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Research Paper

Influence of seedling age and different levels and methods of application of nutrients on yield, nutrient content and uptake of rice (*Oryza sativa* L.)

S.D. RAUT[1], U.V. MAHADKAR[2], G.K. BAHURE[3], A.M. YADAV[4], A.R. CHAVAN[5], D.N. JAGTAP[6], L.S. CHAVAN[7], S.B. DODKE[8], M.M. BURONDKAR[9] AND J.S. DHEKALE[10]

College of Agriculture, Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra 415 712

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2016 and 2017 at Dapoli, Maharashtra, to study the influence of different age of seedling age, levels and methods of fertilizers application on growth, yield, nutrients content, uptake and economics in rice (*Oryza sativa* L.). The result revealed that the 20-day-old seedling resulted in significantly highest grain and straw yield (tonnes/ha) as compared to 30-day and 40-day old seedlings. Among different levels of fertilizer application, 125% recommended doses of fertilizer (RDF) resulted in significantly higher grain and straw yields followed by 100% RDF and 75% RDF in that descending order. Significantly higher value of grain and straw yields (tonnes/ha) were recorded in treatment split application of potassium with Zn, B and Cu spray (K_4) followed by basal application of potassium with Zn, B and Cu spray (K_3) which were at par and also significantly superior to all other treatments. The result also revealed that the 20 days old seedling showed the highest content of N (1.125, 1.126% in grain and 0.554, 0.56 % in straw), P (0.227 and 0.225% in grain and 0.114 and 0.112 % in straw), K (0.340 and 0.325 % in grain and 1.139 and 1.134 % in straw) and total uptake of N (137.09 and 130.31 kg/ha), P (27.85 and 25.26 kg/ha), K (131.94 and 122.07 kg/ha), Zn (361.99 and 321.78 g/ha), Cu (284.15 and 257.26 g/ha) and B (99.68 and 93.28 g/ha) as compared to 30 days and 40 days old seedling during both the years of study. While Zn contents (20.54 and 19.93 mg/kg in grain and 22.35 and 20.43 mg/kg in straw) were found to be significantly superior to 45 days old seedling and at par with 30 days old seedling during both the years. Among different levels of fertilizer application, the 125% RDF significantly increased content of N (1.143 and 1.145% in grain and 0.559 and 0.552% in straw), P (0.221 and 0.218% in grain and 0.112 and 0.109% in straw), K (0.319 and 0.318% in grain and 1.136 and 1.132% in straw) and total uptake of N (132.19 and 122.81 kg/ha), P (25.97 and 23. 22 kg/ha), K (123.74 and 114.03 Kg/ha), Zn (341.63 and 298.12 g/ha), Cu (267.83 and 237.51 g/ha) and B (93.84 and 86.39 g/ha), followed by 100% RDF and 75% RDF in that descending order during both years. The significantly higher value of N (1.115 and 1.117 %) and P (0.219 and 0.217) contents in grain and uptake of N (126.03 and 118.88 kg/ha), P (25.05 and 22.82 kg/ha), K (121.37 and 112.88 kg/ha), Zn (334.11 and 295.23 g/ha), Cu 260.70 and 233.89 g/ha) and B (91.84 and 85.70 g/ha) were recorded in treatment K_4 (split application of potassium with Zn, B and Cu spray), followed by K_3 (basal application of potassium with Zn, B and Cu spray) which were on par with each other and significantly superior to the remaining treatments. The contents of K, Zn, B and Cu in grain and straw were not influenced significantly as different methods of fertilizer application.

Key words: Fertilizer doses, Foliar spray, Seedlings age, Split application, Rice and Yield

Rice is one of the most important cereals and major staple food for more than half of global population and considered as the "global grain". In India, it is cultivated on an area of 43.39 million ha, with an annual production of 104.32 million tonnes and productivity about of 2.40 tonnes/ha (Jagtap *et al.,* 2018). In Maharashtra, area under rice is 1.53 million ha, with 2.63 million tonnes production and with an average productivity of 1.714 tonnes/ha in 2016 (Jagtap *et al.,* 2018). In *Konkan* rice is cultivated over an area of 0.3851 million ha with an annual production of about 1.52 million tonnes and average productivity of 3.86

[1]**Corresponding author's Email:** santoshraut0227@gmail.com
[1]Ex-Ph.D. Student, [2]Associate Dean, COA, Dr. B.S.K.K.V. Dapoli, [3]Assistant Professor, COA, Khandala, Aurangabad, Maharashtra, [4]Assistant Professor, GNCA, COA, Mankipaluan, Ratnagiri, Maharashtra, [5]Assistant Professor, GNCA, COA Mandakipaluan, Sindhudurg, Maharashtra, [6]Officer Incharge, ARS, Awashi, Dr. BSKKV, Dapoli, [7]Ex. Associate Director of Rsearch, RRRS, Karjat, Dr. B.S.KKV, Dapoli, [8]Head of Department, SSAC, Dr. BSKKV. Dapoli, [9]Associate Dean, College of Forestry, Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra 415 712
[10]Associate Professor, Department of Economics, Dr. BSKKV, Dapoli.

tonnes/ha (Anonymous, 2015). Increase production of rice is an important requirement to meet the needs of ever-increasing population in World with limited cultivated area thus, it is necessary to increase the productivity per unit area. Among the improved agro-management practices, seedling age and nutrient management play important role in enhancing the yield of hybrid rice. Growth and tillering ability of rice hampered when optimum aged seedlings are not transplanted at the right time. Therefore, it is essential to evaluate appropriate age of seedling for recently introduced high-yielding rice hybrid 'Sahyadri 3' to produce higher and sustainable yield production under Konkan condition. Among the various inputs in agriculture, fertilizer is a vital input since it replenishes the nutrients removed from the soil by crops and also enhances the yield. Hybrid rice showed better response to applied fertilizer. Hybrid rice produce 20–30% more yield than conventional varieties with proper management (Yuan and Virmani, 1988). So, adequate and balanced fertilization is essential to achieve potential yield and enhancing the productivity in hybrid rice.

The efficient N absorption depends on age of seedling and rate of its application. Time of application may considerably influence crop response to applied potassium. Potassium management appears to be difficult in lowland conditions. In order to maintain utmost economy of potassium fertilization and adequate supply of potassium during peak period of its demand, it is imperative that efforts must be taken up to increase the efficiency of the applied potassium by reducing its loss through leaching and fixation (Shiroshita, 1963). Micronutrient deficiency is a major yield-limiting factor for rice particularly, zinc. Rice-growing soils are mostly deficient in zinc, boron and copper in all over world and India. This has become a major constraint to production and productivity of rice. Thus, there is an urgent need for the correction of these nutrient deficiencies by adopting proper method for reducing their further spread. Thus, evolution of appropriate micronutrient management for increasing productivity and quality of rice crop is the need of present-day agriculture. Hence a study was carried out determine the influence of seedling age different levels and methods of fertilizers application on nutrients content and uptake in rice.

MATERIAL AND METHODS

The present investigation was conducted at the College of Agriculture, Dapoli, the rainy during (*kharif*) season of 2016 and 2017. The composite soil samples from 0–22.5 cm layer were taken with the help of screw auger before the layout of an experiment and after the harvesting during both years of experimentation. The soil was clay loam, high in organic carbon, moderately acidic with pH 6.14 and 6.08 during 2016 and 2017. It was medium in available nitrogen (340.42 and 321.60 kg/ha), low in available phosphorus (11.08 and 10.58 kg/ha) and fairly high in available potassium (276.21 and 256.20 kg/ha). The DTPA-extractable Zn and Cu were determined with AAS and B determined with hot-water-soluble B using azamethine-H by colorimetric method during both the years. The experiment was laid out in a split split-plot design, comprising 36 treatment combinations, replicated thrice. The main-plot treatment consisted of 3 age of seedlings, viz., 20 days old seedlings (A_1), 30 days old seedlings (A_2) and 40 days old seedlings (A_3). The subplot treatment consisted of 3 levels of fertilizer application, namely 125% 187.5 kg N, 62.5 kg P_2O_5 and kg 62.5 K_2O RDF (F_1), 100% RDF (150:50:50) (F_2) and 75% RDF (112.5 N: 37.5 P : 37.5 K) (F_3); while sub-subplot treatment comprised 4 methods of fertilizer application, *i.e.,* basal K (K_1), split K (K_2), K_1+ Zn, B and Cu spray (K_3) and K_2 + Zn, B and Cu spray (K_4). The gross plot of 3.20 m × 3.90 m size and net plot 2.80 m × 3.60 m size were used for the experimentation. The raised beds of 10 m length, 1 m breadth and 10 cm height were prepared for sowing of 'Sahydri 3' hybrids. Well-decomposed brownish colour FYM @ 1 kg/m^2 was spread and mixed with soil over the beds. Urea @ 1 kg and single superphosphate @ 3 kg/100 m^2 were applied at the time of sowing. The seeds of 'Sahydri 3' rice hybrids was treated with thiram @ 2.5 g/kg and sown in line, 10 cm apart at 2–3 cm depth. Top-dressing of urea @ 1 kg/100 m^2 area was done 10 days after sowing. Transplanting was done on the same day with spacing 20 cm × 15 cm. Basal dose of 40% nitrogen (urea) along with full dose of phosphorus (single superphosphate) was applied at the time of transplanting. The remaining nitrogen and potassium (150 + 50 + 50 NPK as RDF for rice) applied into 2 splits (40% at maximum tillering and 20% at panicle-initiation stage). A recommended dose of 50 kg of K_2O was applied basal through muriate of potash and split as per treatments. Basal K treatment 100% RDK (50 kg K_2O) applied at the time of transplanting and in, split 100% RDK (50 kg K_2O) applied in 3 splits. Manual weeding done. Foliar spray of 0.5% zinc sulphate, 0.5% copper sulphate and 0.2% borax was applied in combination at panicle emergence (65 DAS) and flowering (90 DAS). The nitrogen, phosphorus, potassium, zinc, copper and boron content in plant were determined separately after harvesting of crop. The nitrogen, phosphorus and potassium contents in rice grain and straw were determined by modified Microkjeldahl's method, ammonium molybdovanadate method and flame photometer, respectively. The uptake was calculated by multiplying grain and straw yield with respective percentage figure. Micronutrients, viz*.,* zinc and copper content (mg/kg), in grain and straw of rice were determined by using AAS and boron content (mg /kg) was determined by spectrophotometry using curcumin-oxalic method. The accumulation of micronutrients, *viz.,* zinc, copper and boron (g/ha), in grain and straw were calculated as:

$$\frac{\text{Nutrient content in dry-matter (mg/kg)} \times \text{yield of dry matter (kg)}}{1,000}$$

Total uptake of nutrients was calculated by addition of grain and straw uptake of respective treatments. In general, the weather conditions were very much suitable for cultivation of rice during both the years. The high rainfall during initiation of flowering to end of flowering was responsible for less pollen setup, increased number of chaffy grains and ultimately reduced the yield in rice crop during 2017.

RESULT AND DISCUSSION

Age of seedling

Transplanting of 20 days old age seedling (A_1) recorded significantly more grain yield and straw yield than the 30 days and 40 days old age seedlings (Table 1). The increase in grain yields with 20 and 30 days old seedlings over 40 days old seedlings were 25.04 and 12.08% and straw yield 21.17 and 8.42% in pooled mean. Our results confirm the finding of Vijayalaxmi *et al*. (2016) and Bahure (2017).

Nitrogen, phosphorus, potassium contents (%) and their uptake (kg/ha) in both the grain as well as straw increased in rice crop significantly with 20 days old seedlings as compared to 30 days and 40 days old seedling in during both the years. However, in 2017, 20 days old seedlings (A_1) and 30 days (A_2) seedlings were on par with each other in respect of nitrogen content (%) in grain of rice (Tables 2, 4 and 6). This might be owing to vigorous and healthy growth of the plant which developed more productive tillers and stronger root-system which insure better resource utilization and higher uptake of nutrients. The present results confirm the findings of Chaudhari *et al.* (2015), Vishwakarma (2015) and Bahure (2017). Micronutrients (zinc, boron and copper) contents were not influenced significantly by the treatments, but significantly the highest uptake of these micro-nutrients (Zn, Cu and B) in grain, straw and their total uptake (g/ha) by rice were recorded under of 20 days old seedling followed by 30 days old seedlings and 40 days old seedlings in that descending order of significance in 2016 and 2017 (Tables 3, 5 and 6). Marked variation in the extraction capability of micronutrients from the soil was due to vigorous and healthy growth of the hybrid rice in young seedlings (20 days) which insure greater resource utilization and resulted in higher yield (grain and straw t/ha) than the 30 and 40 days old seedlings which ultimately increased the uptake of above-mentioned nutrients. Our results confirm those of Krishna *et al.* (2008).

Effect of fertilizer application

Data present in Table 1 indicated that, increasing levels of fertilizer increased the grain and straw yields in 2016, 2017 and pooled mean. The increase in the grain and straw

Table 1. Effect of age of seedlings, levels and methods of fertilizers application on mean grain and straw yield (t/ha) of rice during 2016 and 2017

Treatment	Grain yield (t/ha)		Pooled	Straw yield (t/ha)		Pooled
	2016	2017	mean	2016	2017	mean
Age of seedlings (A)						
A_1 : 20 DAS	7.58	7.25	7.421	9.31	8.67	8.99
A_2 : 30 DAS	6.90	6.40	6.652	8.44	7.64	8.04
A_3 : 40 DAS	6.12	5.75	5.935	7.75	7.08	7.42
SEm±	0. 07	0.08	0.054	0.06	0.08	0.05
CD (P=0.05)	0.28	0.32	0.178	0.26	0.32	0.17
Levels of fertilizer application (F)						
F_1 : 125% RDF	7.22	6.76	6.996	8.84	8.16	8.50
F_2 : 100% RDF	6.93	6.54	6.739	8.57	7.75	8.16
F_3 : 75% RDF	6.44	6.10	6.273	8.10	7.48	7.79
SEm±	0.07	0.07	0.030	0.06	0.07	0.03
CD (P=0.05)	0.22	0.23	0.092	0.21	0.23	0.10
Methods of fertilizer application (K)						
K_1 : Basal K	6.71	6.29	6.507	8.28	7.40	7.84
K_2 : Split K	6.74	6.33	6.540	8.31	7.59	7.95
K_3 : Basal K with Zn, Cu and B spray	6.99	6.60	6.803	8.69	8.03	8.36
K_4 : Split K with Zn, Cu and B spray	7.01	6.63	6.827	8.72	8.17	8.44
SEm±	0.06	0.08	0. 053	0.07	0.10	0.06
CD (P=0.05)	0.17	0.24	0.149	0.19	0.28	0.17

yields with the application of 125% RDF was 2.91 and 12.16 and 2.54, 11.09% over the application of 100% and 75% RDF, respectively, in the pooled data. This findings also corroborate the finding of Kanthi *et al.* (2014) and Pawar (2017).

Nitrogen, phosphorus and potassium contents and also uptake of nutrients (N, P, K, Zn, B and Cu) by rice were found to be differed significantly due to various levels of fertilizer application. The micro-nutrient contents of Zn, B and Cu were not influenced significantly by the various levels of fertilizer (Table 3). The application 125% RDF (F_1) recorded significantly highest content (N, P and K %) and uptake (N, P, K, Zn, B and Cu) by rice in grain, straw and total uptake followed by 100% RDF (F_2) and 75% RDF (F_3) in that descending order of significance during both the years (Tables 2, 4, 5 and 6). However, the application of 125% RDF and 100% RDF remained at par with each other in respect of nitrogen content in the straw, during 2017 and potassium content in the grain during 2016. This could be ascribed to the increase in the available N, P and K contents in the soil, resulting from the increasing availability of these nutrients which ultimately increased nutrient content in the plant tissue and greater biomass production. Since the uptake of nutrient is a function of dry matter and nutrient content, the increased straw and grain yields together with respective treatments resulted in greater uptake of these elements. The results confirm the findings of Lakshmanan *et al.* (2005), Paramasivan *et al.* (2016) and Nath *et al.* (2018).

Effect of methods of fertilizer application

Increase in the grain and straw yields over treatment basal K and split K due to K_4 (K_2+ Zn, B and Cu spray) was 4.92, 4.39 and 7.66, 6.21% respectively. Treatment K_3 increased the grain and straw yields over basal K and split K treatment, being 0.50 and 1.36% higher grain and straw yield than treatment K_1 in pooled mean of 2016 and 2017. These results corroborated the findings of Vidya (2011) and Kankal (2015).

The split or basal application of potassium along with micronutrient spray treatments (K_4 or K_3) significantly increased the nitrogen and phosphorus content (%) in grain and straw of rice as compared to split or basal application of K without micronutrients spray (K_2 and K_1). Uma et *al.* (2013) and Rana and Kasif (2014) also reported that foliar application of micronutrients increased the N and P content in grain. The treatment K_2 (split K) and K_1 (basal K) not only failed to significantly influence mean nitrogen and phosphorus content (%) in straw, but also potassium, zinc, boron and copper content in rice grain and straw (mg/kg) as foliar spray of micronutrients or by altering time of K application. Kankal (2015) and Vidya (2011) also reported

Table 2. Effect of age of seedlings, levels and methods of fertilizers application on nitrogen, phosphorus and potassium content (%) in grain and straw in rice during 2016 and 2017

Treatment	N content in grain (%)		N content in straw (%)		P content in grain (%)		P content in straw (%)		K content in grain (%)		K content in straw (%)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Age of seedlings (A)												
A_1: 20 DAS	1.126	1.125	0.554	0.561	0.227	0.225	0.114	0.112	0.340	0.325	1.139	1.134
A_2 : 30 DAS	1.109	1.107	0.545	0.549	0.216	0.212	0.109	0.105	0.319	0.309	1.134	1.130
A_3 : 40 DAS	1.075	1.069	0.538	0.536	0.208	0.207	0.104	0.100	0.282	0.285	1.126	1.124
SEm±	0.004	0.006	0.001	0.002	0.001	0.001	0.000	0.001	0.002	0.001	0.001	0.001
CD (P=0.05)	0.016	0.024	0.003	0.006	0.004	0.005	0.001	0.002	0.007	0.004	0.002	0.003
Levels of fertilizer application (F)												
F_1 : 125% RDF	1.143	1.145	0.559	0.552	0.221	0.218	0.112	0.109	0.319	0.318	1.136	1.132
F_2 : 100% RDF	1.105	1.098	0.542	0.552	0.217	0.214	0.108	0.105	0.312	0.305	1.133	1.130
F_3 : 75% RDF	1.062	1.058	0.536	0.541	0.213	0.211	0.106	0.102	0.310	0.294	1.130	1.127
SEm±	0.010	0.007	0.001	0.003	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001
CD (P=0.05%)	0.030	0.022	0.005	0.008	0.003	0.002	0.002	0.002	0.005	0.005	0.003	0.003
Methods of fertilizer application (K)												
K_1 : Basal K	1.092	1.083	0.545	0.546	0.215	0.213	0.108	0.105	0.311	0.311	0.305	1.132
K_2 : Split K	1.093	1.087	0.545	0.549	0.215	0.213	0.109	0.105	0.312	0.312	0.305	1.132
K_3: Basal K with Zn, Cu and B spray	1.114	1.115	0.546	0.550	0.218	0.216	0.110	0.106	0.314	0.314	0.307	1.134
K_4 : Split K with Zn, Cu and B spray	1.115	1.117	0.547	0.550	0.219	0.217	0.110	0.107	0.317	0.317	0.307	1.134
SEm±	0.007	0.008	0.001	0.002	0.001	0.001	0.001	0.001	0.02	0.02	0.02	0.01
CD (P=0.05%)	0.020	0.022	NS	NS	0.002	0.002	NS	NS	NS	NS	NS	NS

similar findings. Significantly the highest N, P, K, Zn, B and Cu uptake in grain, straw and their total uptake (kg/ha or g/ha) by rice were observed in treatment K_4, followed by treatment K_3, which were found to be at par with each other and significantly superior to K_2 and K_1 treatments, respectively. Further, treatment K_2 was at on par with treatment K_1 during the both years. This might be due to quick and better utilization of micronutrients through foliar feeding.

Table 3. Effect of age of seedlings, levels and methods of fertilizers application on zinc, copper and boron content by grain and straw in rice during the year 2016 and 2017

Treatment	Zn content grain (mg/kg)		Zn content straw (mg/kg)		Cu content grain (mg/kg)		Cu content straw (mg/kg)		B content grain (mg/kg)		B content straw (mg/kg)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Age of seedlings (A)												
A_1: 20 DAS	20.54	19.93	22.35	20.43	20.27	19.03	12.98	13.98	4.26	4.20	7.23	7.25
A_2: 30 DAS	20.17	19.43	22.12	20.22	20.04	18.80	12.61	13.61	4.16	4.12	7.14	7.12
A_3: 40 DAS	19.84	19.12	21.77	19.87	19.95	18.71	12.44	13.45	4.06	4.02	7.04	6.97
SEm±	0.19	0.16	0.11	0.13	0.06	0.07	0.11	0.11	0.05	0.03	0.04	0.06
CD (P=0.05)	0.74	0.64	0.44	0.52	NS	NS	NS	NS	NS	NS	NS	NS
Levels of fertilizer application (F)												
F_1: 125% RDF	20.30	19.62	22.13	20.21	20.15	18.91	12.78	13.78	4.19	4.15	7.17	7.13
F_2: 100% RDF	20.18	19.51	22.09	20.19	20.07	18.83	12.68	13.69	4.16	4.12	7.13	7.13
F_3: 75% RDF	20.07	19.35	22.02	20.12	20.04	18.80	12.57	13.58	4.13	4.07	7.11	7.08
SEm±	0.11	0.08	0.04	0.04	0.04	0.04	0.07	0.07	0.02	0.03	0.02	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Methods of fertilizer application (K)												
K_1: Basal K	20.06	19.41	22.02	20.12	20.08	18.84	12.66	13.67	4.13	4.09	7.12	7.08
K_2: Split K	20.08	19.46	22.08	20.18	20.08	18.84	12.66	13.67	4.15	4.10	7.13	7.13
K_3: Basal K with Zn, Cu and B spray	20.28	19.54	22.10	20.20	20.10	18.86	12.69	13.69	4.17	4.13	7.15	7.12
K_4: Split K with Zn, Cu and B spray	20.32	19.55	22.11	20.20	20.09	18.85	12.70	13.69	4.18	4.14	7.16	7.12
SEm±	0.13	0.14	0.08	0.09	0.05	0.05	0.07	0.07	0.03	0.04	0.03	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Effect of age of seedlings, levels and methods of fertilizers application on nitrogen, phosphorus and potassium uptake by grain and straw in rice during 2016 and 2017

Treatment	N uptake grain (kg/ha)		N uptake straw(kg/ha)		P uptake grain (kg/ha)		P uptake Straw (kg/ha)		K uptake grain (kg/ha)		K uptake straw (kg/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Age of seedlings (A)												
A_1: 20 DAS	85.5	81.8	51.6	48.7	17.2	16.3	10.6	9.7	25.8	23.6	106.1	98.3
A_2: 30 DAS	76.6	71.0	46.0	42.0	14.9	13.6	9.2	8.0	22.0	19.8	95.8	86.5
A_3: 40 DAS	65.9	61.6	41.8	38.0	12.8	11.9	8.1	7.1	17.3	16.3	87.4	79.7
SEm±	0.6	0.6	0.4	0.4	0.1	0.2	0.1	0.1	0.2	0.2	0.8	0.9
CD (P=0.05)	2.5	2.3	1.4	1.6	0.5	0.6	0.3	0.4	0.7	0.7	3.0	3.6
Levels of fertilizer application (F)												
F_1: 125% RDF	82.7	77.8	49.5	45.2	16.0	14.8	10.0	8.9	23.2	21.6	100.5	92.4
F_2: 100% RDF	76.7	72.0	46.5	42.9	15.1	14.1	9.3	8.2	21.8	20.1	97.1	87.6
F_3: 75% RDF	68.6	64.7	43.5	40.6	13.8	12.9	8.6	7.7	20.2	18.0	91.6	84.5
SEm±	0.8	1.2	0.4	0.5	0.2	0.2	0.1	0.1	0.2	0.3	0.8	0.8
CD (P=0.05)	2.4	3.6	1.3	1.4	0.6	0.6	0.4	0.3	0.7	1.0	2.4	2.6
Methods of fertilizer application (K)												
K_1: Basal K	73.6	68.5	45.2	40.5	14.5	13.4	9.0	7.8	21.1	19.3	93.8	83.7
K_2: Split K	74.0	69.2	45.4	41.8	14.6	13.6	9.1	8.0	21.2	19.5	94.2	85.7
K_3: Basal K with Zn, Cu and B spray	78.2	74.0	47.6	44.2	15.3	14.3	9.6	8.6	22.1	20.4	98.7	90.8
K_4: Split K with Zn, Cu and B spray	78.3	74.2	47.8	45.0	15.5	14.5	9.6	8.7	22.4	20.5	99.0	92.4
SEm±	0.8	1.0	0.4	0.6	0.2	0.2	0.1	0.1	0.2	0.3	0.8	1.1
CD (P=0.05)	2.2	2.9	1.1	1.7	0.5	0.5	0.3	0.3	0.7	0.8	2.2	3.2

Table 5. Effect of age of seedlings, levels and methods of fertilizers application on zinc, copper and Boron uptake by grain and straw in rice during 2016 and 2017

Treatment	Zn uptake by grain (g/ha)		Zn uptake by straw (g/ha)		Cu uptake by grain (g/ha)		Cu uptake by straw (g/ha)		B uptake by grain (g /ha)		B uptake by straw (g/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Age of seedlings (A)												
A_1 : 20 DAS	155.90	144.64	208.18	177.16	153.81	144.64	130.35	112.62	32.33	30.48	67.35	62.80
A_2 : 30 DAS	139.16	124.51	186.87	154.62	138.31	124.51	115.00	96.44	28.70	26.39	60.35	54.45
A_3 : 40 DAS	121.48	109.97	168.87	140.79	122.12	109.97	104.35	88.16	24.86	23.14	54.65	49.42
SEm±	2.16	1.77	2.37	1.68	1.41	1.77	1.80	1.26	0.46	0.33	0.67	0.80
CD (P=0.05)	8.48	6.96	9.30	6.60	5.54	6.96	7.07	4.93	1.79	1.28	2.61	3.15
*Levels of fertilizer application (**F**)*												
F_1 : 125% RDF	146.83	133.00	195.92	165.10	145.71	133.00	122.12	104.51	30.33	28.13	63.51	58.26
F_2 : 100% RDF	140.15	127.93	189.49	156.66	139.28	127.93	117.44	98.42	28.89	27.00	61.17	55.36
F_3 : 75% RDF	129.56	118.18	178.51	150.81	129.24	118.18	110.14	94.29	26.67	24.89	57.67	53.06
SEm±	1.44	1.62	1.70	1.66	1.39	1.62	1.36	1.10	0.33	0.40	0.55	0.76
CD (P=0.05%)	4.43	5.00	5.23	5.13	4.29	5.00	4.18	3.39	1.01	1.24	1.68	2.34
*Methods of fertilizer application (**K**)*												
K_1 : Basal K	134.86	122.50	182.59	149.09	134.98	122.50	113.38	93.99	27.84	25.79	59.05	52.56
K_2 : Split K	135.61	123.56	183.84	153.39	135.54	123.56	113.90	96.34	28.05	26.03	59.38	54.21
K_3 : Basal K with Zn, Cu and B spray	142.04	129.40	192.38	162.40	140.76	129.40	119.31	102.09	29.27	27.34	62.24	57.30
K_4, Split K with Zn, Cu and B spray	142.87	130.02	193.08	165.21	141.03	130.02	119.67	103.87	29.36	27.53	62.48	58.17
SEm±	1.48	1.83	1.67	2.18	1.23	1.83	1.20	1.45	0.34	0.49	0.54	0.83
CD (P=0.05%)	4.19	5.18	4.73	6.19	3.50	5.18	3.40	4.13	0.98	1.38	1.54	2.35

Table 6. Effect of age of seedlings, levels and methods of fertilizers application on total uptake of nutrients after the harvesting of rice during 2016 and 2017

Treatment	Total uptake of nutrients after harvesting of rice											
	N (kg/ha)		P (kg/ha)		K (kg/ha)		Zn (g/ha)		Cu (g/ha)		B (g/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Age of seedlings (A)												
A_1 : 20 DAS	137.1	130.3	27.9	25.3	131.9	122.1	362.0	321.8	284.2	257.3	99.7	93.3
A_2 : 30 DAS	122.7	112.8	24.1	20.9	117.8	106.3	325.2	279.1	253.3	221.0	89.1	80.9
A_3 : 40 DAS	107.7	99.6	20.8	18.9	104.7	96.0	291.0	250.8	226.5	198.1	79.5	72.6
SEm±	0.6	0.4	0.1	0.3	0.8	0.8	3.1	1.9	2.7	1.0	1.0	0.8
CD (P=0.05)	2.5	1.5	0.5	1.2	3.3	3.3	12.2	7.6	10.4	4.1	3.9	3.1
Levels of fertilizer application (F)												
F_1 : 125% RDF	132.2	122.8	26.0	23.2	123.7	114.0	341.6	298.1	267.8	237.5	93.8	86.4
F_2 : 100% RDF	123.2	114.6	24.4	21.6	118.9	107.8	328.8	284.6	256.7	226.4	90.1	82.4
F_3 : 75% RDF	112.1	105.3	22.4	20.3	111.7	102.5	307.8	269.0	239.4	212.5	84.3	78.0
SEm±	0.8	1.5	0.2	0.3	0.8	1.0	2.1	2.5	1.9	2.4	0.5	0.8
CD (P=0.05)	2.4	4.7	0.6	0.8	2.4	3.1	6.4	7.6	5.9	7.2	1.7	2.4
Methods of fertilizer application (K)												
K_1 : Basal K	118.8	109.0	23.5	20.7	114.9	103.0	317.6	271.6	248.4	216.5	86.9	78.4
K_2 : Split K	119.4	110.8	23.6	20.8	115.5	105.3	319.4	277.0	249.4	219.9	87.4	80.2
K_3 : Basal K with Zn, Cu and B spray	125.7	118.2	24.9	22.4	120.8	111.2	333.2	291.8	260.1	231.5	91.5	84.6
K_4 : Split K with Zn, Cu and B spray	126.0	118.9	25.1	22.8	121.4	112.9	334.1	295.2	260.7	233.9	91.8	85.7
SEm±	0.9	1.4	0.2	0.3	0.8	1.2	1.9	2.7	1.6	2.4	0.6	1.0
CD (P=0.05)	2.5	4.1	0.5	0.8	2.2	3.4	5.4	7.7	4.7	6.7	1.6	2.8

These results corroborated the findings of Kankal (2015), Kumar *et al.* (2016) and Nagula and Prabhakar (2016). Time of potassium application not showed any significant effect on nitrogen, phosphorus and potassium uptake (kg/ha) also reported by Vidya, (2011).

Thus, transplanting of 20 days old seedlings with 125% RDF along with split application of recommended dose of potassium should be used with foliar application of micronutrients (Zn, Cu and B) for obtaining higher nutrients content and uptake of N, P, K, Cu, Zn and B in grain and straw.

REFERENCES

Anonymous, 2015. Annual Report of Agriculture Cooperation of Maharashtra on rice, Govt. of Maharashtra.

Bahure, G.K. 2017. 'Agronomic assessment of different rice hybrids for sustainable production through agronomic manipulation under high rainfall conditions of *Konkan'*. Ph.D. Thesis, Department of Agronomy, Dr B.S.K.K.V., Dapoli, Ratnagiri, Maharashtra, India (unpublished).

Chaudhari, P.R., Patel, A.P., Patel, V.P., Desai, L.J., Patel, J.V., Chaudhari, D.R. and Tandel, D.H. 2015. Effect of age of seedlings and fertilizer management on yield, nutrient content and uptake of rice (*Oryza sativa* L.). *The Bioscan* **10**(1): 351–353.

Jagtap, D.N., Sutar, M.W., Mahadkar, U.V., Chavan, S.A., Pinjari, S.S. and and Jadhav, M.S. 2018. Studies on agrometeorological indices in rice as affected by different crop establishment methods and varieties. *Journal of Research, SKUAST* **20**(2): 225–229.

Kankal, V.Y. 2015. Effect of establishment techniques, weed control and integrated nutrient management on growth, yield and quality of drilled rice. (*Oryza sativa* L.). Ph.D. (Agric.) Thesis, Dr B.S.K.K.V., Dapoli, Maharashtra, India (unpublished).

Kanthi, M.S., Ramana, A.V. and Murthy Ramana, K.V. 2014. Effect of different crop establishment techniques and nutrient doses on nutrient uptake and yield of rice (*Oryza sativa* L.) *Karnataka Journal of Agricultural Science* **27**(3): 293–295.

Krishna, A, Biradapatil, N.K., Manjappa, K. and Channappagoudar, B.B. 2008. Evaluation of system of rice intensification cultivation, seedling age and spacing on seed yield and quality in Samba Mahsuri (BPT-5204) rice. *Karnataka Journal of Agricultural Sciences* **21**(1): 20–25.

Kumar, D., Uppal, R.S., Ram, H. and Dhaliwal, S.S. 2016. Effect of N, Zn and Fe application on N, P, K content and their total up take in parmal rice *(oryza sativa* L.). *Journal of Progressive Agriculture* **16**(1): 71–76.

Lakshmanan, R., Prasad, R. and Jain, M.C. 2005. Effects of duration of variety and nitrogen fertilization on biomass accumulation at 45 days after transplanting (DAT) and grain and straw yield and Zn, Fe, Mn and Cu concentration and uptake in rice. *Archives of Agronomy and Soil Science* **51**(1): 1–14.

Nagula, S. and Prabhakar, N. 2016. Effect of silicon and boron on soil nutrient status in laterite derived paddy soils of northern Kerala. *Advances in Life Sciences* **5**(7): 2,687–2,691.

Nath, S., Rajput, R., Gautam, A.D., Kumar, V., Singh, Y., Singh, S. and Rajput, P. 2018. Effect of fertilization and varieties on yield and nutrient uptake of hybrid rice (*Oryza sativa* L.) *Journal of Pharmacognosy and Phytochemistry* **7**(2): 2,092–2,093.

Paramasivan, M., Arunkumar, V. and Senthilkumar, N. 2016. Effect of nutrient levels on productivity, profitability and soil fertility in rice (*Oryza sativa* L.) in alfisols of Tambiraparani tract. *Madras Agricultural Journal* **103**(1–3): 31–34.

Pawar, S.S. 2017. 'Study the response of hybrid rice (*Oryza sativa* L.) to the age of seedlings at transplanting, spacing and levels of fertilizer under South Konkan condition on lateritic soil having low to moderate soil fertility status. Ph.D. Thesis Dr B.S.K.K.V., Dapoli, Ratnagiri, Maharashtra, India

Rana, W.K. and Kashif, S.R. 2014. Effect of different Zinc source and methods of application on rice yield and nutrients concentration in rice grain and straw *Journal of Environmental and Agricultural Sciences* **1**(9): 1–5.

Shiroshita, T. 1963. Theory and Practice of Growing Rice, Pp. 183–189. Fujis Publishing Company Tokyo, Japan.

Uma, S. R., Srivastava, V.K., Hemantaranjan, A., Sen, A., Singh, R.K., Bohra, J.S. and Shukla, U. 2013. Effect of Zn, Fe and FYM application on growth, yield and nutrient content of rice. *Oryza* **50**(4): 351–357.

Vidya, Y. 2011. 'Hybrid rice response to levels and time of potassium application'. M.Sc. (Agric.) Thesis (unpublished) Acharya N.G. Ranga Agricultural University, Hyderabad, Telangana, India.

Vijayalaxmi, G., Sreenivas, G. Leela Rani, P. and Madhavi, A. 2016. Effect of plant densities and age of seedlings on growth and yield parameters of *kharif* rice. *International. Journal of Science, Environment and Technology* **5**(3): 1,153–1,162.

Vishwakarma, A. 2015. Effect of date of transplanting and age of seedling on growth, yield and quality of rice (*Oryza sativa* L.) hybrids under system of rice intensification. Ph.D. Thesis, Banaras Hindu University, Varanasi, Uttar Pradesh, India (unpublished).

Yuan, L.P. and Virmani, S.S. 1988. Status of hybrid rice research and development (In) *Hybrid rice. Proceedings of the International Symposium on Hybrid Rice*. Changsha, Hunana, China, pp. 7–24.