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IMPACT OF NITROGEN FERTILIZER MANAGEMENT ON THE PRODUCTION OF DRY SEEDED PADDY (*Oryza sativa* L.) IN RAINFED AREAS OF TELANGANA (INDIA)

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ABSTRACT

The experiment was aimed on to assess the influence of various nitrogen levels on growth and yield of dry seeded paddy in farmer's fields. The study was conducted in three consecutive *kharif* seasons of 2017-2019 in a randomized block design with each treatment replicated 5 times. The treatments comprised of four nitrogen levels i.e. 100, 125, 150 and 175% recommended N and farmer's practice. Pooled data revealed higher dry matter (kg ha^{-1}) in 150% N treatment (2465), followed by 175% N (2369) and 125% N (2095) treatments over the farmer's observe (1940) at active tillering stage. However, at panicle initiation, grain filling and maturity stages dry matter was high in 150% N treatment (5433) which was at par with 175% N (5294), followed by 125% N (4924) treatments over the farmers practice (4877). The panicle length (cm) showed non-significant difference while grains panicle^{-1} was high in 150% N treatment (193), followed by 175% N (182) and 125% N (176) treatments over the farmers practice (169). In turn, it resulted in higher grain yield (kg ha^{-1}) in 150% N treatment (4952) which was at par with 175% N (4811) followed by 125% N (4360) treatments over the farmers practice (3901). The straw yield (kg ha^{-1}) was high in 150% N treatment (6652) which was at par with 175% N treatment (6427), followed by farmers observe (5619) and 125% N treatment (5704). Harvest index was 42.7% in 150% N treatment over the farmer's practice (41.0%).

Keywords: Dry seeded paddy, N-fertilizer, stuffed grains, grain yield and harvest index

INTRODUCTION

More than half of the world's population consumes rice as staple food. Worldwide, rice is cultivated on an area of 160.5 million ha with production of 496 million metric tonnes and productivity of 4.6 t ha^{-1} (Anonymous, 2020). In India, rice occupies an area of 44.5 million ha with production of 102.7 million t. India ranks first in rice area followed by China, but the productivity is extremely low 2.20 t ha^{-1} (Tanmoy Shankar *et al.*, 2020).

Rice consumes 34-43% of the world's irrigation water (Bouman *et al.*, 2007). In India, water use by rice has been reported to be 1140 mm in Bihar and 1560 mm in Haryana. In India, water scarcity is increasing severely. Increased use of groundwater for rice cultivation has led to decline in ground water table by 1 m yr^{-1}. Therefore, the increasing water scarcity has threatened the productivity and sustainability of irrigation rice system in India. Direct seeded rice (DSR), a common practice before green revolution in India, is becoming popular once again because of its potential to save water and labour. Currently, direct seeded rice occupies about 29 million ha in Asia is approximately 21% of the total area under rice in the continent. Countries like USA and Australia extensively practice direct seeding of rice with profitable results as it avoids all the penalties entailed in transplanting. Rice can be established by four principal methods: dry-DSR, wet-DSR, water seeding, and transplanting. Dry-DSR, wet-DSR and water seeding are commonly referred to as direct seeding as in these methods the seeds are sown directly in the main field. Seeding is the oldest method of rice establishment. Prior to 1950s, direct seeding was most common, but was gradually replaced by puddle transplanting. At present, globally 23% rice is direct-seeded (Rao *et al.*, 2007). Direct seeding offers the advantage of fast and easier planting, reduced labour and drudgery, early crop maturity by 7-10 days, efficient water use, higher tolerance of water deficit, fewer methane emissions, and often higher profit in areas with an assured water supply (Rajesh Lomror *et al.*, 2017).

Nitrogen is the key element in the production of rice and crops respond faster to their field application (Khan *et al.*, 2012). N is required more consistently than other nutrients and it accounts for 67% of the total fertilizers used in agriculture (Mahajan *et al*., 2011). Moderate N could greatly improve the crop yield and quality; however, excessive N application often leads to serious problems in ecosystem. The improper use of nitrogenous fertilizer instead of yield advantage may reduce the productivity. Many workers have reported a significant favourable response of rice to nitrogen (Para *et al*., 2018). Almost every farmer has tendency to excessively apply N fertilizer to achieve maximum rice yield and such imbalanced fertilizer application often causes harm to the crop and decreases the grain yield. Proper N application in DSR not only reduces the N loss but also improves crop growth and yield. The N management in DSR is likely to be different from that of transplanted rice as it involves different development processes and crop management practices. However, N management in DSR has received very little attention and the N management practices in DSR adopted by farmers were almost same as in transplanted rice (Patel *et al.*, 2019). Hence, the present study was aimed to assess the influence of various nitrogen fertilizer levels on growth and yield of dry seeded paddy in the farmer's field under rainfed conditions of Telangana (India).

MATERIALS AND METHODS

A field experiment was conducted on paddy (*Oryza sativa* L.) cv. 'BPT-5204'during *kharif* 2017, 2018 and 2019 in the farmer's field in Marlapadu, Khammam district, Telangana (India). The soil of the experimental site was clay loam in texture, neutral, non-saline in nature (pH, 7.34 and EC, 0.39 dSm^{-1}), low in organic carbon (0.25%) and available nitrogen (163.7 kg ha^{-1}), medium in available phosphorus (35.7 kg ha^{-1}) and high in available potassium (255.7 kg ha^{-1}). The experiment was conducted in a randomized block design with each treatment replicated five times. The treatments comprised of four fertilizer levels i.e. 100% N (recommended dose of 120 kg N ha^{-1}), 125% N, 150% N and 175% N and farmer's practice (farmer-applied fertilizer as per local practice of recommendations). In dry seeded paddy, the seeds were broadcast on 10^{th} July, 2017, 9^{th} June, 2018 and 20^{th} June, 2019 after primary, secondary tillage and spraying of paraquat herbicide. Two day after seed sowing, pendimethalin was applied to the field @ 3.0 L ha^{-1} as pre-emergence herbicide as it effectively manages weed germination for 10 to 15 days. For post-emergence weed control, bispyribac sodium was applied @ 250 mL ha^{-1}. Dry sown paddy converted as wet paddy 25-30 days after sowing and was maintained flooded and saturated till the maturity of crop.

For fertilizer management studies, the P and K were applied in four treatments as per the recommended dose of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} while in farmer's practice treatment, the local practice of famers was followed. In test treatments nitrogen was applied in three split doses i.e. 30% at basal, 40% at active tillering stage and 30% at panicle initiation stages in the form of urea. Also, basal application of phosphorus as DAP @ 130 kg ha^{-1} and potassium as MOP @ 70 kg ha^{-1} was done. In farmer's practice, the farmer generally applied 151 kg N, 126 kg P_2O_5 and 38 kg K_2O ha^{-1} in the form of urea @ 188 kg ha^{-1}, DAP @ 125 kg ha^{-1}, MOP @ 63 kg ha^{-1} and complex (20-20-0/13-0-45) fertilizers @ 250 kg ha^{-1}. From randomly selected five plants each treatment, recorded the data on growth parameters like crop dry matter accumulation at different stages and yield attributes like panicle length (cm), filled grains panicle^{-1} and test weight (g). At harvest of the crop collected the plants per square meter for recording of grain and stover yield (kg ha^{-1}), calculated the harvest index (%) for dry seeded paddy and presented the data statistically. Weed management and pest control measures was taken as per the recommendations. In dry seeded paddy observed the stem borer, brown plant hopper, stem rot and leaf spot in entire study and they were controlled by recommended chemicals. The harvest index (%) was calculated and expressed as:

$$\text{Harvest index} = \frac{\text{Economical yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \text{x } 100$$

The data obtained was statistically analyzed using the analysis of variance technique for randomized block design (Gomez and Gomez, 1984). The significant differences between the treatments were compared pair-wise by critical difference at 5% level of probability.

RESULTS AND DISCUSSION

During *kharif* 2017, crop dry matter production (kg ha^{-1}) at active tillering stage, panicle initiation, grain filling and maturity stages was maximum in 150% N treatment (2170, 3074, 4319 and 4824, respectively) but at par with 175% N treatment (2064, 3015, 4253 and 4703), followed by 125% N (1835, 2648, 4000 and 4501) and farmer's practice (1840, 2239, 4102 and 4416). During *kharif* 2018, higher crop dry matter production at above stages was observed in 150% N treatment (2701, 3646, 5740 and 5922, respectively) which was at par with 175% N treatment (2637, 3491, 5696 and 5854), followed by 125% N (2404, 3269, 5122 and 5342) over the farmer's practice (2146, 3035, 4960 and 5237). Similar trend was noticed in *kharif* 2019 with high dry matter production at active tillering stage, panicle initiation, grain filling and maturity stages in 150% N treatment (2522, 3353, 4576 and 5522, respectively) but at par with 175% N (2406, 3233, 4471 and 5325), followed by 125% N (2045, 3011, 4189 and 4929) and farmer's practice (1835, 2753, 4053 and 4979). Pooled data revealed that at active tillering stage higher crop dry matter (kg ha^{-1}) in 150% N treatment (2465), followed by 175% N (2369), 125% N (2095) and farmer's practice (1940); however at panicle initiation, grain filling and maturity stages the maximum crop dry matter (kg ha^{-1}) was observed in 150% N treatment (3357, 4878 and 5433, respectively) which was at par with 175% N treatment (3246, 4807 and 5294), followed by 125% N (2976, 4437 and 4924) and farmer's practice (2676, 4372 and 4877) [Table 1 and 2]. This may be owing to the immediate availability of nutrient in the desired amount from the higher dose of N fertilizers. The increase in plant growth might be due to the N-effect on multiplication of tissues and increase in growth substances such as normally occurring phytohormones and increase in auxin supply with higher N level. These results corroborate with those

Table 1: Influence of N-fertilizer on crop dry matter production (kg ha^{-1}) at active tillering and panicle initiation stages of dry seeded paddy

Treatments	Active tillering stage				Panicle initiation stage			
	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean
100% N (120 kg ha^{-1})	1361	2108	1916	1795	2335	3149	2818	2767
125% N (150 kg ha^{-1})	1835	2404	2045	2095	2648	3269	3011	2976
150% N (180 kg ha^{-1})	2170	2701	2522	2465	3074	3646	3353	3357
175% N (210 kg ha^{-1})	2064	2637	2406	2369	3015	3491	3233	3246
Farmer's practice	1840	2146	1835	1940	2239	3035	2753	2676
SE(m)±	62	62.8	57.9	21.3	82	54	68	37
$CD_{0.05}$	186	190	175	64	249	164	205	113

Table 2: Influence of N-fertilizer on crop dry matter production (kg ha^{-1}) at grain filling and maturity stages of dry seeded paddy

Treatments	Grain filling stage				Maturity stage			
	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean
100% N (120 kg ha^{-1})	3782	5055	3961	4266	4377	5096	4478	4650
125% N (150 kg ha^{-1})	4000	5122	4189	4437	4501	5342	4929	4924
150% N (180 kg ha^{-1})	4319	5740	4576	4878	4824	5922	5522	5433
175% N (210 kg ha^{-1})	4253	5696	4471	4807	4703	5854	5325	5294
Farmers practice	4102	4960	4053	4372	4416	5237	4979	4877
SE(m) ±	40	39	53	24	45	88	74	48
$CD_{0.05}$	121	119	160	72	135	265	223	145

of Singh and Kumar (2014), Vinod Kumar *et al.* (2015), Tiwari *et al.* (2015), Pandey and Namdeo (2016) and Para *et al.* (2018).

The panicle length showed non-significant improvement in all the years, except for the year 2019. Higher panicle length was observed in 150% N treatment (24.2 cm) which was, however, at par with 175% N (21.6 cm), 125% N (21.6 cm) and farmer's practice (18.6 cm) treatments during *kharif* 2019 (Table 3). The filled grains panicle^{-1} was high in 150% N treatment (198, 189 and 193), followed by 175% N (181, 177 and 182), 125% N (177, 173 and 176) and farmer's practice treatments (168, 165 and 169) during *kharif* 2017, 2019 and overall pooled values, respectively. During *kharif* 2018 the filled grains panicle^{-1} was high in 150% N treatment (191) and was at par with 175% N treatment (188), followed by 125% N (180) and farmers practice (175) (Table 3). The test weight was high in 150% N treatment (15.6 and 15.6 g) which was at par with 175% N (14.9 and 14.8 g), followed by 125% N (14.5 and 14.5 g) and farmer's practice (14.1 and 13.5 g) during *kharif* 2017 and 2018, respectively. Similarly, the test weight was high in 150% N treatment (15.8 and 15.6 g), followed by 175% N (14.8 and 14.8 g), 125%N (14.4 and 14.4 g) and farmer's practice (14.1 and 14.1 g) during *kharif* 2019 and overall pooled values, respectively (Table 3). High nitrogen use increases the growth parameters and photosynthetic surface thereby help plants to attain higher number of leaves plant^{-1}. Further, increased photosynthates might have enhanced the translocation of photosynthates from source to the sink. The present results corroborate with those of Vinod Kumar *et al.* (2015), Tiwari *et al.* (2015), Pandey and Namdeo (2016) and Sudhakara *et al.* (2017).

Overall higher grain yield (kg ha^{-1}) during *kharif* 2017, 2018, 2019 and in pooled data, was observed in 150% N treatment (4910, 5020, 4926 and 4952, respectively) which was at par with 175% N treatment (4723, 4872, 4840 and 4811), followed by 125% N treatment (4143, 4520, 4416 and 4360) and farmer's practice (3980, 3724, 3998 and 3901) (Table 4). Similarly, higher straw yield (kg ha^{-1}) during *kharif* 2017, 2018, 2019 and in pooled data was recorded in 150% N treatment (6425, 6963, 6567 and 6652, respectively) which was at par with 175% N treatment (6091, 6695, 6496 and

Table 3: Influence of N-fertilizer on panicle length, filled grains panicle^{-1} and test weight of dry seeded paddy

Treatments	Panicle length (cm)				Filled grains panicle^{-1}				Test weight (g)			
	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean
100% N (120 kg ha^{-1})	20.6	21.8	20.8	21.1	170	173	163	169	14.9	14.2	14.8	14.7
125% N (150 kg ha^{-1})	20.8	20.6	21.6	21.0	177	180	173	176	14.3	14.5	14.5	14.4
150% N (180 kg ha^{-1})	21.3	19.4	24.2	21.6	198	191	189	193	15.6	15.6	15.8	15.6
175% N (210 kg ha^{-1})	20.6	21.2	21.6	21.1	181	188	177	182	14.9	14.8	14.8	14.8
Farmer's practice	20.2	20.6	18.6	19.8	168	175	165	169	14.1	13.5	14.7	14.1
SE(m) ±	0.7	0.6	0.9	0.5	3.2	2.5	3.2	1.3	0.3	0.3	0.1	0.2
$CD_{0.05}$	ns	ns	2.7	Ns	10	7	10	4	0.8	0.9	0.4	0.5

Table 4: Influence of N-fertilizer on grain yield (kg ha^{-1}) and straw yield (kg ha^{-1}) and harvest index (%) of dry seeded paddy

Treatments	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})				Harvest index (%)			
	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean	2017	2018	2019	Pooled mean
100% N (120 kg ha^{-1})	3973	3930	4213	4039	5044	5493	5251	5263	44.0	41.7	44.5	43.4
125% N (150 kg ha^{-1})	4143	4520	4416	4360	5102	5630	5781	5504	44.8	44.6	43.3	44.2
150% N (180 kg ha^{-1})	4910	5020	4926	4952	6425	6963	6567	6652	43.2	41.9	42.9	42.7
175% N (210 kg ha^{-1})	4723	4872	4840	4811	6091	6695	6496	6427	43.7	42.1	42.7	42.8
Farmer's practice	3980	3724	3998	3901	5697	5723	5437	5619	41.2	39.4	42.4	41.0
SE(m) ±	120	136	67	48	130	139	35	76	-	-	-	-
$CD_{0.05}$	363	412	204	146	394	419	106	231	-	-	-	-

6427), followed by farmer's practice (5697, 5723, 5437 and 5619) and 125% N treatment (5102, 5630, 5781 and 5704) (Table 4). The significant increase in grain and straw yields of rice was observed when the rate of N application was increased from 100 to 150% N. Further increase in N application from 150 to 175% N had no significant effect on grain and straw yields. Application of 150% N significantly increased rice grain yield by 27% over the farmer's practice. It appears that higher yields were due to higher nitrogen use. In dry seeded paddy the N response was noticed up to 150% N; and beyond this no increase in grain and straw yield was observed. Above 175% N, the rice grain and straw yield declined because of pest incidence at higher N dose i.e. 210 kg N ha^{-1}. The beneficial effect of N can be explained in light of the fact that it increased panicle length, filled grains panicle^{-1} and test weight that ultimately contributed to higher grain yield. Our findings are supported by Pandey and Namdeo (2016), Qian Chen *et al.* (2018), Para *et al.* (2018) and Danying *et al.* (2019).

Harvest index was recorded as 43.2% in 150% N treatment over farmer's practice (41.2) during *kharif* 2017, 41.9% in 150% N treatment over the farmer's practice (39.4%) during *kharif* 2018, 42.9% in 150% N treatment over the farmer's practice (42.4%) during *kharif* 2019 and 42.7% in 150% N treatment over the farmer's practice (41.0%) in pooled data (Table 4). Similar findings were observed by Kaushal *et al.* (2010), Rajnesh Tomar *et al.* (2018) and Patel *et al.* (2019).

Conclusion: The present study revealed that in dry seeded paddy, high dry matter production and yield attributes i.e. panicle length, filled grains panicle^{-1} and test weight resulted in higher grain yield (4952 kg ha^{-1}), straw yield (6652 kg ha^{-1}) and harvest index (43.2%) over the farmer's practice.

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