The Andhra Agric. J 64 (2): 299-303, 2017

Nutrient management in yield of Semi-dry Rice (*Oryza sativa* L.) for North Coastal Zone of A.P

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ABSTRACT

Field experiment was conducted during *kharif*, 2015 on sandy loam soils of Agricultural College Farm, Naira to find out the response of NPK levels and time of application of nitrogen on semi-dry rice. The experiment was laid out in split-plot design with four NPK levels assigned to main plots and four time of application of nitrogen to sub plots, each replicated thrice. Application of 160-90-75 kg NPK ha^{-1} with dhaincha as brown manuring (L_4) resulted in significantly superior performance in terms of growth and yield attributes and yield a well as B:C ratio compared to other levels. Among the different time of application of N treatments, scheduling N in four equal splits at 15, 45, 60 and 75 DAS (S_1) was found to significantly enhance growth parameters, yield attributes and yield as well as B: C ratio over rest of the treatments. Significantly higher grain (6228 kg ha^{-1}) and straw yield and B:C were associated with L_4 at S_1, while they were found to be significantly lower with L_1 at S_4 except in case of productive tillers and straw yield, which were minimum with L_3 at S_4.

Key words: *Brown manuring, Dhaincha, Nutrient dynamics and semi-dry rice.*

Rice (*Oryza sativa* L.) is one of the world's most predominant staple cereal food crops in about 40 countries and for more than 65 per cent of the population in India. In India, it is grown in an area of 43.86 M ha with a production of 105.48 M t. In Andhra Pradesh, it is grown in an area of 38.09 lakh ha with a production of 115.65 lakh tones and productivity of 2,856 kg ha^{-1} in *kharif* (Ministry of Agriculture, Government of India, 2014 -15).

Contrary to conventional system of transplanting rice, which depends mainly on release of canal water and consequential delay in cropping season, a labour and water saving, semi-dry rice system is getting wide acceptance among the farmers of North-Coastal A.P. Direct seeding of rice reduces labour requirement, cost of cultivation, shortens the duration of crop and provide comparable grain yield with transplanting rice (Sharma *et al*., 2005).

In semi-dry system, part of the rice crop's life cycle passes through aerobic and part through anaerobic conditions, thus results in different nutrient dynamics, hence it requires precise N, P, K management by adopting appropriate agronomic interventions. By effective utilization of time and space, growing of rice crop along with green manure crop and their incorporation facilitates in bringing nutrients to the top from deep layers of soil and improves the nutritional status and sustains productivity of the soil. The major barrier in improving the productivity of rice in semi- dry system is inefficient use of N, the king pin in the rice crop nutrition. Hence, it requires special emphasis on generating precise nutrient management of major nutrients and time of nitrogen application to obtain satisfactory yields under semi-dry system.

MATERIAL AND METHODS

Field experiment was conducted during *kharif* 2015 at the Agricultural College Farm, Naira, Andhra Pradesh. The soil of the experimental site was sandy loam in texture with a pH of 6.27 and EC of 0.11 dSm^{-1} , low in organic carbon (0.42%) and available nitrogen (147 kg ha^{-1}), medium in available phosphorus (48.73 kg ha^{-1}) and potassium (221.76 kg ha^{-1}). Healthy seeds of rice variety 'MTU-1010' sown at 20 cm row spacing at a seed rate of 75 kg ha^{-1} on 17th August, 2015. The plot size adopted was 6 m × 4.4 m. The experiment was laid out in split- plot design, comprising of 16 treatment combinations with NPK levels (4); 120-75-60 kg NPK ha^{-1} (L_1), 160-90-75 kg NPK ha^{-1} (L_2), 120-75-60 kg NPK ha^{-1} with dhaincha as brown manuring (L_3) and 160-90-75 kg NPK ha^{-1}

with dhaincha as brown manuring (L_4) assigned to main plots and time of application of N (4) viz., four equal splits at 15, 45, 60 and 75 DAS (S_1), 10% of N at 15 DAS, 20% at 45 DAS, 30% at 60 DAS and 40% at 75 DAS (S_2), five equal splits at 15, 45, 60, 75 and at 90 DAS (S_3) and 10% of N at 15 DAS, 20% at 45 DAS, 25% at 60 DAS, 25% at 75 DAS, 20% at 90 DAS (S_4) assigned to sub plots and each replicated thrice. Application of nutrients was done as per the treatments. Brown manuring of dhaincha was done by spraying of 2, 4-D Sodium salt @ 1.0 kg a.i ha^{-1} at 36 DAS. The crop was harvested on 12-12-2015.

RESULTS AND DISCUSSION

EFFECT OF NPK LEVELS

Significantly taller plants at 90 DAS and higher dry matter were noticed with application of 160-90-75 kg NPK ha^{-1} with dhaincha as brown manuring (L_4). The shortest plants and minimum dry matter accumulation were observed in the plots which received the lowest level of NPK (L_1) and found significantly inferior to other higher levels. The increase in growth stature might be due to increased cell division and cell elongation associated with adequate and continuous availability of nitrogen supplied at regular intervals with L_4 and also due to increased response of rice under semi-dry growing situation that allows relatively lesser losses of N during the early part of the life cycle of crop compared to puddled conditions. Higher growth attributes due to liberal and continuous supply of NPK matching with the crop peak requirements has also been reported from several locations by a number of earlier workers (Murthy *et al.,* 2015; Jhansi Lakshmi Bai *et al.*, 2014 and Ramesh *et al.* 2007).

Graded levels of NPK exerted statistically measurable disparities among the yield attributes viz., productive tillers m^{-2}, filled grains $panicle^{-2}$ and thousand grain weight. Application of the highest level of NPK (160-90-75 kg ha^{-1}) with dhaincha as brown manuring (L_4) exhibited its statistical superiority in producing higher number of productive tillers m^{-2} (320), filled grains $panicle^{-2}$ and test weight, while the lowest productive tiller number m^{-2} (278), number filled grains per panicle as well as1000 grain weight were associated with L_1. Larger yield structure might be due to better nitrogen supply through fertilizer N as well as organic source (dhaincha brown manuring) that helps in liberal and continuous supply of N which leads to higher nutrient uptake, delays senescence and increases photosynthetic efficiency. Gradual release of nitrogen due to incorporation of brown manuring right through flowering stage might have increased the amount of budding spore on stigma that result in increased amount of germinated spores on stigma, which in turn increase the number of filled grains per panicle. These findings were in agreement with the views expressed by Murthy *et al.* (2015); Chaudary *et al.* (2011) and Nalini *et al*. (2008).

Grain (5599 kg ha^{-1}) and straw yield of semi-dry rice was found be significantly higher with the application of the highest dose of NPK (160-90-75 kg NPK ha^{-1}) with dhaincha as brown manuring (L_4). Application of L_3 was the next best treatment in this regard, which was however, comparable with L_2. Application of the lowest level of NPK (L_1) resulted in producing the lowest grain yield (4703 kg ha^{-1}). Maximum straw yield (6788 kg ha^{-1}) was obtained with the application of 160-90-75 kg NPK ha^{-1} with dhaincha as brown manuring (L_4) which was however comparable with L_2.While, straw yield was minimum with application of L_1, which was however, comparable with L_3 and L_2 and found significantly inferior to L_4. Significantly superior values for grain and straw yield registered with the application of the highest dose of NPK with dhaincha as brown manuring (L_4) might be ascribed to the fact that the nutro-physiology around the eco-rhizosphere of semi-dry rice might have created a favorable ambiance for continuous absorption of adequate amounts of NPK, besides essential micronutrients that were pumped from lower layers of the soil profile by dhaincha and the subsequent decomposition and release up on brown manuring. These findings are in corroboration with those reported by Murthy *et al.* (2015), Chaudary *et al.* (2011) and Kaushal *et al.* (2010).

Significantly higher B:C ratio (0.96) was registered with L_4, which was however, comparable with L_3 and L_2, while the lowest B:C ratio (0.79) was found to be associated with the lowest level of NPK (L_1) tried.

Table 1. Growth and yield parameters of semi-dry rice as influenced by NPK levels and time of N application.

Treatments	Plant height at 90 DAS (cm)	Dry matter accumulation at harvest (kg ha^{-1})	Productive tillers (m^{-2})	Filled grains panicle^{-1}	1000 grain weight (g)
Levels of NPK					
L1- 120-75-60 kg NPK ha^{-1}	74.2	10984	278	93	21.09
L2- 160-90-75 kg NPK ha^{-1}	79.7	12307	298	99	21.76
L3- 120-75-60 kg NPK ha^{-1} with	78.8	11862	297	104	21.88
Dhaincha as brown manuring	84.6	13228	320	119	22.13
L4- 160-90-75 kg NPK ha^{-1} with Dhaincha as brown manuring					
SEm (±)	1.15	232.28	5.20	1.68	0.07
C.D (P=0.05)	4.0	804	18	6	0.25
CV%	5.00	6.65	6.05	5.60	1.15
Time of application of Nitrogen					
S1 - Four equal splits at 15, 45, 60 and 75 DAS.	84.2	13245	330	109	22.11
S2 - 10% of N at 15 DAS, 20% at 45 DAS, 30% at 60 DAS and 40% at 75 DAS.	76.1	11791	285	101	21.45
S3 - Five equal splits at 15, 45, 60, 75 and 90 DAS.	80.8	12247	313	105	21.76
S4 -10% of N dose at 15 DAS, 20% at 45 DAS, 25% at 60 DAS, 25% at 75 DAS and 20% at 90 DAS	76.2	11097	265	101	21.54
SEm (±)	1.12	250.59	3.59	1.47	0.11
C.D (P=0.05)	3.3	731	10	4	0.33
CV%	4.89	7.18	4.17	4.90	1.80
Interaction effect (L X S)					
S.Em ±	2.25	292.28	8.10	3.05	0.21
CD (P=0.05)	NS	NS	25	NS	NS

EFFECT OF TIME OF APPLICATION OF NITROGEN

As regards time of application of nitrogen, the growth parameters viz., plant height and dry matter accumulation were found to be the highest when N was supplied in four equal splits (S_1) and found significantly superior to rest of the treatments while, application of N in five splits (S_4) produced the shortest stature of these parameters, which were however, comparable with S_2. Significant increase in growth attributes might be due to sufficient and continuous availability of nitrogen supplied at regular intervals and also due to increased response of rice under semi-dry growing situation that allows relatively lesser losses of N during the early part of the life cycle of crop. Similar views were observed by Jhansi Lakshmi Bai *et al.* (2014) and Kaushal *et al.* (2010).

Time of nitrogen application has considerable influence on number of productive tillers m^{-2}, filled grains per panicle and test weight. Maximum number of productive tillers m^{-2} (330), filled grains panicle^{-1} and 1000 grain weight were noticed in the plots which received N in four equal splits (S_1), which was however, comparable with S_3 in case of filled grains per panicle. While, the lowest number of productive tillers m^{-2} (265) was associated with S_4. Significantly lower number of

filled grains per panicle was associated with S_4, which was however, comparable with S_2, while the test weight was minimum with S_2, which was however, comparable with S_4 and S_3. Higher yield structure associated with S_1 might be due to substantial release of nitrogen at critical growth stages of semi-dry rice which manifested in increased number of productive tillers m^{-2}. While, more number of grains $panicle^{-1}$ could be attributed to favourable nutrition at primordial imitation which decides the number of grains $panicle^{-1}$. Similar results were reported from several locations by number of earlier workers Jhansi Lakshmi Bai *et al.* (2014), Chaudary *et al.* (2011) and Mahajan *et al.* (2011).

Application of nitrogen in four equal splits at 15, 45, 60 and 75 DAS (S_1) exerted a significant and positive influence in escalating the grain as well as straw yield of semi-dry rice compared to rest of the N scheduling treatments, while the lowest grain and straw yields were recorded when N was applied @ 10% of N at 15 DAS, 20% at 45 DAS, 25% at 60 DAS, 25% at 75 DAS, 20% at 90 DAS (S_4), which was however, found parity with S_2 in case of straw yield. The increment in grain yield between the best (S_1) and the least (S_4) N scheduling treatment was to the tune of 575 kg ha^{-1} (10.4%). Similar finding were noticed by Chaudary *et al.* (2011) and Kaushal *et al.* (2010).

The B:C ratio of semi-dry rice was found to be the highest when N was supplied in four equal splits (S_1), while the B:C ratio between S_2 and S_3 was found to be statistically comparable. The B:C ratio was minimum with S_4 and found significantly inferior to rest of the N scheduling treatments.

INTERACTION EFFECT :

Statistically measurable disparities were noticed with regard to number of productive tillers m^{-2}. Significantly higher number of productive tillers m^{-2} was found with L_4 at S_1, which was however, comparable with L_3 at the same N scheduling treatment (S_1). The productive tillers m^{-2} was found

Table 2. Grain yield, straw yield and B: C of semi-dry rice as influenced by NPK levels and time of N application.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	B:C
Levels of NPK			
L1- 120-75-60 kg NPK ha^{-1}	4703	6170	0.79
L2- 160-90-75 kg NPK ha^{-1}	5182	6381	0.89
L3- 120-75-60 kg NPK ha^{-1} with Dhaincha as brown manuring	5259	6352	0.91
L4- 160-90-75 kg NPK ha^{-1} with Dhaincha as brown manuring	5599	6788	0.96
SEm (±)	75.06	118.58	0.025
C.D (P=0.05)	260	410	0.09
CV%	5.01	6.40	9.79
Time of application of Nitrogen			
S1 - Four equal splits at 15, 45, 60 and 75 DAS.	5524	6735	1.02
S2 - 10% of N at 15 DAS, 20% at 45 DAS, 30% at 60 DAS and 40% at 75 DAS.	5111	6263	0.87
S3 - Five equal splits at 15, 45, 60, 75 and 90 DAS.	5160	6494	0.87
S4 -10% of N dose at 15 DAS, 20% at 45 DAS, 25% at 60 DAS, 25% at 75 DAS and 20% at 90 DAS	4949	6199	0.80
SEm (±)	49.24	59.99	0.016
C.D (P=0.05)	144	175	0.05
CV%	3.29	3.24	6.40
Interaction effect (L X S)			
S.Em ±	113.62	157.67	0.038
CD (P=0.05)	358	509	0.12

to be significantly lower with L_3 at S_4, which was however, found parity with L_1 and L_2 at S_4. Better nitrogen supply through fertilizer N as well as organic source (dhaincha brown manuring) helps in liberal and continuous supply of N which leads to higher nutrient uptake, delays senescence and increases photosynthetic efficiency. Substantial release of nitrogen at critical growth stages of semi-dry rice might be responsible for increased number of productive tillers m^{-2}. Similar views were found with Mahajan *et al.* (2011).

Significantly superior grain and straw yields were associated with the application of L_4 supplied in four equal splits (S_1) and found statistically superior to rest of the treatment combinations. Significantly lower grain yield was realized with L_1 scheduled at S_4, which was however, comparable with the same dose (L_1) at S_2 and S_3. While, the straw yield was minimum with L_3 when supplied in five splits (S_4), which was however, comparable with S_2, S_3 and S_4 at L_1, L_2 at S_4, L_3 at S_2, L_2 at S_2 and L_1 at S_1. These findings are in corroboration with those reported by Ramesh *et al.* (2007).

With regard to the interaction effect between these two factors, significantly higher B:C ratio (1.2) was found to be associated with L_4 at S_1 and exhibited its supremacy over all other treatment combinations while, the B:C was found to be significantly lower (0.73) with L_1 at S_4, which was however, comparable with S_2 same level (L_1).

From the present investigation, it can be concluded that application of 160-90-75 kg NPK ha^{-1} with dhaincha as brown manuring (L_4) and when nitrogen was scheduled in four equal splits at 15, 45, 60 and 75 DAS (S_1) was found to be the best nutrient management package for semi-dry rice grown in North Coastal A.P as it resulted in significantly higher grain yield as well as B:C ratio.

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(Received on 28.06.2016 and revised on 06.02.2017)