The Andhra Agric. J 65 (2): , 2018

Evaluation of Crop Establishment Techniques and N Levels on Growth and Yield of Rice

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ABSTRACT

A field experiment was conducted for two consecutive years 2015-16 and 2016-17 at Agricultural Research station, Ragolu, Andhra Pradesh, with four establishment techniques as main plots and five nitrogen levels as sub plots in a split plot design on sandy clay loam soil. The study revealed that planting with machine technique was stastically on par with normal planting, showing significantly higher values of growth and yield attributes. Growth characters like plant height, drymatter production and yield attributes like number of grains /panicle, filled grains / panicle and test weight were stastically higher in planting with machine technique. Highest grain yield of 6572 kg ha^{-1} and 6954 kg ha^{-1} during 2015 and 2016, respectively was recorded in planting with machine technique. The plant growth characters, yield attributes, grain and straw yields were significantly higher with application of nitrogen @ 210 kg N ha^{-1} and it was comparable with 180 and 150 kg N ha^{-1} during both the years of study.

Key words : *Crop establishment techniques, grain yield, N levels, Rice.*

Rice is the staple food for more than half of the world's population and plays a pivotal role in food security of many countries. More than 90% of the global production and consumption of rice is in Asia (IRRI, 1997). India has the largest area among rice growing countries and stands second in production. In India, rice is grown in an area of 44.1 million hectares with a production of 108.9 million tonnes and productivity of 2391 kg ha^{-1}. In Andhra Pradesh, it is grown in an area of 2.4 million hectares with a production of 7.24 million tonnes and productivity of 3022 kg ha^{-1} (Ministry of Agriculture, Government of India, 2016-17). Projection of India's rice production target for 2025 A.D is 140 million tonnes per year and this need to be achieved against the back drop of plateauing of rice yields coupled with restrictions on area expansion, diminishing natural resources such as land and water (Sridhara *et al*., 2011). Growing more rice with reduced cost of production and maintaining soil health are the major concerns of rice farming. The increase in rice productivity therefore needs to be achieved through adoption of suitable and improved production technologies.

Traditional flooded rice cultivation has increasingly experienced shortages in irrigation water, labour and higher labour wages. In addition to high water requirement, the traditional system of transplanted rice production on puddled soil influences the soil aeration and reduce yields of post sequence crops. These factors have adversely affected the farm operations and profits of rice based cropping systems. Rice growers across the country seek elevated levels of productivity to counter balance ever increasing cost of production. These conditions emphasize the need for shift to labour and water saving rice cultivation methods, which can shorten the duration of crop and increase yields. Good crop establishment is one of the vital components for efficient use of resources and desired level of productivity in rice. In order to reduce the manpower requirement and cost of production, a need has been felt to replace the manual transplanting with some scientifically sound, technically feasible, economically viable and environmentally safe establishment technique (Sanjay *et al*., 2006). Direct seeding of dry seed, Drum seeding, aerobic rice and planting with machine transplanter are some of the methods of crop establishment which may ensure better plant population and less reliant on labour compared to conventional practice of manual transplanting (Mankotia *et al*., 2009) and are gaining popularity among the farmers with the advent of highly efficacious herbicides.

Rice yields generally depend on its genetic potential, agro climatic conditions and management practices. Nutrient management must be sound and effective for achieving the production targets on sustainable basis. As nitrogen is the king pin of rice nutrition, optimum nitrogen management is highly imperative to realize the full potential of improved methods of crop establishment because of variations in N dynamics under different establishment methods. The information on nitrogen requirement of rice under varied establishment techniques for realizing optimum yield is meager. The present experiment was under taken to study the effect of different establishment techniques and nitrogen levels on growth and yield of rice.

MATERIAL AND METHODS

The present investigation was conducted during 2015-16 and 2016-17 at Agricultural Research Station, Ragolu in North coastal agro climatic zone of Andhra Pradesh, situated at $18^{0}.24'$ N latitude, $83^{0}.84'$ E longitude and at an altitude of 27.0 m above the mean sea level. The experimental soil was sandy clay loam in texture, neutral in reaction, low in organic carbon, low in available nitrogen, medium in available phosphorus and potassium. The experiment was laid out in a split plot design, replicated thrice with four crop establishment techniques as main plots and five nitrogen levels as sub plots. The main plot treatments consisted of (i) Dry direct sown rice (ii) Aerobic rice (iii) Planting with machine and (iv) Normal planting**.** The subplot treatments consisted of five nitrogen levels (90, 120, 150, 180 and 210 kg N ha^{-1}). The cultivar used in the study for rice was MTU 1001(vijetha).

Nitrogen in the form of urea was applied as per the treatments in three equal splits as one third basal, one third at active tillering and one third at panicle initiation stage. A common dose of 60 kg $P_2 O_5$ and 50 kg K_2O ha^{-1} was applied uniformly through single super phosphate and muriate of potash, respectively. Entire dose of phosphorus was applied as basal. Whole potassium was applied in 2 splits as basal and 1/3 at panicle initiation stage along with urea. A common dose of $ZnSO_4$ @ 20 kg ha^{-1} was applied to all the treatments uniformly as basal.

The sowing of dry direct sown rice(DDS rice) and aerobic rice was done in lines in the non puddled and non flooded soil at a spacing of 20 x10 cm. Nursery was raised in trays for planting with machine technique on the same day of sowing of dry direct sown rice and aerobic rice. Tray nursery was used to suit mechanical transplanting. Seedlings from tray nursery of 14 days age were machine transplanted to ensure uniform depth and seedlings per hill at a spacing of 30cm x 18cm. Nursery was raised on thoroughly puddled and levelled nursery bed for normal planting method of establishment, on the same day of sowing of dry direct sown rice and aerobic rice. Nursery was raised upto the age of 25 days and transplanted manually at a spacing of 20 cm x 15 cm. In direct seeded rice and transplanting rice, weeds were controlled by applying pendimethalin @ 2.5 litres ha^{-1} within 2 days of sowing and transplanting of rice and bispyribac sodium @250 ml ha^{-1} at 30 days after sowing and 25 days after transplanting of rice, respectively. The left over weeds were removed by 2 hand weedings in direct seeded rice techniques and 1 hand weeding in transplanted rice techniques respectively.

The observation on growth parameters *viz.,* plant height, drymatter production and yield attributes *viz.,* number of productive tillers m^{-2}, number of grains per panicle, filled grains per panicle, test weight, grain yield, straw yield and harvest index were analysed by using standard procedures.

RESULTS AND DISCUSSION

Growth parameters

Plant height (cm) measured at harvest during both the years was affected significantly by both crop establishment techniques and nitrogen levels, however their interaction on plant height was non significant during both the years of study (Table 1). Among the crop establishment techniques, planting with machine recorded taller plants and showed its superiority over aerobic rice and was comparable with that of normal planting and DDS rice during both the years. This might be due to proper row to row and plant to plant spacing followed at uniform depth by machine which lead to reduced competition and the plants got sufficient space to grow and increased light transmission in the canopy might have increased the plant height. Similar results were reported by Rakesh kumar *et al.*(2015) and Senthil kumar (2015). Plant height differed significantly due to nitrogen levels at harvest. In general, plant height increased with increase in level of nitrogen application from 90 to 210 kg N ha^{-1}. At harvest , plant height showed significant increase with increasing nitrogen level upto 120 kg N ha^{-1} during 2015 and upto 150 kg N

ha^{-1} in 2016 and further increase in N level did not influence the plant height conspicuously. Milthrope and Moorby (1979) observed that under adequate nitrogen supply, cell elongates extensively along the main axis leading to longer growth of internodes and increase in the length of culm. Such a favourable effect of nitrogen on increase in plant height of rice was also reported by Shukla *et al.*(2015).

At harvest, significantly highest drymatter was recorded in planting with machine, but, it was on par with normal planting and superior to that of aerobic rice and DDS rice. The lowest drymatter production was registered with aerobic rice during both the years (Table 1). There was no significant difference in drymatter production between normal transplanting and DDS rice. However both are significantly superior to that of aerobic rice during both the years of study. Higher drymatter production in the machine planting technique might be due to optimum plant population and geometry which led to availability of more natural resources and inputs to plants. Agronomically, it is not uncommon that the seedlings with high initial seedling vigour, especially in case of transplanted rice of any version, setout their growth very quickly and produce larger rhizosphere and planophile. Voluminous rhizosphere absorbs optimum quantity of nutrients from the soil and triggers the vegetative growth, which will be expressed in the form of taller plants with better tiller production containing more number of leaves with larger photosynthetic area, resulting in accrual of higher drymatter production, which is the primary pre requisite for the production of higher economic yield through elevated stature of yield contributing parameters. These findings are in conformity to the findings of Senthil Kumar, (2015) and Kumhar *et al*. (2016).

There was a progressive increase in drymatter production with the increase in nitrogen levels from 90 to 210 kg N ha^{-1}. Nitrogen @ 210 kg N ha^{-1} recorded significantly higher drymatter and it was on par with 180 and 150 kg N ha^{-1} and significantly superior over other lower levels of N during both the years of study. the drymatter production was lowest with the application of N@ 90 kg N ha^{-1}. Increase in drymatter production with increasing rate of nitrogen application might be due to cumulative effect of increased chlorophyll formation and better photosynthesis. These observations are in confirmity with those of Anil *et al.* (2014) and Singh *et al.* (2015).

Yield attributes

Number of productive tillers m^{-2} was significantly influenced by both crop establishment techniques and nitrogen levels. However, their interaction was non significant during both the years of study(Table 1) . Among the crop establishment techniques, maximum number of productive tillers m^{-2} was recorded with aerobic rice, but, it was at par with DDS rice and significantly superior to planting with machine and normal planting. The number of productive tillers m^{-2} was significantly lowest in planting with machine over other crop establishment techniques, but, it was at par with normal planting during both the years. The increase in number of productive tillers m^{-2} under direct sowing might be due to greater plant population rather than tillers $plant^{-1}$. Such an increase in productive tillers with direct sowing techniques were also reported by Rakesh Kumar *et al*.(2012) and Gill and walia (2013).

Among the nitrogen levels, the number of productive tillers m^{-2} increased significantly with increase in nitrogen level upto 150 kg N ha^{-1} during both the years of study . Further increase in N level did not influence productive tillers m^{-2} significantly. The lowest number of productive tillers m^{-2} was observed with 90 kg N ha^{-1} during both the years of study. The increase in number of panicle m^{-2} with increasing level of nitrogen might be due to continuous supply of adequate nitrogen to the crop resulting in increased N uptake by rice which inturn promoted the production of more number of productive tillers .

Among the crop establishment techniques, significantly higher number of grains $panicles^{-1}$ and filled grains $panicle^{-1}$ was recorded in planting with machine during both the years but it was comparable with normal planting. There was no significant difference in number of grains $panicle^{-1}$ and filled grains $panicle^{-1}$ between DDS rice and normal planting (Table 2). The number of grains $panicle^{-1}$ and filled grains $panicle^{-1}$ was significantly lowest with aerobic rice over other crop establishment techniques during both the years, but, comparable with that of DDS rice in 2015 only. The maximum number of grains $panicle^{-1}$ and filled grains $panicles^{-1}$ obtained in transplanting might be due to sufficient moisture and nutrients available to the plants due to deep penetration and wide spread of roots at panicle initiation and flowering stages which in turn might have increased the light interception because of wider spacing, that resulted in more drymatter accumulation and partitioning into sink (panicles). Similar views were also expressed by Ali *et al*. (2012) and Sheeja *et al*. (2012).

Total number of grains panicle^{-1} and filled grains panicle^{-1} increased with increase in level of nitrogen from 90 to 210 kg N ha^{-1}. Maximum total number of grains panicle^{-1} and filled grains panicle^{-1} were recorded with 210 kg N ha^{-1}. Which were on par with nitrogen @ 180 and 150 kg ha^{-1} during both the years of study. Further increase in N level did not affect number of grains panicle^{-1}and filled grains panicle^{-1}. This is in consonance with the findings of Gangadevi and Sumathi, (2011). The effect of nitrogen on seed filling is a primary function of assimilate accumulation and inturn, facilitating higher N assimilation with adequate supply of photosynthates to grain (Kumar *et al*., 2008).

The highest test weight was recorded in planting with machine, which was significantly superior to aerobic rice only in 2015 and other establishment techniques (aerobic rice, DDS rice and normal transplnting) in 2016. There was a slight increase in test weight with increasing nitrogen levels from 90 to 210 kg N ha^{-1}. This might be due to increased translocation of photosynthates from source to sink. During 2015 and 2016, application of 210 kg N ha^{-1} registered significantly highest test weight (24.85 g and 24.25 g respectively) over other lower levels which were on par with 180 and 150 kg N ha^{-1} during both the years of study .

Yield

Grain and straw yield of rice was significantly influenced by both crop establishment techniques and nitrogen levels during both the years while their interaction was non significant during both the years (Table 3). Among the crop establishment techniques, the highest grain and straw yields were recorded in planting with machine, but it was comparable with normal planting and DDS rice and significantly superior to aerobic rice. The grain and straw yields were significantly lowest with aerobic rice over other crop establishment techniques during both the years. It was observed that different planting methods caused marked variations in grain and straw yields of rice. Higher yield under transplanting methods might be due to better enhanced stature of yield attributing characters through optimum utilisation of resources which had direct bearing on the production of higher grain and straw yield. Lower yields under direct seeding (aerobic rice and dry direct sowing) is attributed to excessively higher competition with weeds and dense population per unit area. Plant density plays a major role in determining the efficiency of solar energy conversion to plant product per unit of land area. Excess plant population than required creates competition for various growth resources, either spatially or temporally and thus results in sub-optimal performance of the crop under a given environment. These results are in confirmation with the findings of Senthil kumar (2015), Islam *et al.*(2016) and Meena *et al* (2017).

Regardless of crop establishment techniques, there was a progressive increase in grain and straw yield of rice with the increase in nitrogen levels from 90 to 210 kg N ha^{-1}. Among N levels the highest grain and straw yields were recorded with 210 kg N ha^{-1}. However, the difference in grain and straw yields between the N levels was measurable upto application of N@150 kg ha^{-1} only and further increase in N level did not augment the grain and straw yields conspicuously. However, the grain and straw yields were lowest with the application of N@ 90 kg ha^{-1}. The linear response observed with grain and straw yield was supported by similar trends recorded with all growth and yield attributing characters studied. This suggests that nitrogen nutrition is important for both source and sink development. Higher straw yield with higher levels of nitrogen might be attributed to higher drymatter and plant height. Nitrogen is the constituent of chlorophyll, which inturn, might have resulted in accumulation of photosynthates in vegetative portion of plants and ultimately enhanced the plant growth in transplanting techniques. These results are in conformity with those of Singh *et al.*(2015) and Prathibhasree *et al*. (2016).

During both the years of study , crop establishment techniques did not influence the harvest index significantly. However, nitrogen levels significantly influenced the harvest index during 2016 only, The interaction effect of crop establishment techniques and nitrogen levels was non significant during both the years .

Among N levels the highest harvest index was recorded with 210 kg N ha^{-1}. However, the difference in harvest index between the N levels was measurable upto application of N@120 kg ha^{-1} only and further increase in N level did not augment the harvest index. The increase in harvest index with increasing levels of nitrogen might be due to better translocation of assimilates from shoot to grain as was observed with number of filled grains per panicle .

Table 1: Growth characters of rice as influenced by crop establishment techniques and N levels

Treatments	Plant height (cm) at harvest		Drymatter production at harvest (kg ha^{-1})		Productive tillers m^{-2}	
	2015	2016	2015	2016	2015	2016
Crop establishment techniques						
M_1:Dry direct sown rice	106.8	108.3	13564	13957	394	407
M_2 : Aerobic rice	104.1	105.0	12270	12686	403	415
M_3 : Planting with machine	109.8	111.4	14327	15394	356	369
M_4 : Normal planting	109.1	109.4	13863	14453	371	385
SEm$\pm$	1.2	1.0	243	275	8	9
CD(P=0.05)	4.0	3.5	842	954	27	33
CV%	4.2	3.6	7.1	7.8	8.0	9.3
Nitrogen levels (kg ha^{-1})						
N_1:90	100.3	100.5	11094	11783	345	357
N_2:120	105.7	107.1	12894	13450	367	383
N_3:150	108.8	110.6	13966	14596	392	406
N_4:180	110.7	111.8	14572	15197	397	409
N_5:210	111.6	112.6	15004	15587	406	414
SEm$\pm$	1.3	1.2	305	298	8	8
CD(P=0.05)	3.7	3.3	878	860	21	22
CV%	4.2	3.7	7.9	7.6	6.8	6.8
Interaction	NS	NS	NS	NS	NS	NS

Table 2: Yield attribuates of rice as influenced by crop establishment techniques and N levels

Treatments	Number of grains panicle^{-1}		Filled grains panicle^{-1}		Test weight (g)	
	2015	2016	2015	2016	2015	2016
Crop establishment techniques						
M1:Dry direct sown rice	179	188	131	135	24.49	23.81
M_2 : Aerobic rice	168	171	118	124	23.81	23.15
M_3 : Planting with machine	196	200	156	161	24.64	24.26
M_4 : Normal planting	183	190	147	153	24.56	23.92
SEm$\pm$	4	3.0	3.0	3	0.2	0.1
CD(P=0.05)	14	10	11	11	0.66	0.25
CV%	8.6	6.0	8.8	8.8	3.0	1.2
Nitrogen levels (kg ha^{-1})						
N_1:90	169	172	126	128	23.63	23.11
N_2:120	178	179	133	137	24.23	23.68
N_3:150	183	191	138	146	24.53	23.80
N_4:180	187	194	145	152	24.65	24.08
N_5:210	190	199	149	155	24.85	24.25
SEm$\pm$	3	4.0	2.0	4	0.2	0.2
CD(P=0.05)	8	11	6	11	0.56	0.54
CV%	5.2	7.2	5.5	9.4	2.8	2.9
Interaction	NS	NS	NS	NS	NS	NS

Table 3: Yield of rice as influenced by crop establishment techniques and N

Treatments	Grain yield (kg ha^{-1})		Straw yield(kg ha^{-1})		Harvest index (%)	
	2015	2016	2015	2016	2015	2016
Crop establishment techniques						
M_1:Dry direct sown rice	6194	6421	7341	7511	45.8	45.9
M_2 : Aerobic rice	5283	5645	6631	6820	44.3	45.2
M_3 : Planting with machine	6572	6954	7728	8177	45.8	45.8
M_4 : Normal planting	6308	6636	7441	7739	45.9	46.1
SEm±	147	155	158	179	0.5	0.7
CD(P=0.05)	508	536	547	618	NS	NS
CV%	9.3	9.4	8.4	9.2	4.7	6.0
Nitrogen levels (kg ha^{-1})						
N_1:90	4848	4947	6074	6367	44.4	43.7
N_2:120	5881	6262	7128	7342	45.2	46.1
N_3:150	6409	6722	7578	7820	45.8	46.2
N_4:180	6597	6984	7763	8043	45.9	46.4
N_5:210	6713	7155	7883	8238	45.9	46.4
SEm±	140	158	152	166	0.6	0.6
CD(P=0.05)	404	455	438	477	NS	1.9
CV%	8.0	8.7	7.2	7.6	4.9	4.9
Interaction	NS	NS	NS	NS	NS	NS

It can be concluded that rice growth and yield was superior in palnting with machine and it was statistically at par with normal planting and DDS rice and significantly higher than aerobic rice. Irrespective of the crop establishment techniques, application of N @ 150 kg ha^{-1} was found to be optimum for reaping higher growth and yield than other lower nitrogen levels in North coastal zone of AP.

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