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Short Communication

Availability and uptake of nutrients as influenced by levels and schedule of application in upland rice

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Abstract
Field experiment was conducted at Coconut Research Station Balaramapuram during *Kharif* season 2017 with an objective to evaluate the effect of nutrient levels and schedule of nutrient application on the nutrient uptake, nutrient availability and yield of upland rice. The experiment was laid out in factorial RBD with nutrient levels as first factor and schedule of nutrient application as second factor. Among the nutrients levels, NPK @ 120:30:60 kg ha^{-1} (n_4) recorded the highest N and K uptake but it was statistically comparable with n_3 (90:30:45 kg ha^{-1}). However, P and Zn uptake was the highest in n_3 (NPK @ 90:30:45 kg ha^{-1}) and it was significantly superior to other nutrient levels. Post-harvest soil nutrient status revealed that available N, P and K status and organic carbon content were the highest in the treatment NPK @120:30:60 kg ha^{-1}. Among the schedules of nutrient application, treatments with foliar application of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 days after sowing (DAS) recorded higher availability of nutrients and uptake of nutrients by crop. Organic carbon content of soil was not significantly influenced by schedule of nutrient application. Grain yield and net returns were significantly influenced by nutrient levels and schedule of nutrient application. Application of N:P:K @ 90:30:45 kg ha^{-1} applied as N in three equal splits, P as basal and K either in two equal splits or three equal splits along with foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate recorded the highest grain yield (3.25 t ha^{-1}) and net returns (35, 637 Rs ha^{-1}) .

Key words: Grain yield, Nutrient availability, Nutrient uptake, Straw yield, Upland rice.

Government of Kerala celebrated 2016 as “Rice year” which signifies the importance of rice in food security and its role in alleviating poverty and malnutrition. Though rice is the staple food of Kerala, area under rice is decreasing day by day due to conversion of paddy land for housing, industrial purposes and other uses. The area under rice declined by 57 per cent between 1980 to 81 and 2000 to 2001, and further by 33 per cent between 2000 to 2001, and 2009 to 2010 (Viswanathan, 2014). Enhancing the production and productivity of rice is the only possible way to meet the food requirement. Utilization of inter-row spaces in coconut garden of more than 25 years age can be exploited to increase the area under rice. Studies conducted by CPCRI and Kerala Agricultural University revealed that upland rice comes up well as intercrop in coconut garden (Gopalasundaram and Nelliat, 1979, KAU, 2016). The inter row spaces of coconut garden can be successfully utilized for rice cultivation. Nearly 60-75 per cent of the land area and 40 per cent of the solar energy in 7.5 m x 7.5 m spaced coconut are left unutilized which provides ample scope for growing compatible intercrops (Nelliat, 1979; Dhanpal, 2010).

Proper nutrient scheduling reduces the nutrient

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losses, increases the use efficiency of fertilizers and prevents environmental pollution while enhancing the grain yield. By application of major nutrients at optimum levels to match the soil fertility, season and climate, the yield can be enhanced to 40 per cent (Murthy et al., 2015). As a fertilizer recommendation for raising upland rice in coconut garden in the red sandy loam soil of Thiruvananthapuram is lacking, a study was undertaken at Coconut Research Station, Balaramapuram, with an objective to investigate the effect of different levels of nutrients and schedule of nutrient application on dry matter production, nutrient uptake and availability, and grain yield of upland rice intercropped in coconut garden.

A field experiment was conducted at Coconut Research Station Balaramapuram in factorial randomized block design with two factors. The first factor comprised of four different nutrient levels *viz*., n_1- NPK @ 60:30:30 kg ha^{-1}, n_2- NPK @ 70:30:35 kg ha^{-1}, n_3- NPK @ 90:30:45 kg ha^{-1} and n_4- NPK @ 120:30:60 kg ha^{-1}. The second factor consisted of four different nutrient schedules *viz*., s_1- N in three equal splits (at 15 DAS, active tillering and panicle initiation stage), P as basal application and K in two equal splits (at 15 DAS and panicle initiation stage), s_2- N in three equal splits (at 15 DAS, active tillering and panicle initiation stage), P as basal application and K in three equal splits (at 15 DAS, active tillering and panicle initiation stage), s_3- s_1 + foliar spray of 0.2 percent zinc sulphate and 0.04 per cent sodium borate at 45 DAS and s_4- s_2 + foliar spray of 0.2 percent zinc sulphate and 0.04 per cent sodium borate at 45 DAS. The experiment was conducted during 2017 *Kharif* season (9/6/2017 to 4/10/2017). The experimental site experiences warm humid climate. The total rainfall received during the crop season was 884.3 mm in 41 rainy days. The soil was red sandy loam in texture, acidic in reaction, medium in organic carbon, high in available P, medium in N and K. The Zn content of soil was in the sufficiency range and B in the deficiency range. Prathyasa (MO 21) a short duration variety was used as the test crop. Seed rate adopted was 80 kg ha^{-1} and the dry paddy seeds were dibbled at a spacing of 20 cm x 10 cm on 9/6/2017. The crop was raised purely as an upland crop. The weeds were controlled by the post emergence application of bispyribac sodium 25 g ha^{-1} at 15 DAS followed by chlorimuron ethyl+metsulfuron methyl (4 g ha^{-1}) at 35 DAS. Soil samples were analyzed for available N, P, K, Zn and B, and organic carbon content using standard procedures. The plant samples were analyzed for N, P, K, Zn and B content and nutrient uptake were worked out by multiplying the respective nutrient content with dry matter production (DMP) at harvest. Panicles m^{-2} and grains per panicle were recorded at harvest. The grain and straw harvested from the net plot area were sun dried to constant weight and expressed in t ha^{-1}. Net returns were calculated based on the prevailing market price of the inputs and produce. All the data were subjected to analysis of variance (ANOVA) and critical difference between the treatment means were compared at 5 per cent probability level.

Nutrient levels had significant effect on N, P, K and Zn uptake by rice crop. However, B uptake was not significantly influenced by nutrient levels (Table 1). Among the nutrients levels, higher nutrient level, NPK @ 120:30:60 kg ha^{-1} (n_4) recorded the highest N and K uptake, but it was statistically comparable with n_3 (90:30:45 kg ha^{-1}). However, P and Zn uptake was the highest in n_3 (NPK @ 90:30:45 kg ha^{-1}) and it was significantly superior to other nutrient levels. Though not significant, B uptake by crop at harvest was also the highest in n_3 (NPK @ 90:30:45 kg ha^{-1}). The higher nutrient uptake observed in n_3 was due to the higher nutrient contents and dry matter production (Table 1) registered in this treatment. Murthy et al. (2015) observed that higher rate of application of nutrients enhanced the rate of availability of nutrients in the soil solution and the plants absorbed the nutrients proportionally leading to higher uptake.

Schedule of nutrient application also significantly influenced the nutrient uptake of N, P, Zn and B (Table 1). Compared to s_1 (N in three splits, K in

Table 1. Effect of nutrient levels and schedule of nutrient application dry matter production and nutrient uptake by crop at harvest stage (kg ha^{-1})

Treatments	DMP	N uptake	P uptake	K uptake	Zn uptake	B uptake
n_1 (NPK @ 60:30:30 kg ha^{-1})	6339	71.56	16.54	59.76	0.429	0.294
n_2 (NPK @ 70:30:35 kg ha^{-1})	6633	75.45	17.26	67.77	0.445	0.309
n_3 (NPK @ 90:30:45 kg ha^{-1})	7152	80.26	18.39	72.43	0.543	0.325
n_4 (NPK @ 120:30:60 kg ha^{-1})	6433	84.57	17.11	76.09	0.475	0.323
SE m (±)	107	2.21	0.28	2.37	0.02	0.02
CD (0.05)	312.7	6.411	0.819	6.873	0.050	NS
s_1- N in 3 splits, P basal and K in 2 splits	6446	73.49	16.65	67.30	0.438	0.272
s_2- N in 3 splits, P as basal and K in three equal splits	6477	76.42	16.71	67.96	0.417	0.298
s_3- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	6945	83.64	17.42	70.60	0.490	0.328
s_4- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	6689	78.29	18.23	70.40	0.546	0.352
SE m (±)	107	2.21	0.28	2.37	0.020	0.020
CD (0.05)	312.67	6.411	0.819	NS	0.050	0.043

DMP: dry matter production, NS: non-significant

two equal splits and P as basal application) and s_2 (N and K in three equal splits and P as basal application), higher values of N, P, K, Zn and B uptake were registered in s_3 (s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS) and s_4 (s_2 + foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS). This could be attributed to the enhanced growth and DMP (Table 1) resulting from the consistent availability of nutrients in the rice rhizosphere. The increased B and Zn uptake recorded in s_3 and s_4 might be due to the favourable influence of foliar spray of sodium borate and zinc sulphate on DMP.

Rehman et al. (2012) reported that foliar nutrition of Zn increased the Zn uptake. Increase in N, P and K uptake due to foliar application of B was also

Table 2. Interaction effect between nutrient levels and schedule of nutrient application on dry matter production and nutrient uptake by crop at harvest stage (kg ha^{-1})

Treatments	DMP	N uptake	P uptake	K uptake	Zn uptake	B uptake
n_1s_1	6167	69.75	15.62	55.14	0.505	0.270
n_1s_2	6387	74.02	17.48	59.60	0.385	0.252
n_1s_3	6741	80.81	15.60	56.24	0.414	0.378
n_1s_4	6060	61.64	17.47	68.86	0.410	0.275
n_2s_1	6377	58.16	16.28	68.46	0.387	0.256
n_{2S2}	6471	77.13	17.12	64.92	0.378	0.317
n_2s_3	6927	89.92	15.87	63.94	0.485	0.336
n_2s_4	6757	75.45	19.77	73.77	0.532	0.325
n_3s_1	6978	82.45	19.51	69.75	0.437	0.264
n_3s_2	6791	78.66	14.02	72.04	0.442	0.350
n_3s_3	7576	79.30	21.83	77.47	0.605	0.340
n_3s_4	7263	80.65	18.19	70.46	0.685	0.345
n_4s_1	6260	84.81	15.18	75.83	0.423	0.299
n_4s_2	6258	75.81	18.23	75.27	0.464	0.270
n_4s_3	6534	91.53	16.36	84.74	0.455	0.257
n_4s_4	6678	87.35	18.66	68.51	0.556	0.465
SE (±)	215	4.42	0.56	4.74	0.035	0.030
CD (0.05)	NS	12.822	1.638	NS	0.101	0.087

DMP: dry matter production, NS: non-significant

Note: n_1- N: P: K @ 60:30:30 kg ha^{-1}, n_2- N: P: K @ 70:30:35 kg ha^{-1}, n_3- N: P: K @ 90: 30:45 kg ha^{-1}, n_4- N: P: K @ 120: 30:60 kg ha^{-1}
s_1- N in three splits (15 DAS, active tillering and panicle initiation stage), P as basal application and K in two splits (15 DAS and panicle initiation stage), s_2- N and K in three splits (15 DAS, active tillering and panicle initiation stage) and P as basal application, s_3-s_1+ foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 DAS, s_4-s_2 + foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 D

reported by Remesh and Rani (2017).

Application of NPK @ 90:30:45 (n_3) and 120:30:60 kg ha^{-1} (n_4) along with foliar application of sodium borate and zinc sulphate resulted in higher uptake of nutrients (Table 2), which might be due to the better availability of nutrients resulting from the higher level of application of N and K and favourable influence of Zn and B foliar nutrition on DMP.

From the results, it was observed that with the incremental dose of N and K, the organic carbon content of soil was increased (Table 3). The result is in conformity with the findings of Rao et al. (2014) and Aula et al. (2016) who observed that N application at higher rate increased the soil organic carbon content.

Available N, P and K was highest in n_4 (NPK@ 120:30:45 kg ha^{-1}). However, the soil available N and K was statistically comparable with n_3 (NPK @ 90:30:45 kg ha^{-1}). This might be due to the high soil organic carbon content recorded in these treatments. Higher organic carbon content in the soil might have prevented the leaching of nutrients thus sustaining the soil fertility. Sakin (2012) reported that high nitrogen content in the soil was due to the presence of high soil organic carbon (SOC). Rao et al. (2014) also observed that available N content in the soil increased with increase in N level.

Schedule of nutrient application also significantly influenced the available N, P and K status of post-harvest soil (Table 3). Zinc status of post-harvest soil were not significantly influenced by schedule of application. In general, compared to s_1 (N in three splits, K in two equal splits and P as basal alone) and s_2 (N and K in three equal splits and P as basal alone), higher content of available N, P, K and Zn content in the soil were recorded in s_3 (s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS) and s_4 (s_2 + foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS). Though not significant, higher soil organic carbon content in s_3 and s_4 (Table 3) might have reduced the leaching loss of nutrients and sustained the nutrient content of the soil in these treatments. Singh et al. (1992) observed that high management level favoured the fertility status of upland rice soil.

The interaction effect was also found significant for

Table 3. Effect of nutrient levels and schedule of nutrient application on soil organic carbon content and available nutrient status at harvest stage

Treatments	O.C (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Zn (mg kg^{-1} soil)	B (mg kg^{-1} soil)
Nutrient levels						
n_1 (NPK @ 60:30:30 kg ha^{-1})	0.848	254.79	22.69	82.19	1.057	-
n_2 (NPK @ 70:30:35 kg ha^{-1})	0.886	257.29	25.16	91.22	1.073	-
n_3 (NPK @ 90:30:45 kg ha^{-1})	0.928	304.83	29.81	93.18	1.154	-
n_4 (NPK @ 120:30:60 kg ha^{-1})	1.004	329.83	34.61	97.35	1.242	-
SE m (±)	0.030	4.492	0.819	1.563	0.065	-
CD (0.05)	0.087	13.028	2.377	4.535	NS	-
Schedule of nutrient application (S)						
s_1- N in 3 splits, P basal and K in 2 splits	0.888	280.38	27.32	87.30	1.099	-
s_2- N in 3 splits, P as basal and K in three equal splits	0.899	276.61	26.90	80.95	1.054	-
s_3- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	0.978	292.43	30.13	100.24	1.162	-
s_4- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	0.900	296.78	27.93	95.44	1.210	-
SE m (±)	0.030	4.49	0.82	1.56	0.065	-
CD (0.05)	NS	13.028	2.377	4.535	NS	-

Data on available B content in the soil was below the detectable limit, hence not statistically analysed

Table 4. Interaction effect between nutrient levels and schedule of nutrient application on nutrient availability at harvest stage

Treatments	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Zn (mg kg^{-1} soil)	B (mg kg^{-1} soil)
n_1s_1	0.797	250.90	19.86	80.75	0.982	Bdl
n_1s_2	0.757	255.90	24.52	73.36	1.056	0.089
n_1s_3	0.950	240.90	16.98	82.96	1.012	0.080
n_1s_4	0.890	271.90	29.39	91.69	1.178	0.033
n_2s_1	0.830	250.90	25.48	71.91	1.154	0.071
n_{2S2}	0.900	255.90	19.42	87.58	1.039	Bdl
n_2s_3	0.967	261.53	28.07	113.24	1.078	0.080
n_2s_4	0.847	260.93	27.69	93.04	1.021	0.089
n_3s_1	0.967	283.50	31.16	89.38	0.936	0.061
n_3s_2	1.037	283.50	31.68	78.03	0.910	Bdl
n_3s_3	0.920	356.30	28.80	95.09	1.389	0.089
n_3s_4	0.787	296.03	27.61	110.21	1.383	0.016
n_4s_1	0.960	336.38	32.79	108.64	1.326	Bdl
n_4s_2	0.903	311.13	31.98	84.84	1.213	Bdl
n_4s_3	1.077	311.10	46.67	109.69	1.170	Bdl
n_4s_4	1.077	358.67	27.03	86.24	1.260	Bdl
SE (±)	0.060	8.98	1.64	3.13	0.129	-
CD (0.05)	NS	26.056	4.755	9.069	NS	-

bdl- below detectable level, data on B content in the soil was not statistically analyzed

Note: n_1- N: P: K @ 60:30:30 kg ha^{-1}, n_2- N: P: K @ 70:30:35 kg ha^{-1}, n_3- N: P: K @ 90: 30:45 kg ha^{-1}, n_4- N: P: K @ 120: 30:60 kg ha^{-1}
s_1- N in three splits (15 DAS, active tillering and panicle initiation stage), P as basal application and K in two splits (15 DAS and panicle initiation stage), s_2- N and K in three splits (15 DAS, active tillering and panicle initiation stage) and P as basal application, s_3-s_1+ foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 DAS, s_4-s_2 + foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 DAS

N, P and K status of the post- harvest soil (Table 4). Among the treatment combinations, n_4s_4 registered higher available soil N and was on par with n_3s_3 and n_4s_1. The treatment, n_4s_3 registered the highest available soil P and n_2s_3 recorded higher available K content which was on par with n_3s_4, n_4s_1 and n_4s_3.The data clearly revealed that the treatments having higher content of organic carbon in the soil retained more amount of nutrients.

Grain yield was significantly influenced by nutrient levels (Table 5), however straw yield was not influenced by the treatments (Table 5). The treatment n_3 (NPK @ 90:30:45 kg ha^{-1}) recorded the highest grain yield (3.00 t ha^{-1}) which was significantly superior to other nutrient levels. Higher number of panicle m^{-2} and grains per panicle (Table 5) result from the better and steady supply of nutrients into the soil solution to match the nutrient requirement as well as the better uptake of nutrients (Table 3), contributed to higher grain yield in n_3. The treatment n_3 was followed by n_2 (NPK @ 70:30:35 kg ha^{-1}). The positive effect of filled grains panicle^{-1} on grain yield was also reported by Rajesh et al. (2017) Mahapatra and Panda (1972) reported that balanced fertilization with N, P and K was essential for higher grain yield in upland rice.

The highest net returns registered in n_3 (NPK @ 90:30:45 kg ha^{-1}) was due to significantly higher grain and straw yield (Table 5) registered in the treatment. The lowest net return recorded in n_4 (NPK @ 120:30:60 kg ha^{-1}) was due to the high cost of cultivation and also the lowest grain yield (Table 5) registered in the treatment.

Schedule of nutrient application also significantly influenced the net returns. The highest net return was recorded in s_3 (N in three equal splits, K in two equal splits and P as basal application along foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS). This was owing to high grain and straw yield recorded in the treatment. Kumar and Kumar (2009) opined that foliar application of 0.5 per cent zinc sulphate recorded higher net returns (Rs 86,666) with a moderate B:C

Table 5. Effect of nutrient levels and schedule of nutrient application on panicles m^{-2}, filled grain per panicle, yield and net returns

Treatments	Panicles m^{-2}	Filled grains per panicle	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net returns (Rs ha^{-1})
n_1 (NPK @ 60:30:30 kg ha^{-1})	319.3	64.3	2.66	3.68	20,224
n_2 (NPK @ 70:30:35 kg ha^{-1})	337.7	68.7	2.83	3.81	24,664
n_3 (NPK @ 90:30:45 kg ha^{-1})	337.7	74.2	3.00	4.15	29,978
n_4 (NPK @ 120:30:60 kg ha^{-1})	334.7	69.7	2.52	3.91	16,740
SE m (±)	5.3	1.9	0.04	0.10	380
CD (0.05)	NS	5.62	0.119	NS	1103.5
s_1- N in 3 splits, P basal and K in 2 splits	331.3	70.9	2.72	3.73	22,304
s_2- N in 3 splits, P as basal and K in three equal splits	320.3	62.8	2.67	3.81	21,617
s_3- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	330.3	73.0	2.86	4.09	25,295
s_4- s_1 + foliar spray of 0.2 per cent zinc sulphate and 0.2 percent sodium borate at 45 DAS	347.3	70.2	2.77	3.92	22,389
SE m (±)	5.3	1.9	0.04	0.10	380
CD (0.05)	15.29	5.62	0.119	NS	1103.5

ratio of 1.71.

The interaction was also found significant, and among the treatment combinations, n_3s_3 (NPK @ 90: 30: 45 kg ha^{-1} applied as N in three equal splits, P as basal application and K in two equal splits along with foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS) recorded the highest net returns which might be due to higher grain and straw yield (Table 6) registered in this treatment.

Similarly, schedule of application of nutrients also significantly influenced the grain yield. Application

Table 6. Interaction effect between nutrient levels and schedule of nutrient application on panicles m^{-2}, filled grains per panicle, yield and net returns

Treatments	Panicles m^{-2}	Filled grains per panicle	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net returns (Rs ha^{-1})
n_1s_1	316.0	67.7	2.64	3.53	22,057
n_1s_2	314.7	54.0	2.73	3.66	22,843
n_1s_3	325.3	69.5	2.79	3.95	23,717
n_1s_4	321.3	65.8	2.47	3.59	14,279
n_2s_1	334.7	78.5	2.74	3.64	22,801
n_{2S2}	317.3	66.1	2.68	3.80	22,067
n_2s_3	320.3	64.6	3.03	3.90	28,768
n_2s_4	378.7	65.8	2.87	3.89	25,018
n_3s_1	318.7	70.1	2.88	4.10	27,982
n_3s_2	314.7	63.2	2.73	4.06	24,153
n_3s_3	352.0	83.2	3.25	4.33	35,637
n_3s_4	365.3	80.4	3.15	4.12	32,140
n_4s_1	356.0	67.4	2.60	3.66	18,376
n_4s_2	334.7	67.8	2.55	3.71	17,404
n_4s_3	324.0	74.7	2.35	4.19	13,058
n_4s_4	324.0	68.8	2.58	4.10	18,120
SE (±)	10.5	8.9	0.08	0.21	760
CD (0.05)	30.59	11.24	0.238	NS	2206.9

Note: n_1- N: P: K @ 60:30:30 kg ha^{-1}, n_2- N: P: K @ 70:30:35 kg ha^{-1}, n_3- N: P: K @ 90: 30:45 kg ha^{-1}, n_4- N: P: K @ 120: 30:60 kg ha^{-1}
s_1- N in three splits (15 DAS, active tillering and panicle initiation stage), P as basal application and K in two splits (15 DAS and panicle initiation stage), s_2- N and K in three splits (15 DAS, active tillering and panicle initiation stage) and P as basal application, s_3-s_1+ foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 DAS, s_4-s_2 + foliar application of 0.2 % zinc sulphate and 0.04 % sodium borate at 45 DAS

of N in three equal splits, K in two equal splits and P as basal application along with foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS (s_3) recorded higher grain yield (2.86 t ha^{-1}), which was statistically on par with s_4 (N and K in three equal splits and P as basal application along with foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate at 45 DAS). However, the treatment s_4 was statistically comparable with s_1 (N in three equal splits, K in two equal splits and P as basal application) and s_2 (N and K in three splits and P as basal application). Interaction effect was also found significant. Better production of yield attributes particularly panicles m^{-2} and fertile grains $panicle^{-1}$ resulting from the better expression of growth attributes and better availability and uptake of nutrients might be the reason for higher grain yield in s_3 and s_4. Moreover, these treatments also included foliar spray of Zn and B. Both the micronutrients might have had significant effect on grain yield by their role in grain setting and accumulation of carbohydrate in grain. Rehman et al. (2014) revealed that foliar nutrition of B significantly improved the grain yield and yield related parameters.

Among the treatment combinations, n_3s_3 recorded the highest grain yield (3.25 t ha^{-1}) which was statistically comparable with n_3s_4 and n_2s_3 (Table 6). This was owing to the production of higher number of panicle m^{-2} and filled grains per panicle (Table 5). Rehman et al. (2014) reported that foliar application 0.32M Boran along with recommended dose of NPK and Zn enhanced the grain yield by increasing the grain size and decreasing the spikelet sterility.

Hence considering the nutrient uptake, availability, yield and net returns, NPK @ 90:30:45 kg ha^{-1} applied as N in two equal splits, P as basal application and K in two equal splits along with foliar spray of 0.2 per cent zinc sulphate and 0.04 per cent sodium borate (n_3s_3) can be recommended for higher yield in upland rice intercropped in coconut.

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