five plants were selected randomly and tagged in each experimental plot for recording biometric observations. Yield attributes, including total number tillers m^{-2} (recorded at 75 DAS) and the number of panicles m^{-2}, were measured at harvest. The number of panicles per m^{-2} was determined using a quadrate and the total count was recorded. The crop was manually harvested from the net plot of each treatment, then threshed and cleaned separately. The grains were sun-dried to a moisture content of 14% and weighed, with grain yield expressed in kg ha^{-1}. The straw collected from each plot was also sun-dried for two consecutive days and weighed separately, with straw yield expressed in kg ha^{-1}. A detailed economic analysis was carried out by calculating cost of cultivation, gross return, net return and benefit cost ratio for each treatment based on prevailing market rates for inputs, produce and labour wages. Data from the field experiment were subjected to statistical analysis (7). Wherever treatment differences were found to be significant, the F test and critical differences were calculated at a 5% probability level. If treatment differences were not significant at this level, they were denoted as "NS".

Table 1. Treatment details

Main plot (varieties)
V_1 - CO-54
V_2 - ADT-53
Sub plot (foliar application)
F_1 -1% urea + 2% DAP + 1% KCl at panicle initiation (PI) and 10 days later
F_2 - 0.5% $ZnSO_4$ and 1% $FeSO_4$ at tillering and PI stages
F_3 - 2% MAP + 1% KCl at heading and grain filling stages
F_4 - 1.5% fermented egg extract at tillering, PI and flowering stage
F_5 - 1% $FeSO_4$ at 25- 30 DAS
F_6 - Control (no spray)

Results and Discussion

Total number of tillers m^{-2}

The number of tillers per square meter was recorded under foliar application on 75 DAS. Analysis of the data indicated that CO-54 (V_1) recorded greater number of tillers m^{-2} significantly higher than ADT-53. The treatment V_1 recorded the higher value of 330 on 75 DAS for number of tillers m^{-2} (Table 2). Application of supplemental nutrition through foliage showed significant variations among different treatments. Foliar spray of 1% urea + 2% DAP + 1% KCl at panicle initiation and 10 days later (F_1) registered higher number of tillers m^{-2} about 342 on 75 DAS. The lowest number of tillers m^{-2} (323) was recorded in the no spray treatment (F_6). The interaction between varieties and foliar application was found significant and higher value (344) observed in CO-54 variety applied with 1% urea + 2% DAP + 1% KCl (V_1F_1) on 75 DAS. The least value (319) registered under the treatment ADT -53 with RDF alone (V_2F_6). Sufficient supply of nitrogen would encourage early tillering, improve source capacity and boost the number of tillers. These results align with the previous results where significant increment with foliar sprays of Zn, Fe and other micronutrients (8-10). The availability of more phosphorus from water soluble fertilizer (MAP) favoured the production of more tillers and these results agree with the previous findings (11).

Number of panicles m^{-2}

Foliar application of macro and micronutrients significantly influenced the number of panicles m^{-2} of two rice varieties under drip fertigation. Among the two varieties tested, CO-54 produced greater number of panicles m^{-2} (213) than ADT-53 (206). Among the different foliar application treatments, foliar spray of 1% urea + 2% DAP + 1% KCl (F_1) recorded higher value (230) for panicles m^{-2} followed by F_3 and F_2. This was significantly differed from all other treatments, with the lowest value (195 panicles m^{-2}) observed under the no-spray (F_6) treatment (Table 2). Rice varieties and different foliar application treatments exerted a significant interaction and CO-54 with supply of 1% urea+2% DAP + 1% KCl (V_1F_1) recorded higher number of panicles m^{-2} (240) and the least value (193) was under ADT-53 with no spray (V_2F_6). Nutrient supplement through foliar spray as 1% urea + 2% DAP + 1% KCl produces greater number of panicles m^{-2}. Application of DAP fertilizer boost vegetative growth by increasing the availability of nutrients in the soil which in turn increasing the better nutrient uptake and higher productivity of photosynthetic products improved the crop's quantitative traits (12). This might be due to the higher availability of nutrients through foliar spraying might be the cause of the increased panicles m^{-2} and this helps in better utilization of resources by the plants transforming the majority of the tillers into productive panicles and also foliar nutrition spray had a considerable impact on rice leaf area index and crop growth rate (13). High rice yields depend on the filling of the grain, which is influenced by the foliar application of nutrients at panicle initiation. By increasing the accumulation and transmission of non-structural carbohydrates in stems and leaf pods, foliar applications of nutrients could increase the activities of enzymes like sucrose synthetase, which in turn improve partitioning of photosynthates and it was reflected in the number of filled grains per panicle and the weight of the grains in rice plants (8).

Number of filled grains m^{-2}

Analysis of data pertaining to number of filled grains m^{-2} indicated that different foliar nutrition treatments influenced the rice crop and exhibited significant difference among them and between tested varieties. Rice variety CO-54 recorded higher value (147) and it was significantly differed from ADT-53 (Table 2). Foliar spray of 1% urea + 2% DAP + 1% KCl (F_1) at panicle initiation and 10 days later produced greater number of filled grains m^{-2} (149) followed by F_3 and F_2. The least number (140) was recorded under no spray treatment. The interaction effect between varieties and foliar application was found to be significant and the variety CO-54 applied with 1% urea + 2% DAP + 1% KCl (V_1F_1) registered higher value (151) for number of filled grains m^{-2} followed by V_1F_3 and V_1F_2.

Foliar application of macro- and micronutrients resulted in more accumulation of photosynthate in plant parts especially reproductive parts such as panicles. Partitioning of photosynthates in reproductive parts decide the yield components including number of panicles and weight of panicles. The supplemental nutrition improves the DMP and the partitioning to reproductive parts. Foliar application increases the number of filled grains per panicle and grain weight (14). Foliar applications of F_1 - 1% urea + 2% DAP + 1% KCl resulted in a higher number of grainswhich helps to increase the number of filled and diseases-filled grains in Asian countries, it is common practice to foliar-apply macro- and micronutrients to rice which significantly increase the leaf greenness, photosynthetic rate and the yield and it is in line with the findings of (13, 15).

Table 2. Effect of foliar application of nutrients on yield parameters of rice under drip fertigation

Treatments	Total number of tillers m^{-2} (on 75 DAS)			Number of panicles m^{-2} (on 90 DAS)			Number of filled grains m^{-2}			1000 grain weight (g)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
F_1	344	340	**342**	240	220	**230**	151	147	**149**	15.5	14.7	**15.6**
F_2	341	333	**337**	212	207	**209**	148	142	**145**	15.5	14.7	**15.6**
F_3	342	336	**339**	221	218	**220**	149	144	**147**	15.5	14.6	**15.5**
F_4	335	323	**329**	204	196	**200**	145	138	**141**	15.3	14.7	**15.5**
F_5	337	330	**334**	207	201	**204**	147	140	**144**	15.5	14.7	**15.6**
F_6	327	319	**323**	197	193	**195**	144	136	**140**	15.2	14.5	**15.3**
Mean	**338**	**330**		**213**	**206**		**147**	**141**		**15.4**	**14.6**	

	V	F	V at F	F at V	V	F	V at F	F at V	V	F	V at F	F at V	V	F	V at F	F at V
SE	2.6	0.9	2.1	1.4	3.2	1.8	4.0	2.6	1.3	0.5	1.4	0.7	0.3	0.2	0.4	0.1
CD (p=0.05)	7.2	2.0	7.4	2.9	7.6	3.9	8.5	5.5	5.4	1.1	5.5	0.6	0.4	NS	NS	NS

SE - standard error of the difference between means; CD - critical difference; NS - non-significant

Grain weight

The test weight of 1000 grain weight is primarily a genetic trait and no significant variation was observed among the test varieties. The test weight of seeds of CO-54 (15.4 g) and ADT-53 was recorded (14.6 g). The effect of different foliar nutrition on test weight also found to be non-significant (Table 2). However, the foliar nutrition did not show any significant difference in test weight of the two rice varieties under drip fertigated aerobic conditions in present study. However, studies also reported non-significant impact on 1000 grain weight due to foliar application (16).

Grain yield

The grain yield of ADT-53 and CO-54 was significantly influenced by the different foliar application of nutrients (Table 3). The data pertaining to grain yield showed that the higher grain yield was recorded in CO-54 compared to ADT-53 variety, irrespective of foliar application treatments. Among the different foliar application treatments, F_1 recorded the higher grain yield (5,449 kg ha^{-1}) when compared to other treatments. Among other treatments, the difference between F_1, F_2 and F_3 was comparable with each other and the same trend was followed in F_4 and F_5 also. The lowest values for grain yield registered under control treatment (F_6) (4,511 kg ha^{-1}) (17). Different foliar spray treatments demonstrated on different varieties significantly influenced the grain yield and highest grain yield was obtained under V_1F_1 followed by V_1F_3. The percentage increase of grain yield because of supplemental nutrition through foliar application ranged from 5 to 20. The interaction between the tested varieties and foliar application was found to be significant. The highest grain yield was recorded under V_1F_1 (5,509 kg ha^{-1}), followed by V_1F_3 (5,447 kg ha^{-1}) and V_1F_2 (5,297 kg ha^{-1}) (17).

Upland rice varieties perform well under aerobic soil conditions due to their adaptive root zone, efficient nutrient uptake, translocation and accumulation (18). In this study CO -54 is performed well which moderately resistant to water stress and contributed higher grain yield than ADT-53. The grain yield increment due to foliar application over control treatment was ranged from 4.9% to 20.7%. The increment was higher under 1% urea + 2% DAP + 1% KCl (F_1) followed by F_3 and F_2. Supplemental nutrition through foliar spray enhances the leaves to absorb nutrients rapidly into the inner cell layers of plant cells and other plant organs. Foliar application of DAP increased the rice grain yield and it might be due to the enhancement of ammonium and nitrate and helps in more accumulation of nutrients in the grain. This aligns with the findings of (19, 20). The addition of nitrogen (N) as foliar application improved grain yield by increasing the assimilate source by raising nitrogen (N) concentration and by improving sinks by lowering spikelet deterioration (21). Application of 1% urea solution as foliar spray with or without zinc (Zn) fertilizer was adequate to achieve the best grain production in rice under V_1F_1 (5,509 kg ha^{-1}) (22). The present study revealed that there is a need for a comprehensive supply of macronutrients DAP along with micronutrients (zinc and iron) for getting the benefit of all supplied nutrients. This result aligns with the findings that the foliar application of macro- and micronutrients under aerobic soils and reported that foliar application of DAP increased the uptake of nutrients in the crop and accumulated in grains under aerobic condition (17, 23).

Straw yield

The data pertaining to straw yield indicated that it was significantly influenced by the foliar application of macro- and micronutrients in tested varieties. The higher straw yield was recorded in CO-54 when compared to ADT-53 with irrespective of different foliar application treatments. Among the different foliar nutrient application, F_1 recorded the higher straw yield (7,687 kg ha^{-1}) when compared to other treatments. The difference between F_1, F_2 and F_3 was comparable with each other and the same trend is followed for F_4 and F_5 also. The lowest value (5,746 kg ha^{-1}) for straw yield observed under control treatment (F_6) (Table 3). Different foliar spray treatments on two varieties showed significant variations for straw yield and highest straw yield (7,689 kg ha^{-1}) was obtained under V_1F_1 followed by V_1F_3 (7,021 kg ha^{-1}) and V_1F_2 (6,623 kg ha^{-1}). The foliar application of nutrients at critical stages leads to increase in dry matter accumulation and consequently yield attributes, grain and straw yield (24).

Nitrogen, phosphorus and potassium partitioning in crop

The data analyzed for nutrient uptake indicated that different foliar nutrient management strategies influenced the N partitioning of varieties significantly (Fig. 1). Among the two varieties tested, CO-54 recorded highest nitrogen uptake of 50.63, 38.59 and 89.21 kg ha^{-1} than ADT-53 recorded 49.23, 36.59 and 85.82 kg ha^{-1} in grain, straw and total plant respectively at harvest stage.

The data pertaining to phosphorus uptake indicated that different foliar nutrient management strategies influenced phosphorus partitioning of varieties significantly (Fig. 1). Among the two varieties tested, CO-54 recorded highest phosphorus uptake of 11.98, 7.32 and 19.30 kg ha^{-1} in

Table 3. Effect of foliar application of nutrients on grain and straw yield of rice under drip fertigation

Treatments	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})		
	V_1		V_2	Mean	V_1	V_2	Mean
F_1	5509		5388	**5449**	7689	7684	**7687**
F_2	5297		4807	**5052**	7406	6623	**7015**
F_3	5447		4983	**5215**	7625	7021	**7324**
F_4	4807		4665	**4736**	6509	5816	**6163**
F_5	5145		4701	**4923**	7000	6019	**6510**
F_6	4570		4451	**4511**	5951	5542	**5746**
Mean	**5129**		**4833**		**7030**	**6451**	

	V	F	V at F	F at V	V	F	V at F	F at V
SE	67	78	121	110	102	118	184	168
CD (p=0.05)	289	163	336	230	439	247	509	349

SE - standard error of the difference between means; CD - critical difference

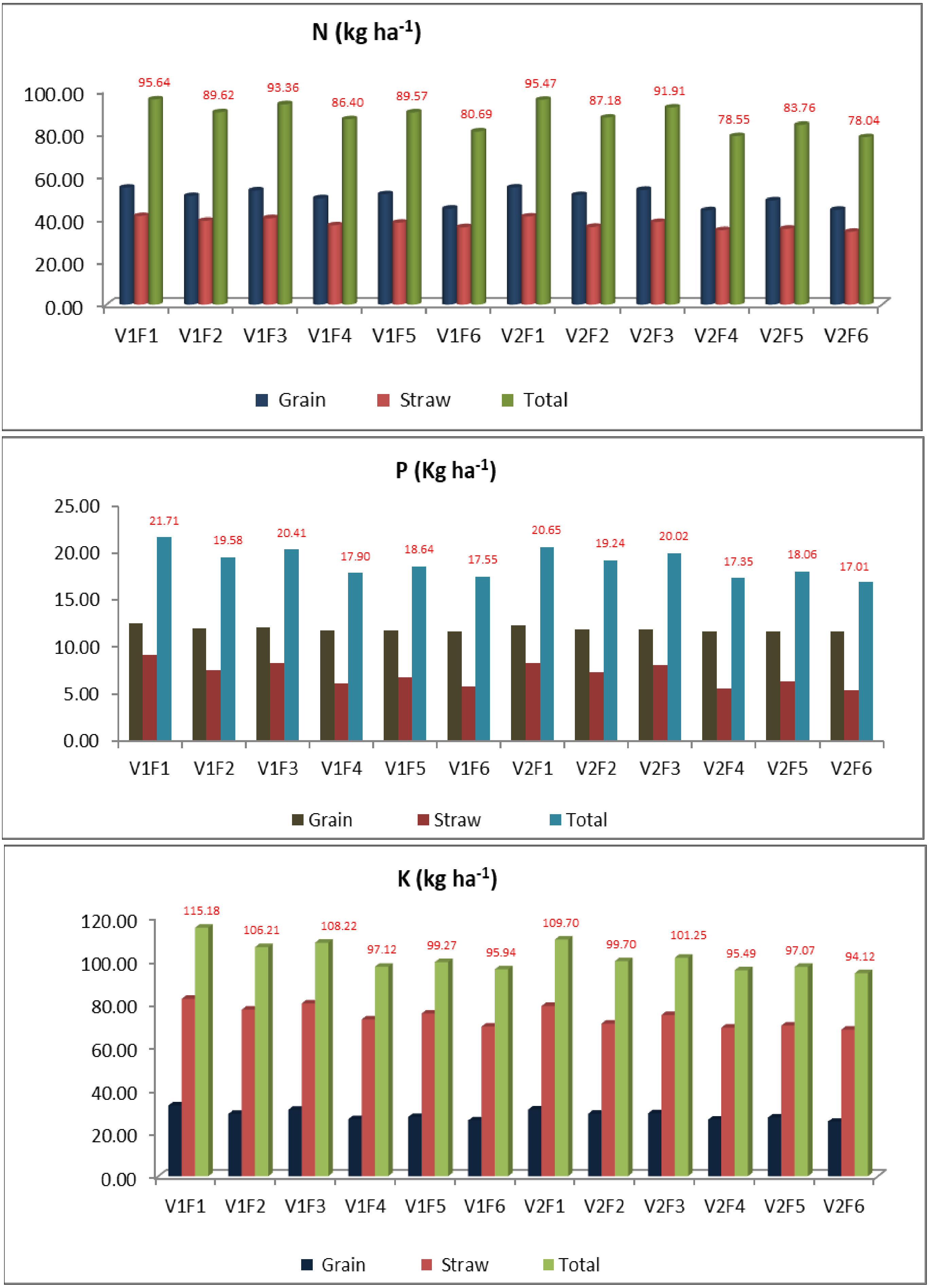

Fig. 1. Effect of foliar application of nutrients on uptake of N, P and K (kg ha^{-1}) at harvest stage of rice varieties under drip fertigation.

grain, straw and total plant, respectively at harvest stage. Among the different foliar nutrient application, F_1 (1% urea + 2% DAP + 1% KCl) recorded significantly higher uptake (12.42, 8.76 and 21.18 kg ha^{-1} in grain, straw and total plant uptake, respectively at harvest stage) than other treatments. The low phosphorus uptake in grain, straw and total plant registered under no spray (F_6) treatment. The interaction between varieties and foliar application was found as non-significant.

The data with respect to potassium uptake revealed that different foliar nutrient management strategies influenced phosphorus partitioning significantly among the varieties tested. Among the two varieties tested, CO-54 recorded highest potassium uptake of 28.76, 76.16 and 103.45 kg ha^{-1} in grain, straw and total plant, respectively at harvest stage (Fig. 1). Among the different foliar nutrient application, F_1 (1% urea+2% DAP + 1% KCl) recorded significantly higher uptake (31.90, 80.65 and 112.43 kg ha^{-1} in grain, straw and total plant uptake, respectively at harvest stage) than other treatments. The low P uptake in grain, straw and total plant registered under no spray (F_6) treatment.

Zinc and iron partitioning in crop

The data pertaining to zinc uptake showed that foliar nutrient applications on tested varieties had significant influence. Among the two varieties demonstrated, CO-54 recorded higher zinc uptake of 96.23, 53.08 and 149.30 g ha^{-1} in grain, straw and total plant, respectively. Among the different foliar nutrient application of 1% urea + 2% DAP + 1% KCl (F_1) recorded significantly higher uptake of 96.66, 55.50 g ha^{-1} in grain, straw and total uptake during the harvest stage. The low values for zinc uptake recorded under the no spray (F_6) treatment (Fig. 2). Among two varieties tested, CO-54 recorded higher iron uptake of 89.42, 66.31 and 155.74 g ha^{-1} than ADT-53 in grain, straw and total plant, respectively. With respect to different foliar nutrient application, 1% urea + 2% DAP + 1% KCl (F_1) recorded higher uptake of 91.78, 70.41 and 162.18 g ha^{-1} in grain, straw and total plant, respectively when compared to other treatments. The low iron uptake was reported under no spray treatment (Fig. 2). The interaction effect between varieties and foliar application was found not significant.

Foliar zinc application either alone or in combination with soil application, significantly increased grain zinc concentration (25). Regardless of varieties, foliar application resulted in higher concentration of micronutrients including zinc and iron in grains and straw eventually on total plant. Supply of all macronutrients as foliar spray influence the plant to absorb micronutrients such as zinc and iron accumulated in plants. This aligns with the findings of (26). Foliar application of zinc fertilizers enhanced grain zinc concentration, 2 to 3 folds depending on the plant availability (27). Foliar application of 0.5% ferrous sulphate and 0.2% zinc sulphate at critical period of crop growth significantly increased the uptake (28). Foliar application of zinc has been

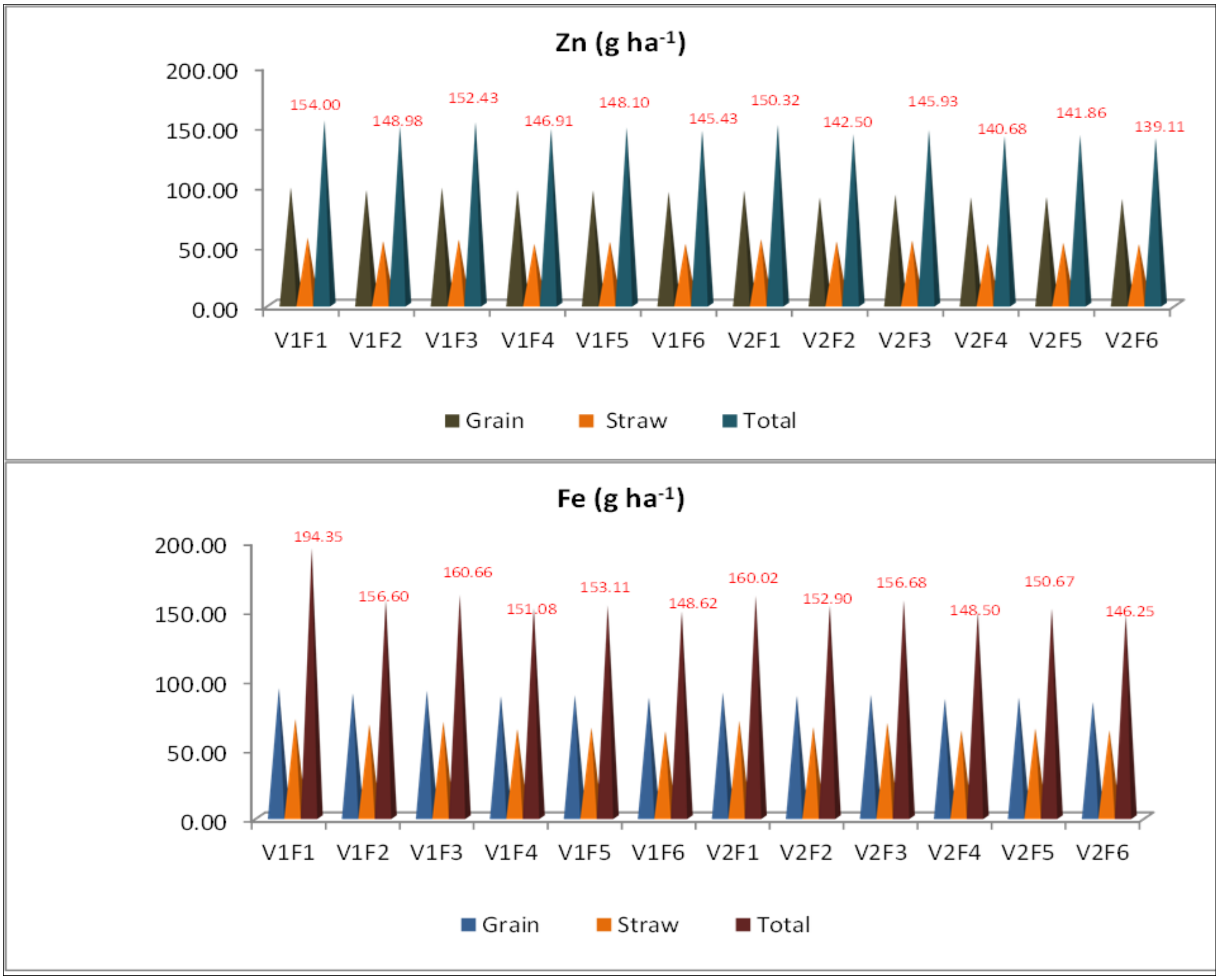

Fig. 2. Effect of foliar application of nutrients on uptake of Zn and Fe (g ha^{-1}) at harvest stage of rice varieties under drip fertigation.

recommended as an effective method to treat deficiencies and increase the zinc content of rice grains (29). The zinc was absorbed through leaf epidermis and remobilized and transmitted to rice grain through the phloem with the contribution of zinc-regulating proteins and foliar-supplied zinc and nitrogen are synergistically efficient for increasing zinc availability which significantly raised the zinc concentrations in leaves, unhusked grains and brown rice.

Economic analysis

A detailed analysis of the data pertained to economic indicators clearly indicated that a higher net return of Rs. 54330 ha^{-1} recorded under CO-54 with foliar application of 1% urea + 2% DAP + 1 KCl (V_1F_1) followed by (V_1F_3) CO-54 with 2% MAP + 1% KCL as Rs. 41244 ha^{-1} (Table 4). Rice varieties CO-54 with foliar application of 1% urea + 2% DAP + 1% KCl (V_1F_1) recorded a higher B:C ratio of 2.12 followed by CO-54 with 2% MAP + 1% KCL (V_1F_3) with a B:C ratio of 2.06. ADT-53 with no spray (V_1F_6) recorded a lower of B:C ratio of 1.83. The cost of cultivation was higher under V_1F_1 (Rs. 48672 ha^{-1}). The higher cost of cultivation is mainly due to addition of nutrients and labour cost for spraying when compared to no spray. The gross income, net income and B:C ratio (Rs. 103002, Rs. 54330 and 2.12) were higher in V_1F_1 followed by (Rs. 101855, Rs. 52485 and 2.06) V_1F_3 and (Rs. 99109, Rs. 49305 and 1.99) V_1F_2. Income from more grain and straw yield contributed more gross income, net income and B:C ratio. The least value was registered under no spray treatment because of lower grain and straw yield even though less cost of cultivation when compared to other foliar applied treatments. The higher net income and B:C ratios were also obtained under supplemental nutrition through foliar application.

Conclusion

Rice crop performance improved with the application of RDF of nitrogen (N), phosphorus (P) and potassium (K) through drip fertigation, supplemented with foliar application of various nutrients and their combinations. Among two rice varieties tested, CO-54 outperformed ADT-53. The study results indicated that the rice variety CO-54, when combined with the RDF of N, P and K through drip fertigation, led to a significant increase in yield components and grain yield. Additionally, foliar application of 1% urea + 2% DAP + 1% KCl at panicle initiation and 10 days later significantly enhanced Zn and Fe partitioning in aerobic rice under drip fertigation, improving nutrient accumulation and grain quality. These findings suggest that RDF of N, P and K through drip fertigation, along with foliar application of 1% urea + 2% DAP + 1% KCl at panicle initiation and 10 days later could be a cost -effective strategy to enhance aerobic rice yield under drip fertigation.

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Authors' contributions

ST conceived the idea, planned the study and developed the research methodology. KA conducted the field experiments and laboratory analysis. TS and KA wrote the original manuscript, while JB, SKN, ST and SM edited and reviewed the final version. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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Table 4. Effect of foliar application of nutrients on economic analysis of drip fertigated rice

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
V_1F_1	48672	103002	54330	2.12
V_1F_2	49804	99109	49305	1.99
V_1F_3	49370	101855	52485	2.06
V_1F_4	48454	89771	41317	1.85
V_1F_5	49454	96412	46958	1.95
V_1F_6	47954	85232	37278	1.78
V_2F_1	48672	100841	52169	2.07
V_2F_2	49804	90347	40543	1.81
V_2F_3	49370	92122	42752	1.87
V_2F_4	48454	86888	38434	1.79
V_2F_5	49454	88072	38618	1.78
V_2F_6	47954	82902	34948	1.73

Data is not statistically analysed. Rs. - Indian Rupees

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