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Soil Test Based Nutrient Management Approaches on Growth and Yield of Dry Direct Seeded Rice (Dry Dsr)

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ABSTRACT

An experiment was conducted during kharif seasons of 2015-16 and 2016-17 in the farmer field of Vijayanagar camp, Tq/Dist: Raichur, to identify the suitable nutrient management approaches for enhancing production potentials of Dry DSR. The experiment consisted of ten treatments with application of different category of nutrients as per soil test based nutrient management approaches including control and farmers fertilizers practice. Significantly higher grain (54.73 q ha^{-1}) and straw (68.38 q ha^{-1}) yield of rice was recorded in SSNM approach targeted yield of 55 q ha^{-1} (T_8) and the increase was to an extent of 7.9 and 16.7 per cent, respectively when compared to Farmers' Fertilizer Practice (FFP). The increase in grain and straw yield of rice in T_8 could be due to the maximum number of panicles per m^{-2} (438.1), Length of panicle (19.8 cm), Number of grains per panicle (143.9), Test weight (13.98 g), lower sterility percentage (6.8), higher plant height (72.8 cm), higher dry matter production (62.25 g $plant^{-1}$), higher number of tillers m^{-2} (678.0) and maximum leaf area (1418 cm^2 $plant^{-1}$).

Key words: *Dry Direct Seeded Rice, Targeted yield approach, Soil test, Growth and yield, SSNM*

INTRODUCTION

Rice is a vital food to more than half of the world's population. It is the most important food grain in the diets of hundreds of millions of peoples in Asia, Africa and Latin America. In India, rice continues to hold the key to sustain food production by contributing 20 to 25 per cent and assures food security for more than half of the total population. Rice accounts for 55 per cent of total cereal production in the country. Rice is generally cultivated by transplanting or direct seeding methods. Transplanting method is extensively used, but it is laborious, cumbersome, time-consuming and expensive than direct seeding method. Dry direct seeded rice (Dry DSR) is method establishing rice with limited water supply, labour requirement and optimum nutrients. It has becoming a boon for tail-end farmers of command areas of Tungabhadra (TBP) where, water supplies are limited.

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The actual yield potentiality of Dry DSR had not been achieved because of existing fertilizer recommendation, as it consist of fixed rates and timing of N, P and K for vast areas of production. Such recommendations are in practice over the years in large areas. But crop growth and crop need for supplemental nutrients are strongly influenced by genotype, soil type and climate which can vary greatly among fields, seasons and years. A judicious use of fertilizers is essential since the cost of fertilizers has gone up very high in recent years. At present, the state or regional recommendations are very general and does not consider site-specific crop nutrient requirements. On other side farmer of TBP command area in Karnataka are known for using imbalanced dose of nutrients with higher tendency for N and P fertilizers application. This causes environmental damage and increase the total cost of production as heavy N use makes the rice crop more susceptible to pest and disease and thus increases cost of protection. Unbalanced fertilizer use also causes soil degradation, particularly when N fertilizer use drives the removal of P and K that are not replenished by the addition of fertilizer nutrients. Fertilizer requirements of different crops vary due to their differential production potential and ability to mine nutrients from native and fertilizer sources. Therefore, the quantity of fertilizer to be applied to crops depends upon the initial nutrient status of the soil and thereby, soil test value need considerable attention. The fertilizer requirement of crop also depends upon the yield targets to be achieved. For achieving a definite yield target of a crop, a definite quantity of nutrients must be applied to the crop and this requirement of nutrients can be calculated by taking into consideration the contribution of native soil available nutrients and applied fertilizer nutrients. This research provides a synthesis of current information on Dry DSR production systems, pros and cons of existing nutrient management strategies and the fertilizer best management practices for bridging yield gaps in current and emerging Dry DSR in the tail end of TBP command area.

MATERIAL AND METHODS

The field experiments were conducted during *kharif* and *rabi* seasons of 2015-16 and 2016-17, in the farmer field of Vijayanagar camp, Tq: Raichur, Dist: Raichur, which is situated on the latitude of 16^{o} $11^{\prime}$ North, longitude of 77^{o} $13^{\prime}$ East and at an elevation of 393 meters above mean sea level and is located in the North Eastern Dry Zone (Zone-2) of Karnataka. The soil of the experimental site was deep black clay in texture (Sand 36.47 %, silt 10.75 % and clay 52.80 %) with a bulk density of 1.12 Mg m^{-3} and water holding capacity 60.45 per cent. The soil pH was 8.20 with electrical conductivity of 0.69 dS m^{-1}. The organic carbon content was medium (6.82 g kg^{-1}). The soil was low in available nitrogen (192.36 kg ha^{-1}), high in available phosphorus (74.68 kg ha^{-1}), potassium (348.00 kg ha^{-1}), sulphur (21.20 mg kg^{-1}), exchangeable calcium and magnesium 37.54 and 10.75 c mol (p^{+}) kg^{-1} and low in DTPA extractable Zn (0.46 mg kg^{-1}) and high in DTPA extractable Fe, Cu and Mn were 5.89, 1.23 and 2.40 mg kg^{-1}, respectively. The monthly meteorological data for the year 2015-16 and 2016-17 as recorded at meteorological observatory, Main Agricultural Research Station, Raichur, and the mean data of last 2 years (2015-2017) of climatic parameters like rainfall, temperature and relative humidity are presented depicted in **Figures 1(a)** and **(b)**. The research location comes under semi-arid tract with an average annual rainfall of 597 mm. The total amount of rainfall received during the crop growing period (July- December) was 479.6 mm and 561.1 mm during 2015-16 and 2016. BPT-5204 is a popular verity grown largely in the south Indian states *viz.,* Andhra Pradesh, Telangana and Karnataka. It matures in 145-150 days, grains are light weight, aromatic and considered to be of premium quality was sown in July with a spacing of 25 cm × 10 cm. FYM at the rate of 7 tonnes per hectare was applied 15-20 days before sowing to all pre-marked plots except absolute control and incorporated in soil. The experiment was laid out in RCBD included ten treatments consisted of T_1: Absolute control (00: 00: 00 NPK kg ha^{-1}), T_2**:** Recommended dose fertilizer (100: 50: 50 NPK kg ha^{-1}), T_3**:** Farmers practice (246: 166: 60 kg NPK kg ha^{-1}), T_4**:** Soil test laboratory method (112.5: 37.5: 37.5 NPK kg ha^{-1}), T_5: STCR approach targeted yield 45 q ha^{-1} (99: 00: 60 NPK kg ha^{-1}), T_6: STCR approach targeted yield 55 q ha^{-1} (134: 28: 80 NPK kg ha^{-1}), T_7: SSNM approach targeted yield 45 q ha^{-1} (123: 35: 95 NPK kg ha^{-1}), T_8: SSNM approach targeted yield 55 q ha^{-1} (150: 43: 115 kg NPK kg ha^{-1}), T_9: Nutrient expert approach targeted yield 45 q ha^{-1} (100: 22: 38 NPK kg ha^{-1}), T_{10}: Nutrient expert approach targeted yield 55 q ha^{-1}(118: 28: 45 NPK kg ha^{-1}). The calculated NPK fertilizer as per nutrient management approaches, were applied total calculated nitrogen was applied in four splits during different nutrient demand stages of DSR. Nitrogen applications are fine-tuned using a chlorophyll meter (SPAD) *i.e* initial $1/4^{th}$ of nitrogen, entire dose of phosphorus and half dose of calculated potassium were applied at early, 25 to 30 days after sowing, in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), later on $1/4^{th}$ of nitrogen, were applied at active tillering stage, and $1/4^{th}$ of nitrogen were applied at early panicle initiation stage. 50 % potash and $1/4^{th}$ of nitrogen were applied at heading stage according to the treatment details. As per soil test result the experimental site was deficient in zinc and iron, so that zinc was applied to experimental site in the form of $ZnSO_4$ at the rate of 25 kg ha^{-1} along with first dose of nitrogen application. Iron sulphate foliar sprayed (2-3 sprayings at 4-5 days intervals) at the rate of 0.5 per cent to correct iron deficiency in Dry-DSR during early growth stage except control plot. The following growth parameters *viz.* Plant height (cm), Number of tillers m^{-2}, Leaf area, Dry matter production in grams (g), yield parameters *viz.* Number of panicle m^{-2}, Panicle length (cm), Number of filled grains, 1000 grain weight, grain yield and straw yield per hectare were recorded. The response of the crop to soil test based nutrient approaches was similar in both the years of study. Therefore, only pooled data of two years results is discussed.

RESULTS AND DISCUSSION

Effect of soil test based nutrient management approaches on grain yield of Dry DSR

Application of nutrients through targeted yield approach exerted significant influence on the grain and straw yield of Dry DSR. Significantly higher grain (54.73 q ha^{-1}) and straw (68.38 q ha^{-1}) yield of Dry DSR was recorded with treatment receiving SSNM approach for targeted yield of 55 q ha^{-1} as compared to farmers' fertilizer practice, RDF and rest of the treatments. The higher grain yield can be attributed to the ability of targeted yield approaches to satisfy the nutrient demand of crop more efficiently. The higher grain yield of Dry DSR was also due to better translocation of photosynthates from source to sink and higher growth attributing characters like plant height (72.8 cm), number of tillers m^{-2} (678.0), leaf area per plant cm^{-2} (1418 cm^{-2} $plant^{-1}$) and dry matter production (62.25 g $plant^{-1}$) (Table 1) and higher yield attributing characters like, number of panicles m^{-2}(438.1), panicle length (19.8 cm), number of grains $panicle^{-1}$(143.9), low per cent sterility (6.8 %) and higher test weight(13.98 g) (Table 2). The results are in confirmation with the findings of Police Patil[6], application of 169:32:113 NPK kg ha^{-1} (SSNM) for targeted yield of 6.5 t ha^{-1} in aerobic rice recorded significantly grain yield (5903 kg ha^{-1}) and straw yield (7279 kg ha^{-1}). Similarly Dhillon *et al.* [3], reported higher grain yield (46.0 q ha^{-1}) with the application of fertilizer based on targeted yield (45.0 q ha^{-1}) approach when compared to farmers practice, RDF and soil test based applications. These results are also coroborated with the findings of Doberman *et al.* [4], Biradar *et al.* [2], Keram *et al.*[5], Umesh *et al.*[11] and Singh *et al.* [10]. SSNM approach provides a scientific basis for the balanced fertilization not only among the fertilizer nutrient themselves but also soil available nutrients to achieve targetd yield [9]. However, it was found on par with T_6: STCR approach targeted yield of 55 q ha^{-1} (51.79 q ha^{-1}) followed by T_3: Farmer practice (50.38 q ha^{-1}), T_7: SSNM approach targeted yield of 45 q ha^{-1} (49.01 q ha^{-1}) and T_{10}: Nutrient expert for attainable yield of 55 q ha^{-1}(47.81 q ha^{-1}). The lowest grain yield was recorded in absolute control (21.40 q ha^{-1}). Further, grain yield is governed by the factors which have direct or indirect impact. The factors which have direct influence on the grain yield are the yield components viz., number of panicles m^{-2}, panicle length, number of grains $panicle^{-1}$, per cent sterility and test weight (Table 2) have an indirect influence on grain yield through the yield components, which intern depends on different growth components *viz.*, plant height (Table 1) leaf area per plant and number of tillers per plant. All these growth components could have been promoted by more quantity of nutrients made available by the treatment received in SSNM approach for targeted yield of 55 q ha^{-1} and evidenced through higher uptake of nutrients as compared to farmer practice, RDF and other soil test based approach.

Effect of soil test based nutrient management approaches on yield components and growth of Dry DSR

Application of nutrients as per SSNM approach for the targeted of 55 q ha^{-1} recorded significantly higher yield attributing characters *viz.*, number of panicle per m^{-2} (438.1), number of grains per panicle (143.9), Filled grains per panicle (134.1), least sterility percentage (6.8 %) this was mainly due to the application of balanced levels of NPK fertilizers as per SSNM approach in combination with FYM. And also adequate supply of potassium fertilizer during early and panicle initiation stage which helped in proper filling of grains which resulted in higher number of plump grains and thus increased the number of grains $panicle^{-1}$ and reduced sterility percentage. The improved grain filling with potassium application was due to increased photosynthetic activity which stimulated some vital biochemical processes. The present findings are in agreement with findings of Venkateshwarlu and Singh (1980)[13]. The test weight is another important yield attribute, higher 1000 seed weight (13.98 g) was recorded with SSNM approach targeted yield of 55 q ha^{-1}. These results are in accordance with the findings of Ravi and Rao[8] they reported that maximum test weight, number of filled grains per panicle and yield were obtained due to application of higher potassium in two equal splits as basal and at panicle initiation stage. Similarly Police Patil[6] reported that, application of 169:32:113 NPK kg ha^{-1} (SSNM) for targeted yield of 6.5 t ha^{-1} in aerobic rice recorded significantly higher filled grains (165.92), panicle length (16.2 cm), 1000 seed weight (27.27 g), productive tillers $hill^{-1}$ (31.92). The higher yield components due to better growth attributes *viz.*, plant height (72.8 cm), leaf area per plant (955 cm^2) and total dry matter production (62.25 g $plant^{-1}$) which were obtained with application of nutrients as per SSNM approach targeted yield of 55 q ha^{-1}. The higher leaf area per plant was responsible for tapping of more solar radiation resulting in high photosynthetic rate which intern resulted in higher dry matter production (62.25 g $plant^{-1}$). All these factors associated with leaf area which contributed towards significant improvement in growth and yield attributes and ultimately resulted in higher panicle length (19.8 cm) (Table 2). Similar interpretations were also reported by Ramesh and Chandrasekaran[7], Bandara *et al.* [1] and Upendra *et al.*[12].

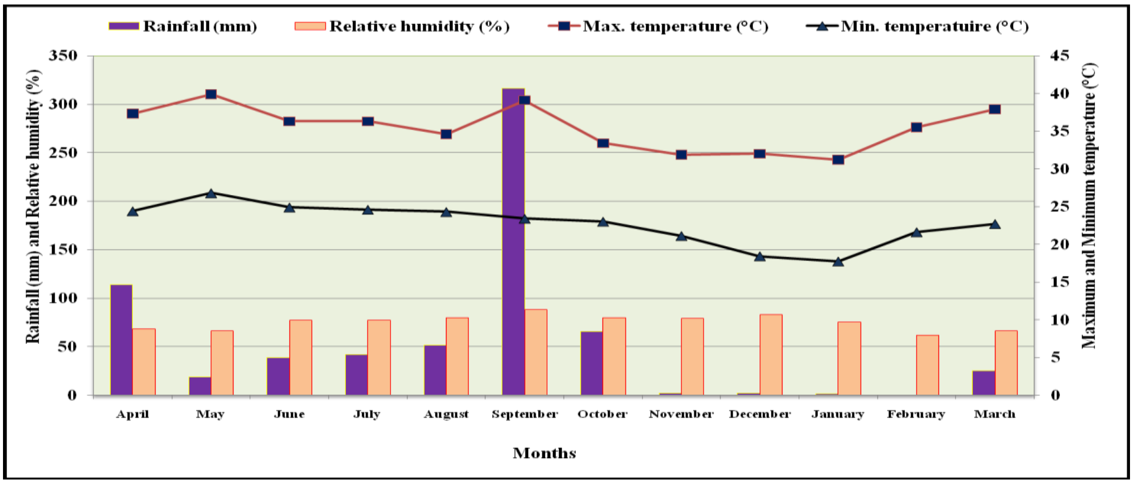

Fig. (a)

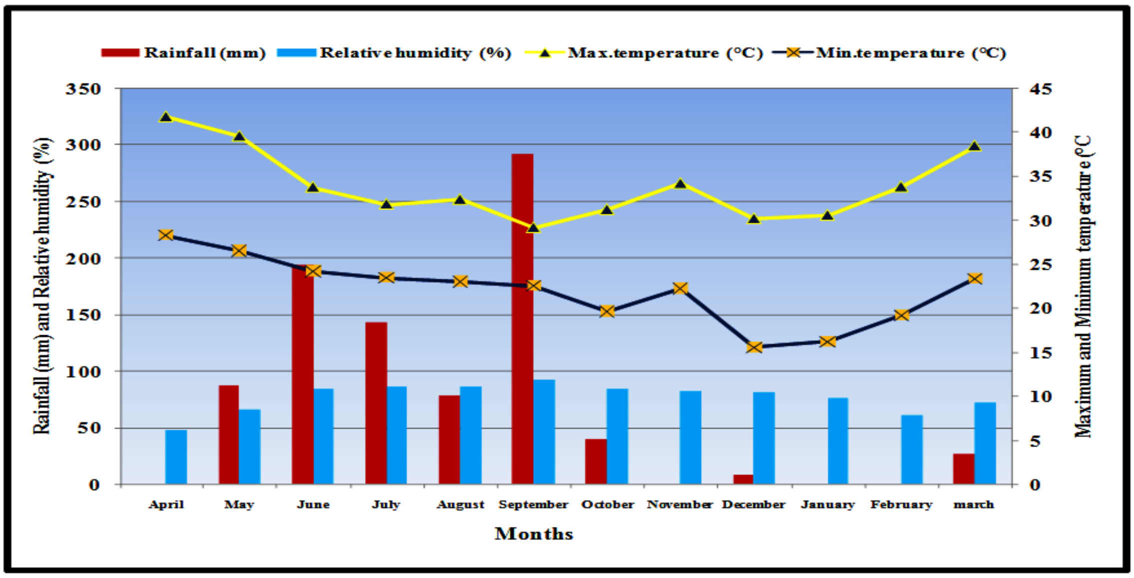

Fig. (b)

Figure 1.Monthly meteorological data recorded at Meteorological Observatory, Main Agricultural Research Station, University of Agricultural Sciences, Raichur for the year 2015-16 Fig. (a) and 2016-17 Fig.(b)

Table 1: Effect of different nutrient management approaches on growth parameters of Dry Direct Seeded Rice (Pooled data of 2 years)

Treatments	Plant height (cm)	Number of tillers m^{-2}	Leaf area per plant (cm^2 $plant^{-1}$)	Total dry matter production ($g\ plant^{-1}$)
T_1	47.0	323.5	448	28.13
T_2	58.4	530.1	761	45.88
T_3	74.7	614.7	882	55.90
T_4	60.5	536.3	766	49.06
T_5	52.0	430.5	619	38.88
T_6	68.3	650.6	921	59.83
T_7	66.5	587.7	843	52.89
T_8	72.8	678.0	955	62.25
T_9	54.1	489.0	701	41.94
T_{10}	61.7	576.5	826	50.76
S. Em.±	3.9	38.6	49	3.87
C.D. at 5 %	11.4	114.6	147	11.51

Table 2: Effect of different nutrient management approaches on yield parameters of Dry Direct Seeded Rice (Pooled data of 2 years)

Treatments	Number of panicles m^{-2}	Number of grains/ panicle	Panicle length (cm)	Sterility percentage	Test weight (g)	Grain yield (q ha^{-1})	(q ha^{-1})
T_1	149.9	113.2	15.7	21.9	11.80	21.41	27.58
T_2	326.2	127.1	16.8	13.6	13.32	44.25	57.09
T_3	380.3	136.0	18.3	10.8	13.66	50.39	62.96
T_4	340.6	129.5	17.4	13.3	13.22	46.94	58.64
T_5	293.8	122.9	16.6	14.1	12.60	39.01	48.75
T_6	423.5	139.3	19.4	8.6	13.90	51.79	64.71
T_7	368.7	134.3	17.7	11.5	13.60	48.48	60.58
T_8	437.6	143.9	19.8	6.8	13.98	54.73	68.55
T_9	317.9	125.0	16.2	12.6	13.12	42.41	52.99
T_{10}	356.6	132.4	17.5	12.7	13.53	47.82	59.74
S. Em.±	28.31	4.56	0.74	0.7	0.20	2.50	3.05
C.D. at 5 %	84.11	13.55	2.15	2.0	0.58	7.42	9.05

CONCLUSION

The results obtained in the present investigation which was carried out for two consecutive years (2015-16 and 2016-17) by following different nutrient management approaches on performance of Dry DSR based on the results following conclusions are made. Applications of nutrients based on the soil test results in *viz.,* SSNM and STCR under field situation is more useful and profitable due to maximizing productivity and profitability as compared to farmers practice.

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