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RESEARCH ARTICLE :

Effect of soil test based nutrient management approaches on grain yield and nutrient uptake of dry DSR-mustard cropping system

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SUMMARY : The improvement in grain yield characters was the manifestation of improved growth characters as a result of higher uptake of nutrients caused by balanced supply of nutrients in this regard soil test based nutrient management approaches aims provide a scientific basis for balanced fertilization to obtain more yield per unit of fertilizer investment. An experiment was conducted during *Kharif* and *Rabi* seasons of 2015-16 and 2016-17in the farmer field of Vijayanagar camp, Tq/Dist: Raichur, to study the effect soil test based nutrient management approacheson grain yield and nutrient uptake pattern in Dry DSR and their residual response was ascertained to mustard in DSR-mustard cropping sequence. Pooled results indicate that maximum rice yield (54.73 q ha^{-1}) was recorded with application of nutrients as per SSNM approach for targeted yield of 55 q ha^{-1} in Dry DSR.Similarly maximum mustard seed yield (592 kg ha^{-1}) was recorded with the residual effect of nutrients through SSNM approach targeted yield of 55 q $ha^{-1}$and higher uptake of nutrients (grain + straw) *viz*., nitrogen (117.72 kg ha^{-1}), phosphorus (40.50 kg ha^{-1}) and potassium (151.93 kg ha^{-1}) by Dry DSR. Similarly higher uptake of nutrients (seed + stover) *viz*., nitrogen (26.07 kg ha^{-1}), phosphorus (5.70kg ha^{-1}), and potassium (34.99kg ha^{-1}) by mustardwas recorded with residual effect of nutrients through SSNM approach targeted yield of 55 q ha^{-1}as compared to RDF, farmer practice and other soil test methods.

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BACKGROUND AND OBJECTIVES

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. 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. 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. Dry DSR-mustard cropping system is most prominent and popular double cropping system under tail-end farmers of command areas of Tungabhadra (TBP) where water supplies are limited during summer. Mustard crop cultivated as winter *Rabi* crop with the available residual soil moisture and nutrients of Dry DSR. Mustard is the major oilseed crop of India. Among the seven annual edible oilseeds cultivated in India, rapeseed-mustard contributed 28.6 per cent of the total production of oilseeds. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively. Nutrient uptake also plays an important role in the determination of yield potential in Dry DSR-mustard cropping system. Application of inorganic fertilizer through different nutrient management approaches based on targeted yield along with FYM improved the uptake of NPK over other treatments. The increased N, P and K uptake might be due to the higher nutrient supply as compared to RDFand other soil test methods. The nutrient retained in the soil after harvest of the crop mainly depends on both supply of nutrients through various sources and uptake by the crop.

RESOURCES 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,whichis situated on the latitude of 16°11| North, longitude of 77°13| 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 clayin texture(Sand 36.47 %, silt 10.75 % and clay 52.80 %) with a bulk density of 1.12Mg m^{-3} and water holding capacity 60.45 per cent. The soil pH was 8.20 with electrical conductivity of 0.69 dSm^{-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 (348.00kg 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 (0.46mg kg^{-1}) and Fe(4.34mg kg^{-1}), high in DTPA extractable Cu and Mn were 1.23 and 2.40 mg kg^{-1}, respectively.BPT 5204 used as a test crop variety.The experiment was laid out in RCBD included ten treatments consisted of T_1: Absolute control (00: 00: 00NPK kg ha^{-1}), T_2: Recommended dose fertilizer (100: 50: 50 NPK kg ha^{-1}), T_3:Farmers practice (246: 166: 60 kgNPK 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: 45NPK 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 1/4th 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 1/4th of nitrogen, were applied at active tillering stage, and 1/4th of nitrogen were applied at early panicle initiation stage. 50 % potash and 1/4th 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. Grain/seed yield and straw/ stover yield per hectare were recorded. Five plants were harvested from each treatment at harveststage, oven dried. Straw/stover and Grain/seed weregroundin a Wiley mill and digested in diacid mixture (9:4) for P, K, S, Zn, Fe and for Nitrogen digestedwith concentrated H_2SO_4 in presence of digestion mixture (K_2SO_4:$CuSO_4$.$5H_2O$: Se in the proportionof 100:20:1) and distilled under alkalinemedium (Kjeldahl's method). Zinc and iron contentsin the extracts were measured by atomic absorptionspectrometry (contra AA).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Effect of different nutrient management approaches on grain/seed yield of Dry DSR-mustard:

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 (68.38q ha^{-1}) (Table 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 other soil test methods.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 and yield attributing characters. The results are in confirmation with the findings of Police Patil (2011) application of nutrients as per SSNM for targeted yield of 6.5 t ha^{-1} in aerobic rice recorded significantly higher grain yield (5903 kg ha^{-1}) and straw yield (7279 kg ha^{-1}) as compared other treatments. Similarly Dhillon *et al.* (2006) 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.* (2002), Biradar *et al.* (2006), Keram *et al*. (2012), Umesh *et al*. (2014) and Singh *et al.* (2014). However, it was found at par with T_6 (51.79 q ha^{-1}) followed by T_3 (50.38q ha^{-1}), T_7 (49.01 q ha^{-1}) and T_{10} (47.81 q ha^{-1}). The lowest grain yield was recorded in absolute control (21.40 q ha^{-1}).

Similarly highest mustard seed yield (592 kg ha^{-1}) was obtained with the residual effect of nutrients through SSNM approach targeted yield of 55 q $ha^{-1}$and it was found at par with farmer practice (570 kg ha^{-1}), STCR approach targeted yield of 55 q ha^{-1} (544 kg ha^{-1}) and SSNM approach targeted yield of 45 q ha^{-1}(531 kg ha^{-1}). Whereas, lowest seed yield recorded in absolute control (217 kg ha^{-1}). Similar trend was noticed with stover yield, significantly higher (1856 kg ha^{-1}) stover yield of mustard was recorded with residual effect of nutrient through SSNM approach targeted yield of 55 q ha^{-1} (Table 1). The better performance of succeeding mustard could be due to higher amount of available nitrogen, phosphorous and potassium after harvest of Dry DSR (Table 1). BPT-5204 being relatively medium duration one, removed

Table 1 : Effect of different nutrient management approaches on grain/seed yield of Dry direct seeded rice-mustard (Pooled data of 2 years)

Treatments	Dry direct seeded rice		Mustard	
	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1: Absolute control	21.41	27.58	217	660
T_2:RDF	44.25	57.09	512	1608
T_3:Farmers practice	50.39	62.96	570	1810
T_4:STL method	46.94	58.64	486	1525
T_5:STCR approach (45 q ha^{-1}yield targeted)	39.01	48.75	413	1296
T_6:STCR approach (55 q ha^{-1}yield targeted)	51.79	64.71	544	1708
T_7:SSNM approach (45 q ha^{-1}yield targeted)	48.48	60.58	531	1667
T_8:SSNM approach (55 q ha^{-1}yield targeted)	54.73	68.55	592	1856
T_9: Nutrient expert approach (45 q ha^{-1}yield targeted)	42.41	52.99	452	1420
T_{10}:Nutrient expert approach (55 q ha^{-1}yield targeted	47.82	59.74	505	1585
S.E.±	2.50	3.05	21.4	70.3
C.D. (P=0.05)	7.42	9.05	62.4	205.9

Note: FYM @ 7 t $ha^{-1}$is common all treatments except T_1

lower amount nutrient from soil and made substantial build up in soil as reflected higher soil nutrient status after harvest of rice. Sharma and Ghosh (1999) residual effect of different levels of fertility applied to soybean, showed significant variation in growth and seed yield of mustard. Similar results reported by Gawai and Pawar (2005); Pankaj *et al.* (2013) and Mahala *et al.* (2006).

Effect of different nutrient management approaches on nutrient uptake by Dry DSR-mustard :

Further, grain/seed yield is governed by the factors which have direct or indirect impact. The factors which have direct influence on the grain/seed yield are the yield components have an indirect influence on grain yield through the yield components, which intern depends on different growth components. 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 *viz.*, nitrogen, phosphorus and potassium as compared to farmer practice, RDF and other soil test based approach.

It has been proved that, application of nutrients through different nutrient management approaches along with recommended FYM improves the absorption and utilization of major nutrients. Total uptake (grain + straw) of nutrients was significantly higher with treatment receiving SSNM for targeted yield of 55 q ha^{-1} (117.72, 40.50 and 151.93 kg N, P and K ha^{-1}, respectively) followed by STCR approach targeted yield of 55 q ha^{-1} (106.09, 31.19 and 130.36 kg N, P_2O_5 and K_2O ha^{-1}, respectively) as compared to other treatments (Table 2).It might be due to application of balanced fertilization based on target yield resulting in higher total NPK and S uptake. The higher nutrient uptake is well reflected in terms of higher grain and straw yield of Dry DSR. Obviously this could be due to application of nitrogen in four splits, potash in two splits and along with required phosphatic fertilizers; this might be the reason for higher uptake of nutrients by the rice crop. The results are in line with the different research workers *viz.*, Sharma and Mittra (1989), Riazeddin Ahamed *et al.* (1999) Sagar and Reddy (1995) reported that the uptake of P and K in grain and straw of rice was significantly increased with the split application of higher levels of N and K. Surendra Singh and Sarkar (2001) indicated that application of 210:90:150 kg NPK ha^{-1} as per SSNM approach recorded significantly higher NPK uptake 158:13:160.7 kg ha^{-1} compared to state recommended dose of 100:60:40 kg NPK ha^{-1} under wheat-maize cropping system.

Nutrient uptake by mustard :

Total uptake (seed + stover) of nutrients by mustard were significantly highest with the residual effect of nutrients through SSNM approach for targeted yield of 55 q ha^{-1} (26.1, 5.7and 35.0 kg N, P_2O_5 and K_2O ha^{-1},

Table 2 : Effect of different nutrient management approaches on NPK uptake (kg/ha) in dry DSR (grain + straw) and mustard (grain + straw) under dry DSR–mustard cropping systems nutrient (Pooled data of 2 years)

Treatments	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	Dry DSR	Mustard	Total uptake	Dry DSR	Mustard	Total uptake	Dry DSR	Mustard	Total uptake
T_1	35.4	7.4	42.8	11.7	1.6	13.3	39.5	11.5	51.0
T_2	78.8	20.3	99.0	32.2	4.3	36.5	95.0	29.0	124.0
T_3	109.3	25.7	134.9	40.2	6.1	46.3	102.7	32.7	135.3
T_4	91.3	19.6	110.9	28.0	4.2	32.1	80.1	27.2	107.3
T_5	65.3	15.3	80.5	20.6	3.1	23.7	93.3	23.2	116.4
T_6	106.1	21.9	128.0	33.7	4.9	38.6	131.6	31.0	162.6
T_7	101.0	21.3	122.3	32.6	4.8	37.4	123.4	30.6	153.9
T_8	117.7	26.1	143.8	40.5	5.7	46.2	152.3	35.0	187.3
T_9	75.1	16.9	92.0	25.3	3.8	29.1	78.5	25.0	103.5
T_{10}	96.7	20.7	117.3	30.3	4.3	34.6	101.5	28.7	130.1
S. E.±	8.5	1.9	7.7	2.9	0.3	3.3	10.6	1.4	11.9
C.D. (P=0.05)	25.3	5.7	22.6	8.5	1.0	9.7	31.4	4.2	34.7

Note: FYM @ 7 t $ha^{-1}$is common all treatments except T_1

T_1: Absolute control
T_2: Recommended Dose Fertilizer
T_3: Farmers practice
T_4: STL method
T_5: STCR approach (45 q ha^{-1}yield targeted)
T_6: STCR approach (55 q ha^{-1}yield targeted)
T_7: SSNM approach (45 q ha^{-1}yield targeted)
T_8: SSNM approach (55 q ha^{-1}yield targeted)
T_9: Nutrient expert approach (45 q ha^{-1}yield targeted)
T_{10}: Nutrient expert approach (55 q ha^{-1}yield targeted)

respectively) followed by STCR approach targeted yield of 55 q ha^{-1} (21.9, 4.9 and 31.0 kg N, P_2O_5 and K_2O ha^{-1}, respectively) over other treatments. The higher uptake of nitrogen, phosphorus and potassium by mustard might be due to higher biomass production coupled with higher availability of NPK after harvest of Dry DSR. The higher availability of N, P and K in SSNM or STCR treated plot may be due to mineralization of organic manure applied for the previous crop and also root biomass which contributed for decomposition in soil itself. Pankaj *et al.* (2013) opinionated that conjunctive use of organic and inorganic source of fertilizer *Kharif* rainfed rice induced significantly higher residual contribution of nutrients N, P, K and S in the soil available pool thereby increased uptake by lentil plant at harvest. Similar results reported by Shreenivas (2016).

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-mustard cropping system based on the results following conclusionsare made.Application of fertilizers through SSNM approach targeted yield of 55 q ha^{-1} (150: 43: 115 kg N, P_2O_5 and K_2O ha^{-1}, respectively) along with FYM 8 t ha^{-1} recorded higher yield and nutrientuptake as compared to RDF, farmer practice and other soil test methods.

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