The Pharma Innovation Journal 2022; 11(11): 2031-2035

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 2031-2035

www.thepharmajournal.com
Received: 01-09-2022
Accepted: 03-10-2022

Dr. Rani B
Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India

Shamsida P
Research Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India

Corresponding Author:
Dr. Rani B
Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India

Growth and yield response of upland rice to secondary and micronutrient application under organic and integrated management

Dr. Rani B and Shamsida P

Abstract
A field experiment was conducted to investigate the effect of secondary and micronutrient application under organic and integrated nutrient management practices on yield attributes, yield and nutrient uptake by upland rice, at farmers field, Venganoor, Thiruvananthapuram, Kerala, during June to September. Foliar spray of 0.5% prepared micronutrient solution (containing $FeSO_4$. $7H_2O$ (0.1%), $ZnSO_4.7H_2O$ (0.25%), borax (0.1%), $MnSO_4$. H_2O (0.025%) and $CuSO_4$. $5H_2O$ (0.025%)) or 1% Sampoorna KAU multimix (containing Zn (7%), B (4.5%), Cu (0.5%), Fe (0.2%), Mn (0.2%) and Mo (0.02%)) along with recommended dose of nutrients with lime or dolomite, produced significant increase in panicle weight, panicle length, number of spikelets per panicle and percent filled grains resulting in higher grain yield compared to the treatment receiving KAU PoP with lime or dolomite and without micronutrient application. Organic farming treatments supplemented with either of the micronutrient sources gave higher grain yield compared to pure organic treatment. Foliar application of micronutrients also resulted in significant increase in total uptake of macro and micronutrients.

Keywords: Upland rice, liming, micronutrients, foliar application

1. Introduction
Rice (*Oryza sativa* L.) is the most important food crop of the world and half of the population subsists wholly or partially on it. The population of India is estimated to reach around 1.4 and 1.6 billion by 2025 and 2050, with the respective requirement of 380 and 450 mt of food grains annually (Yadav *et al*., 2010) [10]. Rice production does not meet the ever increasing demand mainly due to the declining productivity and shrinking area of wet land paddy. The limited wetland area available for rice cultivation with minimum scope for increasing the area under rice, coupled with scarcity of water resources, has forced rice farmers to search for alternate methods of cultivation, to meet the increasing demand. Since rice thrives reasonably well under diverse soil and climatic conditions, more thrust has been recently laid upon upland rice technology.

The average yield of rice in upland areas in the country is less than 1.0 t ha^{-1}. Moisture stress is the primary limiting factor for growth and yield of rice under upland conditions. Indiscriminate use of major fertilizer nutrients without the application of micronutrients, coupled with limited use of organic manures has led to the incidence and expansion of secondary and micronutrient deficiencies in the soil which aggravates the problem of reduced productivity in rice (Singh *et al*., 2010) [21].

Upland rice soils are highly acidic, low in CEC and also encounter mineral stresses. Liming when coupled with balanced nutrient application by way of organics and micronutrients, increases the base saturation of soil, provide balanced nutrition, sustain soil fertility, improve nutrient availability and produce better crop yields under upland conditions.

Soil application of nutrients may not be equally effective in upland rice due to moisture stress, negative effect of pH, nutrient interactions and nutrient losses. Sometimes soil application may be ineffective due to immobilization of soil applied nutrients (Shayganya *et al*., 2012) [18]. Individual application of each of the macro and micro nutrient fertilizers is very difficult, time consuming and increases the cost of production. Hence combined application of nutrients as foliar spray is a viable alternative. Hence the study was conducted to investigate the effect of secondary and micronutrient application under organic and integrated nutrient management practices in enhancing the nutrient uptake and productivity of upland rice.

2. Materials and Methods

The study was carried out at College of Agriculture, Vellayani (Kerala Agricultural University) with a field experiment in farmer's field, Venganoor, Thiruvananthapuram, Kerala, India. The experimental field lies between 8o 41' 56''N latitude and 77o 01' 92''E longitude. The soil of the experimental site before the crop was sandy clay loam in texture with pH 4.95, electrical conductivity 0.612 dS m-1, organic carbon 0.79 per cent, available N 358 kg ha^{-1}, available P 37 kg ha^{-1} and available K 450.8 kg ha^{-1}. The content of exchangeable Ca was 385.9 mg kg^{-1}, and exchangeable Mg 264.0 mg kg^{-1}, available Fe 20.48 mg kg^{-1}, available Mn 15.47 mg kg^{-1}, available Cu 3.31 mg kg^{-1}, available Zn 3.45 mg kg^{-1} and available B 0.30 mg kg^{-1}.

Rice variety Uma, (medium duration (115-120 days)) was raised under upland conditions during June to September, 2018. Healthy seeds @ 80 kg ha^{-1} were dibbled in the main field at a spacing of 20 cm x15 cm, one week after the addition of organic manures. The experiment was laid out in a randomized block design (plots of size of 5 m x 4 m) with three replications and ten treatments *viz*. absolute control (T1), KAU PoP (FYM- 5 t ha^{-1}, N: P2O5: K2O - 60:30:30 kg ha^{-1}) (T2), KAU PoP + dolomite (T3), KAU PoP for organic farming (FYM- 5 t ha^{-1} + 600-800 kg of neem cake per ha, half as basal and half as top dressing at active tillering stage) (T4), foliar application of micronutrient solution or KAU sampoorna multimix respectively along with lime (T5 and T6), dolomite (T7 and T8) and organic farming treatment (T9 and T10).

Organic manures and fertilizers were applied as per the Package of Practices recommendations of Kerala Agricultural University (KAU, 2016; KAU PoP, 2009) [6]. The NPK fertilizer requirements were supplied through urea (46% N), rajphos (20% P2O5) and muriate of potash (60% K2O), respectively. Calcium carbonate and dolomite were used as liming materials. 0.5% micronutrient solution (containing FeSO4.7H2O (0.1%), ZnSO4.7H2O (0.25%), borax (0.1%), MnSO4. H2O (0.025%) and CuSO4. 5H2O (0.025%)), or 1% Sampoorna

KAU multimix (containing Zn (7%), B (4.5%), Cu (0.5%), Fe (0.2%), Mn (0.2%) and Mo (0.02%)) were used for foliar spray. The micronutrient solution was prepared by dissolving FeSO4.7H2O (1 g), $ZnSO_4$. $7H_2O$ (2.5 g), borax (1 g), $MnSO_4$. H2O (0.25 g) and $CuSO_4$. 5H2O (0.25 g) in one litre of water to get the above composition. Foliar spray of micronutrients were given during the critical growth stages of the crop *viz*. active tillering, panicle initiation and one week after flowering.

All growth and yield parameters like length of panicle, weight of panicle, number of productive tillers per m2, thousand grain weight, per cent filled grains and number of spikelets per panicle were recorded using standard methodology. Grain and straw yields recorded per plot were expressed in kg ha^{-1}. Grain and straw samples for chemical analysis were collected at harvest stage, and oven dried at 70 °C and were analysed using standard procedures for N (Modified kjeldahl method), P (Vanado molybdate yellow colour method), K (Flame photometry), Ca and Mg (Versenate titration method), micronutrients (Atomic absorption spectrometer) and B (Azomethine-H colorimetric method) and the respective nutrient uptakes were calculated. The data obtained were statistically analysed using analysis of variance (ANOVA) technique given by Cochran and Cox, 1965.

3. Results and Discussion

3.1 Yield attributes and yield

The treatment effects were found to be significant with respect to the yield attributes of upland rice *viz*. number of productive tillers per m2, length of panicle, weight of panicle, number of spikelets per panicle, per cent filled grains and thousand grain weight (Table 1).

Highest number of productive tillers per m2 was recorded for treatments T5 and T7 receiving micronutrient solution along with lime and dolomite respectively and was found to be on par with other treatments receiving foliar application of sampoorna multimix along with lime or dolomite. The number of panicle bearing tillers contributes towards the production potential of rice crop. Adequate supply of micronutrient elements has led to increased uptake of other essential nutrients, which results in improvement of plant metabolic processes, ultimately translating to crop growth and yield. Similar results were reported by Slaton *et al*. (2002) [19] and Naik and Das (2007) [10].

KAU PoP with lime or dolomite (T2 and T3) gave significantly higher number of productive tillers compared to organic farming treatments (T4, T9 and T10). Lime application was reported to improve the yield attributes of rice *viz*. number of panicle bearing tillers (Chang and Sung, 2004). Since nutrients are released slowly in a phased manner under pure organic farming practices, growth is relatively slower, but foliar application helps in the quick absorption of nutrients. Similar results were published by Asewar *et al*. (2000) [1].

Foliar application of micronutrients produced significant increase in yield and yield attributes with treatment T8 recording the highest value for length of panicle (23.43 cm), panicle weight (2.41 g), percent filled grains (87.17%), number of spikelets per panicle (154.73) and thousand grain weight (23.53 g) which was on par with all the treatments receiving micronutrients (T5 to T10). The number of spikelets per panicle for T2 and T3 was also on par with T8. No significant variation was observed in 1000 grain weight due to the application of different treatments. Treatments which did not receive foliar applications including absolute control gave significantly lower values for yield attributes. Zayed *et al*. (2011) [22] also reported that foliar application of Zn+2, Fe2+ and Mn+2 twice, at 20 and 45 days after transplanting produced the highest values for panicle length. Foliar application of zinc and iron has been reported to significantly increase the length of panicle in rice (Hemantaranjan and Gray, 1988) [4].

Table 1: Effect of treatments on yield attributes of upland rice

Treatments	Productive tillersm^{-2}	Length of panicle (cm)	Weight of panicle (g)	Number of spikelets panicle^{-1}	Per cent filled grains (%)	Thousand grain weight (g)
T1	139.33	15.33	1.30	91.60	77.03	22.03
T2	275.50	20.67	2.04	143.47	82.33	23.07
T3	257.00	20.77	2.03	145.88	82.42	22.90
T4	217.50	20.53	1.88	137.40	79.13	22.77
T5	305.00	22.50	2.31	149.50	85.63	23.47
T6	301.83	22.50	2.39	150.13	85.87	23.40
T7	305.00	21.67	2.35	151.33	85.60	23.03
T8	302.90	23.43	2.41	154.73	87.17	23.53
T9	232.50	21.27	2.17	139.33	83.30	22.87
T10	240.00	21.13	2.15	140.73	83.17	22.90
CD (0.05)	22.870	2.527	0.362	13.602	4.477	NS

The efficiency of micronutrients in improving the various metabolic processes in plants has been well established. This might have enhanced the accumulation of assimilates in the grains and results in heavier grains and lengthy panicle. The improvement in number of grains per panicle and per cent filled grains by supplementing micronutrients might be due to their role in reducing the pollen sterility, improved pollen formation and fertilization and better grain setting. Similar observations were reported by Rehman *et al*. (2012) [15] and Quadir *et al*., (2013) [12]. Amelioration of soil acidity with lime and dolomite leading to increased supply of Ca and Mg might have also influenced grain formation since Ca and Mg plays a pivotal role in maintaining nutritional balance and photosynthesis. Similar results were reported by Sahrawat *et al*., (1999) [17]. Though organic matter is an important secondary source of micronutrients, most of these nutrients are held tightly in complex organic combinations and hence are available only over an extended period. This might be the reason for less number of filled grains per panicle under organic farming alone (T4) in rice, which is a short duration crop.

Micronutrient application either as micronutrient solution or as sampoorna multimix along with KAU PoP (lime or dolomite) gave significantly higher grain yield compared to all other treatments with the highest value obtained for T8 (4158 kg ha^{-1}) (Table 2). Supplementing micronutrient as foliar spray results in adequate and timely supply of micronutrients at critical stages coupled with easy of absorption has resulted in enhanced yield (Tariq *et al*., 2007) [20]. Limig (CaO or dolomite) also found effective in giving higher yield due to amelioration of soil acidity thereby improving the availability of nutrients required by the plants. Similar result was reported by Rahman *et al*. (2002) [13]. Cedari and Malakouti (1998) [2] reported that application of zinc sulfate, copper sulphate and iron sulphate, caused an yield increase of 20 per cent compared to control.

Table 2: Effect of treatments on grain and straw yield of rice (kg ha^{-1})

Treatments	Grain yield	Straw yield
T1- Absolute control	1055.6	2269.6
T2- KAU PoP with lime	3390.0	4337.6
T3- KAU PoP with dolomite	3372.0	4328.0
T4- KAU PoP for organic farming	2808.0	4130.3
T5- T2 + micronutrient solution	3888.0	4897.6
T6- T2+ sampoorna multimix	4024.8	4321.3
T7- T3 + micronutrient solution	3894.0	4372.3
T8- T3 + sampoorna multimix	4158.0	4362.0
T9 - T4 + micronutrient solution	2936.2	4084.3
T10- T4 + sampoorna multimix	3276.4	3933.3
CD (0.05)	472.55	645.87

Yield obtained for the treatment receiving KAU PoP with lime or dolomite and without micronutrient application (T2 and T3) was on par with organic farming treatments supplemented with micronutrients (T9 and T10). This might be due to the balanced nutrition provided to the plants, including micro nutrients at critical growth stages, favourably affecting the growth and yield attributes.

Highest straw yield was recorded by T5 (4897.6 kg ha^{-1}) which was on par with other micronutrient applied treatments (T6 to T8) and KAU PoP receiving lime or dolomite (T2, T3). Straw yield for organic farming treatments were comparatively lower than the other INM treatments with or without micronutrients with significant reduction observed with T5. Micronutrients are involved in various physiological processes like enzyme activation, electron transport, chlorophyll formation and stomata regulation which ultimately results in greater dry matter production. Similar results were reported by Sadana and Nayyar (2002) [16]. Foliar application of nutrients at critical stages facilitated the easy absorption and utilization of these nutrients leading to accelerated plant growth (Khan *et al*., 2010) [9].

3.2 Uptake of nutrients

Foliar application of micronutrients along with lime or dolomite resulted in significant increase in total uptake of macro and micronutrients by the plant. Foliar application of sampoorna multimix along with dolomite (T8) gave higher value for the total uptake of N, K, Mg and Fe by the plant. Treatment T5 registered higher uptake of P, Ca, Zn and B by the plant. Manganese and copper uptake were highest for the T7 and T6 respectively (Table 3 and 4).

The higher value for uptake of macronutrients in the micronutrient supplemented treatments might be due to the presence of iron, zinc and sulphur in the mixture which have facilitated increased uptake of NPK over control (Ravi *et al*., 2008) [14]. Application of liming materials (lime or dolomite) supplies Ca and Mg to the soil which can easily be absorbed by the plants. Similar results was reported by Rahman *et al*. (2002) [13].

Table 3: Effect of treatments on uptake of nutrients (kg ha^{-1})

Treatments	N	P	K	Ca	Mg
T1- Absolute control	25.00	5.12	24.91	8.72	6.89
T2- KAU PoP with lime	90.97	16.56	78.03	25.59	18.91
T3- KAU PoP with dolomite	88.74	16.26	74.21	23.53	21.83
T4- KAU PoP for organic farming	72.67	12.20	60.44	19.17	14.44
T5- T2 + micronutrient solution	106.97	19.62	87.91	28.26	20.06
T6- T2+ KAU sampoorna multimix	107.41	18.54	87.48	27.60	19.29
T7- T3 + micronutrient solution	108.58	17.99	81.47	24.59	21.16
T8- T3 + KAU sampoorna multimix	110.75	18.89	88.49	25.79	23.06
T9 - T4 + micronutrient solution	76.20	15.01	64.03	19.81	15.73
T10- T4 + KAU sampoorna multimix	76.38	14.72	67.25	19.75	16.17
CD (0.05)	19.423	2.934	15.058	5.181	3.526

Table 4: Effect of treatments on uptake of micronutrients (kg ha^{-1})

Treatments	Fe	Mn	Cu	Zn	B
T1- Absolute control	0.878	0.686	0.028	0.191	0.025
T2- KAU PoP with lime	2.174	1.387	0.099	0.648	0.064
T3- KAU PoP with dolomite	2.211	1.390	0.092	0.607	0.063
T4- KAU PoP for organic farming	1.783	1.285	0.072	0.538	0.053
T5- T2 + micronutrient solution	2.902	2.110	0.129	0.867	0.091
T6- T2+ KAU sampoorna multimix	3.020	1.781	0.132	0.823	0.088
T7- T3 + micronutrient solution	3.032	1.892	0.123	0.820	0.083
T8- T3 + KAU sampoorna multimix	3.138	1.793	0.125	0.821	0.090
T9 - T4 + micronutrient solution	2.432	1.369	0.089	0.623	0.061
T10- T4 + KAU sampoorna multimix	2.397	1.324	0.088	0.607	0.063
CD (0.05)	0.548	0.251	0.021	0.116	0.017

Foliar application of micronutrients must have exerted its direct effect on its composition due to direct absorption by the foliage. Application of micronutrients brought out significant increases in Fe, Mn, Cu, Zn and B content in straw and grain of the rice crop, thereby the uptake by plants. Similar findings were also reported by Jin *et al*. (2008) [5] and Narwal *et al*. (2012) [11].

The higher dry matter production as well as higher concentration due to integrated nutrient management coupled with application of secondary and micronutrients might have contributed to better uptake of macro and micronutrients by the plants.

4. Conclusion

Based on the study, it can be concluded that foliar application of micronutrients (sampoorna multimix or micronutrient solution) along with KAU PoP (lime or dolomite) significantly enhanced the growth and yield of upland rice. The uptake of macro and micronutrients were also significantly influenced by liming and micronutrient supplementation. Organic farming treatments supplemented with micronutrients resulted in significantly higher grain and straw yield compared to pure organic treatment and produced yield on par with the KAU PoP (lime or dolomite) treatments.

5. References

1. Asewar BV, Dahiphale VV, Chavan GV, Katare NB, Sontakke JS. Effect of ferrous sulphate on grain yield of upland basmati rice. J Maharastra Agricultural Universities. 2000;25(2):209-210.
2. Cedari MH, Malakouti MG. Determine the critical levels of micronutrients in wheat fields in Kurdistan. J Soil Water. 1998;15:72-81
3. Chang CS, Sung JM. Nutrient uptake and yield responses of peanuts and rice to lime and fused magnesium phosphate in an acid soil. Fld. Crops Res. 2004;89:319-325.
4. Cochran WG, Cox GM. Experimental Designs. John Willey and Sons Inc., New York, 182p. Hemantaranjan, A. and Gray, O. K. 1988. Iron and zinc fertilization with reference to the grain quality of *Triticum aestivum* L. J of Plant Nutri. 1965;11(11):1439-1450.
5. Jin Z, Minyan W, Lianghuan W, Jiangguo W, Chunhai S. Impacts of combination of foliar iron and boron application on iron biofortification and nutritional quality of rice grain. J Plant Nutr. 2008;31:1599-1611.
6. KAU [Kerala Agricultural University]. Package of Practices Recommendation (Adhoc) for Organic Farming: Crops. Kerala Agricultural University, Thrissur; c2009. p. 200.
7. KAU [Kerala Agricultural University]. Package of Practices Recommendations: Crops (15thEd.). Kerala
8. Agricultural University, Thrissur; c2016. p. 393.
9. Khan MB, Farooq M, Hussain M, Shanawaz H, Shabir G. Foliar application of micronutrients improves the wheat yield and net economic return. Int. J Agric. Biol. 2010;12:953-956.
10. Naik SK, Das DK. Effect of split application of zinc on yield of rice (*Oryza sativa* L.) in an Inceptisol. Arch. Agron. Soil Sci. 2007;53:305-313.
11. Narwal RP, Dahiya RR, Malik RS, Kala R. Influence of genetic variability on zinc, iron and manganese responses in wheat. J Geochemical Exploration. 2012;121:45-48.
12. Quadir J, Awan AU, Baloch SM, Shah IH, Nadim AM, Saba MA, *et al*. Application of micronutrients for yield enhancement in rice. Gomal University J Res. 2013;29(2):254-265.
13. Rahman MA, Meisner CA, Duxbury JM, Lauren J, Hossain ABS. Yield response and change in nutrient availability by application of lime, fertilizer and micronutrient fertilizer in acid soil in a rice- wheat cropping system. Symbosium. 2002;05:773.
14. Ravi S, Channal HT, Hebsur NS, Patil BN, Dharmatti PR. Effect of sulphur, zinc and iron nutrition on growth yield nutrient uptake and quality of safflower (*Carthamus tinctorius* L). Karnataka J Agric. Sci. 2008;21(3):382-385.
15. Rehman A, Farooq M, Cheema ZA, Wahid A. Seed priming with boron improves growth and yield of fine grain aromatic rice. Plant Growth Regul. 2012;14(3):28-35.
16. Sadana US, Nayyar VK. Amelioration of iron deficiency in rice and transformations of soil iron in coarse textured soils of Punjab. J Plant Nutr. 2000;23:2061-2069.
17. Sahrawat KL, Jones MP, Diatta S. Phosphorus, calcium, and magnesium fertilization effects on upland rice in an ultisol, Commun. Soil Sci. Plant Anal. 1999;30:1201-1208.
18. Shayganya J, Peivandya N, Ghasemi S. Increased yield of direct seeded rice (*Oryza sativa* L.) by foliar fertilization

through multi-component fertilizers. Arch. Agron. Soil Sci. 2012;58(10):1091-1098.
19. Slaton NA, Wilson CE, Norman RJ, Ghur EE. Development of a critical Mehlich 3 soil zinc concentration for rice in Arkanas. Commun. Soil Sci. Plant Anal. 2002;33:454-458.
20. Tariq M, Sharif M, Shah Z. Effect of foliar application of micronutrients on the yield and quality of sweet orange. Pak. J Biol. Sci. 2007;10:823-1828.
21. Yadav GH, Kumar D, Shivay YS, Singh H. Zincenriched urea improves grain yield and quality of aromatic rice. Better Crops. 2010;3(1):4-5.
22. Zayed BA, Salem AKM, El-Sharkawy HM. Effect of different micronutrient treatments on rice (*Oryza sativa* L.) growth and yield under saline soil conditions. World J Agric. Sci. 2011;7(2):179-184.
23. Kharbuli D., Bhattacharjee B., Pala S. "A review on Improving Phosphorus use efficiency of upland rice with emerging opportunities of breeding". International Journal of Agriculture and Plant Science. 2020:2(3):22-28.