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Site Specific Nutrient Management influence on nutrient use efficiency and balance sheet of primary nutrients (Nitrogen, Phosphorous, and Potassium) in transplanted rice (*Oryza sativa* L.).

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ABSTRACT

An experimental study was conducted during the kharif 2023 season at the Agricultural Research Station, Mugad, to assess the effects of different Site-Specific Nutrient Management (SSNM) techniques on nutrient uptake and use efficiency of primary nutrients in transplanted rice. A split-plot design was used with three replications, featuring two rice varieties, Mugad Siri (M_1) and Mugad Sugandha (M_2), as the main plots and various SSNM-based fertilizer treatments as subplots. These treatments included Soil Test Crop Response (T_2), Rice Crop Manager (T_3), Nutrient Expert (T_4), the Recommended Package of Practices (T_1) and an absolute control (T_5). Soil samples were collected and analysed for N, P_2O_5 and K_2O. The Rice Crop Manager (RCM) treatment (T_3) achieved the highest recovery efficiency (57.07% N, 59.74% P, 128.25% K) and agronomic efficiency (19.17 kg grain kg^{-1} N applied, 80.72 kg grain kg^{-1} P applied). STCR (T_2) showed the highest agronomic efficiency for K (83.85 kg grain kg^{-1} K applied) and physiological use efficiency for N (39.95 kg grain kg^{-1} N uptake) and K (69.54 kg grain kg^{-1} K uptake). M_2 showed more recovery efficiency (38.86%, 38.52% and 96.32%) and agronomic use efficiency (13.81kg grain kg^{-1} N applied, 56.54kg grain kg^{-1} P applied and 43.69kg grain kg^{-1} K applied)of N, P and K respectively. M_1 showed Physiological use efficiency (30.03kg grain kg^{-1} N uptake, 131.15kg grain kg^{-1} P uptake and 39.03kg grainkg^{-1} K uptake) of N, P and K respectively. No actual gain of soil N, P_2O_5 and K_2O was observed. an apparent gain of N (23.68 kg ha^{-1}), P_2O_5 (21.18 kg ha^{-1}) and K_2O (9.74 kg ha^{-1}) was observed.

Keywords: *Soil Test Crop Response, Rice Crop Manager, Nutrient Expert, Recommended Package of Practices, Nutrient Use Efficiency, Balance Sheet*

Introduction

Agriculture in India is progressing rapidly, but one of the major challenges is the inefficient use of fertilizers. Excessive fertilizer application has led to a decline in nutrient use efficiency and loss of nutrients which causes environmental pollution. To address this issue, applying fertilizers at the right time, in the right place, in the correct form, and in the right quantity is essential for improving nutrient uptake and minimizing nutrient losses. Site-specific nutrient management (SSNM) for rice, developed in Asia, is a plant-based approach that ensures nutrients are supplied to rice crops as needed. According to IRRI (2006), SSNM provides guidelines to help farmers apply fertilizers in a way that aligns with the specific nutrient requirements of rice in a particular field and season. The objective of SSNM is not to reduce or increase fertilizer use but to optimize nutrient application rates and timing. This results in higher rice yields, improved nutrient use efficiency and greater economic returns from fertilizer investments, maximizing the harvest's cash value per unit of fertilizer used. SSNM plays a crucial role in achieving this by tailoring fertilizer applications based on the initial soil nutrient content.

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Various SSNM techniques, such as Soil Test Crop Response (STCR), Nutrient Expert, Rice Crop Manager, remote sensing techniques, Leaf Color Chart (LCC) and SPAD meter, are effective tools for optimizing fertilizer use. Rice, being a highly fertilizer-consuming crop, greatly benefits from SSNM, which helps enhance fertilizer efficiency and reduce nutrient losses, ensuring more sustainable and productive farming.

Materials and Methods

The experiment was conducted at the Agricultural Research Station (ARS), Mugad, during the *kharif* 2023. Soil samples from the targeted plot were collected and analyzed for NPK status. A split-plot design with three replications was used, featuring main plots as two rice varieties: Mugad Siri (M_1) and Mugad Sugandha (M_2) and subplots as different Site-Specific Nutrient Management (SSNM) treatments. The treatments included T_1 - Recommended Package of Practices (UASD), T_2 - Soil Test Crop Response (Basavaraja et al., 2016), T_3 - Rice Crop Manager (Anon, 2024), T_4 - Nutrient Expert (Anon, 2019) and T_5 - Absolute Control. The site had clay soil with a pH of 7.60, EC of 0.80 dS m^{-1}, low available nitrogen (224 kg ha^{-1}), medium phosphorus (32.92 kg ha^{-1}), potassium (256.50 kg ha^{-1}) and sulphur (23.75 ppm). Fertilizer doses per treatment were: T_1 - 120:50:50:20 kg N, P_2O_5, K_2O, $ZnSO_4$ per ha, and 5 tons ha^{-1} FYM; T_2 - 181.74:79.73:4.00 kg N, P_2O_5, K_2O per ha and 5 tons ha^{-1} FYM; T_3 - 111.05:31.05:39.00:25.00 kg N, P_2O_5, K_2O, $ZnSO_4$ per ha and 5 tons ha^{-1} FYM; T_4 - 109.00:25.00:49.00 kg N, P_2O_5, K_2O per ha and

5 tons ha^{-1} FYM; T_5 - Absolute Control. Nutrient Use Efficiency (NUE) and balance sheet of N, P and K was evaluated using formulas.

Agronomicefficiency(kggrainkg^{-1}N)

Agronomic efficiency of added N (AEN) was calculated as suggested by Cassman *et al*. (1998).

$$\text{AEN(kg grain kg-1Napplied)} = \frac{\text{Grain yield in N-fertilized plot Grain yield in zero-N plot}}{\text{Quantity of N -fertilizer applied in N-fertilized plot}}$$

Physiological efficiency (kggrainkg-1Nuptake)

Physiological efficiency of N was calculated as worked out by Baligar *et al*. (2001).

$$\text{PE (kg grain kg-1N up take)} = \frac{\text{Grain yield in N-fertilized plot) Grain yield in zero-Nplot}}{\text{Total N up take in N -fertilized plot-Total N up take in zero-N plot}}$$

Recovery Efficiency

Recovery efficiency of added N(REN)was calculated as per the formula given by Cassman *et al*. (1998).

$$\text{Recoveryefficiency(\%)} = \frac{\text{Total N up take in N - fertilized plot-Total N up take in zero-Nplot}}{\text{Quantity of N- fertilizer applied in N-fertilized plot}} \times 100$$

Nutrient balance

Balance sheet of N, P and K was worked out at the end of crop season by considering the initial soil available N, P_2O_5 and K_2O status and N, P_2O_5 and K_2O supplied through fertilizers and manures by subtracting the crop uptake, the expected balance of nutrients will arrive. Net gain or loss of nutrients was worked out by subtracting expected balance from initial N, P_2O_5 and K_2O.

Apparent gain/ loss of nutrient = Actual available amount of nutrient in soil – Expected balance in soil

Actual gain/ loss of nutrient = Amount of nutrient in initial soil sample – Amount of nutrient in final soil sample.

Results and Discussion

Nutrient Use Efficiency

Between the two main plots, Mugad Sugandha (M_2) demonstrated higher recovery efficiency for nitrogen (38.86%), phosphorus (38.52%) and potassium (96.32%), as well as superior agronomic use efficiency for nitrogen (13.81kg grain kg^{-1} N applied), phosphorus (56.54 kg grain kg^{-1} P applied) and potassium (43.69 kg grain kg^{-1} K applied) with no significant difference between two varieties. P and K showed significant differences between the two varieties for recovery efficiency due to differences in uptake of nutrients and N showed no significant difference. On the other hand, Mugad Siri (M_1) exhibited greater physiological use efficiency with values of 30.03 kg grain per kg N uptake, 131.15k g grain per kg P uptake with no significant difference between two varieties for nitrogen and phosphorus and 39.03kg grain per kg K uptake which showed significant difference between two varieties due to difference in uptake of nutrients for potassium.

Among the different treatments, the Rice Crop Manager (T_3) demonstrated the highest recovery efficiency for nitrogen (57.02%), phosphorus (59.74%) and potassium (128.25%), along with superior agronomic use efficiency of 19.12 kg grain kg^{-1} N applied and 80.72 kg grainkg^{-1}Pdue to higher grain yield and nutrient uptake observed for unit applied fertilizer. In contrast, the highest agronomic use efficiency of potassium was observed in the Soil Test Crop Response (T_2) treatment, with 83.85 kg grain kg^{-1}K applied.

T_2 also showed lower recovery efficiency for nitrogen (28.89%) and phosphorus (30.00%), and lower agronomic use efficiency for nitrogen (11.52 kg grain kg^{-1} N applied) and phosphorus (44.92 kg grain kg^{-1} P applied). For potassium, low recovery efficiency (93.02%) and low agronomic efficiency (37.17 kg grain kg^{-1} K applied) were observed in the Recommended Package of Practices (T_1). High physiological use efficiency for nitrogen (39.95 kg grain kg^{-1} N uptake) and potassium (69.54 kg grain kg^{-1}K uptake) was seen in T_2, while T_1 exhibited the highest physiological use efficiency for phosphorus (177.56 kg grain per kg P uptake). T_3 had lower physiological use efficiency for nitrogen (33.70 kg grain per kg N uptake), phosphorus (133.18 kg grain per kg P uptake) and potassium (35.51 kg grain per kg K uptake). T_3 showed the highest recovery efficiency of N, P and K due to their more uptake and less application of fertilizer. T_3 showed the highest agronomic efficiency for N and P and for K T_2 showed the more due to their more grain yield per quantity of fertilizer applied. Physiological use efficiency of N was more in T_2 and for P by T_1 and K by T_3 due to their difference in grain yield and nutrient uptake. Similar results were found in Ashish Kumar Mannade*et al.* 2019, Kumar *et al.* 2015, Kaur *et al.* 2020, Joshi *et al*. 2018, Banerjee *et al.* 2014, Rani B and John J 2022.

The interaction M_2T_3 exhibited higher recovery efficiency for nitrogen (59.67%) and phosphorus (66.05%), while M_2T_2 showed the highest recovery efficiency for potassium (138.07%). For agronomic use efficiency, M_2T_3 had the highest nitrogen agronomic use efficiency (19.73 kg grain kg^{-1} N applied), M_2T_4 showed the highest phosphorus agronomic use efficiency (85.64 kg grain kg^{-1} P applied), and M_2T_2 had the highest potassium agronomic use efficiency (88.57 kg grain kg^{-1} K applied).

In contrast, low recovery efficiency for nitrogen (26.91%) and phosphorus (26.49%), along with low agronomic use efficiency (10.87 kg grain kg^{-1}N applied and 43.20 kg grain kg^{-1} P applied), was observed in M_1T_2. Additionally, M_1T_1 showed low recovery efficiency for potassium (84.57%) and low agronomic use efficiency (35.19 kg grain kg^{-1} K applied). M_1T_2 demonstrated high physiological use efficiency for nitrogen (40.47 kg grain kg^{-1} N uptake) and potassium (74.47 kg grain kg^{-1} K uptake), while M_1T_1 exhibited high phosphorus physiological use efficiency (183.22 kg grain kg^{-1} P uptake). However, low physiological use efficiency for nitrogen (33.10 kg grain kg^{-1} N uptake) and phosphorus (123.16 kg grain kg^{-1} P uptake) was observed in M_2T_3 and low potassium physiological use efficiency (35.35 kg grain kg^{-1}K uptake) was recorded in M_1T_3.

Balance Sheet

No actual gain of nitrogen and potassium was observed across treatments. An apparent gain of N occurred in M_1T_5 (Mugad Siri - control) with 23.68 kg ha^{-1} and M_2T_5 (Mugad Sugandha - control) with 14.84 kg ha^{-1}which was due to lower uptake of nitrogen by the crop. The highest apparent nitrogen loss was in M_2T_2 (Mugad Sugandha - STCR) at -101.55 kg ha^{-1} due to more application of nitrogen than required, while the lowest loss was in M_1T_3 (Mugad Siri - RCM) at -14.91 kg ha^{-1}. Actual soil nitrogen loss was highest in M_1T_5 (-28.53 kg ha^{-1}) and M_2T_5(-26.24 kg ha^{-1}), while M_1T_2 and M_2T_2 showed the lowest loss (-5.92 kg ha^{-1}).

Apparent phosphorus gain was highest in M_1T_5 (21.18 kg ha^{-1}) and M_2T_5 (16.56 kg ha^{-1}) as less uptake by crop was observed, while M_1T_2 had the greatest loss (-48.45 kg ha^{-1}) due to more application and less uptake by the crop. Actual phosphorus gain occurred in M_1T_2 (1.34 kg ha^{-1}) due to more application of fertilizer and M_1T_5 (1.09 kg ha^{-1}) due to less uptake by crop, with the highest actual loss in M_1T_4 (-4.06 kg ha^{-1}) due to less amount of fertilizer applied. For potassium, the highest apparent gain was in M_1T_5 (9.74 kg ha^{-1}) due to less uptake by crop, while M_1T_2 saw the greatest apparent loss (-26.05 kg ha^{-1}) due to less amount of fertilizer applied and more uptake of K from soil. The greatest actual loss was in M_1T_2 (-75.28 kg ha^{-1}) and M_2T_2 (-73.99 kg ha^{-1}). Similar results were found in Kumar *et al.* 2015, Singh *et al.* 2015.

Conclusion

This study demonstrates that applying fertilizers through the Rice Crop Manager effectively reduces nutrient losses and enhances the nutrient use efficiency of N, P, and K. By tailoring fertilizer applications to the initial soil nutrient levels and crop requirements for a specific yield target, the Rice Crop Manager helps balance soil nutrients. It minimizes nutrient loss and boosts nutrient uptake by ensuring a balanced application of all primary nutrients, leading to better soil health and improved crop performance.

Future Scope

The findings of this study emphasize the importance of adopting site-specific nutrient management (SSNM) techniques to enhance nutrient use efficiency and sustainability in rice cultivation. Future research can focus on integrating SSNM with precision agriculture technologies such as remote sensing and GIS for real-time nutrient monitoring and decision-making. Long-term field trials across different agro-climatic zones are also essential to validate and refine SSNM strategies for broader applicability and climate resilience.

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Table 1: Nitrogen use efficiency of rice crop under different SSNM treatments

Treatments	Nitrogen Recovery Efficiency (%)	Nitrogen Agronomic use Efficiency (kg-grain kg^{-1} N applied)	Nitrogen Physiological use Efficiency (kg-grain kg^{-1} N uptake)
Main plot (varieties)			
M_1	34.27	12.60	30.03
M_2	38.86	13.81	28.91
S. Em. ±	**2.02**	**0.32**	**0.56**
CD at 5%	**NS**	**NS**	**NS**
Sub plot (fertilizer recommendations)			
T_1	45.65	17.00	37.55
T_2	28.89	11.52	39.95
T_3	57.02	19.12	33.70
T_4	51.27	18.39	36.15
T_5	0.00	0.00	0.00
S. Em. ±	**1.03**	**0.44**	**1.21**
CD at 5%	**3.10**	**1.33**	**3.63**
Interactions			
M_1T_1	42.09	16.08	38.48
M_1T_2	26.91	10.87	40.47
M_1T_3	54.36	18.52	34.31
M_1T_4	47.98	17.52	36.91
M_1T_5	0.00	0.00	0.00
M_2T_1	49.20	17.92	36.62
M_2T_2	30.87	12.16	39.42
M_2T_3	59.67	19.73	33.10
M_2T_4	54.56	19.25	35.39
M_2T_5	0.00	0.00	0.00
S. Em. ±	**0.85**	**0.30**	**0.80**
CD at 5%	**NS**	**NS**	**NS**

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM), NS – No Significant difference

Table 2: Phosphorous use efficiencyof rice crop under different SSNM treatments

Treatments	Phosphorous Recovery Efficiency (%)	Phosphorous Agronomic use Efficiency (kg-grain kg^{-1} P applied)	Phosphorous Physiological use Efficiency (kg-grain kg^{-1} p uptake)
Main plot (varieties)			
M_1	31.40	50.73	131.15
M_2	38.52	56.54	117.98
S. Em. ±	**0.99**	**1.48**	**4.76**

CD at 5%	**6.00**	**NS**	**NS**
Sub plot (fertilizer recommendations)			
T_1	34.02	62.01	177.56
T_2	30.00	44.92	150.43
T_3	59.74	80.72	133.18
T_4	51.06	80.52	161.66
T_5	0.00	0.00	0.00
S. Em. ±	**1.85**	**1.04**	**8.29**
CD at 5%	**5.56**	**3.12**	**24.85**
Interactions			
M_1T_1	31.41	55.14	183.22
M_1T_2	26.49	43.20	160.71
M_1T_3	53.39	79.92	143.20
M_1T_4	45.72	75.41	168.63
M_1T_5	0.00	0.00	0.00
M_2T_1	36.62	68.89	171.90
M_2T_2	33.52	46.65	140.16
M_2T_3	66.08	81.51	123.16
M_2T_4	56.40	85.64	154.69
M_2T_5	0.00	0.00	0.00
S. Em. ±	**1.24**	**0.78**	**5.55**
CD at 5%	**NS**	**3.69**	**NS**

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM)
NS – No Significant difference

Table 3: Potassium use efficiencyof rice crop under different SSNM treatments

Treatments	Potassium Recovery Efficiency (%)	Potassium Agronomic use Efficiency (kg-grain kg^{-1} K applied)	Potassium Physiological use Efficiency (kg-grain kg^{-1} K uptake)
Main plot (varieties)			
M_1	81.7	39.64	39.03
M_2	96.32	43.69	35.74
S. Em. ±	**1.61**	**1.11**	**0.32**
CD at 5%	**9.79**	**NS**	**1.95**
Sub plot (fertilizer recommendations)			
T_1	93.02	37.17	40.21
T_2	122.23	83.85	69.54
T_3	128.25	45.46	35.51
T_4	101.56	41.84	41.66
T_5	0	0.00	0.00
S. Em. ±	**2.66**	**1.32**	**1.99**
CD at 5%	**7.97**	**3.97**	**5.98**
Interactions			
M_1T_1	84.57	35.16	41.65
M_1T_2	106.39	79.14	74.47
M_1T_3	124.92	44.02	35.35
M_1T_4	92.61	39.87	43.66
M_1T_5	0	0.00	0.00
M_2T_1	101.46	39.19	38.76
M_2T_2	138.07	88.57	64.61
M_2T_3	131.57	61.43	35.67
M_2T_4	110.5	43.80	39.66
M_2T_5	0	0.00	0.00
S. Em. ±	**1.78**	**0.91**	**1.31**
CD at 5%	**6.38**	**NS**	**NS**

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM),
NS – No Significant difference

Table 4: Balance Sheet for soil available Nitrogen with rice crop under different SSNM treatments

Treatment	Initial soil N (kg ha^{-1})	Applied N through FYM (kg ha^{-1})	Applied N through Fertilizer (kg ha^{-1})	Total N (kg ha^{-1})	Total N uptake (kg ha^{-1})	Expected balance (kg ha^{-1})	Actual available N (kg ha^{-1})	Apparent gain/ loss (+/-) of N (kg ha^{-1})	Actual gain/ loss (+/-) of N (kg ha^{-1})
M_1T_1	224.00	25.00	120.00	369.00	113.23	255.77	201.34	-54.43	-22.66
M_1T_2	224.00	25.00	181.73	424.53	111.74	318.99	218.08	-100.91	-5.92
M_1T_3	224.00	25.00	111.05	360.05	126.17	233.88	212.77	-21.11	-11.23
M_1T_4	224.00	25.00	109.00	358.00	116.5	241.50	217.32	-24.18	-6.68
M_1T_5	224.00	0.00	0.00	224.00	52.21	171.79	195.47	+23.68	-28.53
M_2T_1	224.00	25.00	120.00	369.00	112.43	256.57	212.36	-44.21	-11.64
M_2T_2	224.00	25.00	181.73	424.53	110.86	319.87	218.08	-101.79	-5.92
M_2T_3	224.00	25.00	111.05	360.05	122.27	237.78	202.02	-35.76	-21.98
M_2T_4	224.00	25.00	109.00	358.00	114.2	243.80	210.53	-33.27	-13.47
M_2T_5	224.00	0.00	0.00	224.00	41.08	182.92	197.76	+14.84	-26.24

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM)

Table 5: Balance Sheet for soil available Phosphorous with rice crop under different SSNM treatments

Treatment	Initial soil P_2O_5 (kg ha^{-1})	Applied P_2O_5 through FYM (kg ha^{-1})	Applied P_2O_5 through Fertilizer (kg ha^{-1})	Total P_2O_5 (kg ha^{-1})	Total P_2O_5 uptake (kg ha^{-1})	Expected balance (kg ha^{-1})	Actual available P_2O_5 (kg ha^{-1})	Apparent gain/ loss (+/-) of P_2O_5 (kg ha^{-1})	Actual gain/ loss (+/-) of P_2O_5 (kg ha^{-1})
M_1T_1	32.92	22.90	50.00	105.82	49.72	56.10	33.28	-22.82	+0.36
M_1T_2	32.92	22.90	79.72	135.54	52.83	82.71	34.26	-48.45	+1.34
M_1T_3	32.92	22.90	31.05	86.87	60.49	26.38	29.03	+2.65	-3.89
M_1T_4	32.92	22.90	25.00	80.82	51.97	28.85	28.86	0.00	-4.06
M_1T_5	32.92	0.00	0.00	32.92	20.09	12.83	34.01	+21.18	+1.09
M_2T_1	32.92	22.90	50.00	105.82	51.98	53.84	33.29	-20.54	+0.37
M_2T_2	32.92	22.90	79.72	135.54	58.86	76.68	33.72	-42.96	+0.80
M_2T_3	32.92	22.90	31.05	86.87	67.44	19.43	29.03	+9.60	-3.89
M_2T_4	32.92	22.90	25.00	80.82	56.70	24.12	29.11	+4.99	-3.81
M_2T_5	32.92	0.00	0.00	32.92	17.43	15.49	32.05	+16.56	-0.87

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM)

Table 6: Balance Sheet for soil available Potassium with rice crop under different SSNM treatments

Treatment	Initial soil K_2O (kg ha^{-1})	AppliedK_2O through FYM (kg ha^{-1})	Applied K_2O through Fertilizer (kg ha^{-1})	Total K_2O (kg ha^{-1})	Total K_2O uptake (kg ha^{-1})	Expected balance (kg ha^{-1})	Actual available K_2O (kg ha^{-1})	Apparent gain/ loss (+/-) of N (kg ha^{-1})	Actual gain/ loss (+/-) of N (kg ha^{-1})
M_1T_1	256.50	30.25	50.00	336.75	114.89	221.86	204.78	-17.08	-51.72
M_1T_2	256.50	30.25	4.10	290.85	83.57	207.28	181.22	-26.05	-75.28
M_1T_3	256.50	30.25	39.00	325.75	133.54	192.21	185.02	-7.20	-71.48
M_1T_4	256.50	30.25	41.00	327.75	113.00	214.75	193.18	-21.57	-63.32
M_1T_5	256.50	0.00	0.00	256.50	47.02	209.48	219.22	+9.74	-37.28
M_2T_1	256.50	30.25	50.00	336.75	118.88	217.87	203.91	-13.96	-52.59
M_2T_2	256.50	30.25	4.10	290.85	84.88	205.97	182.51	-23.46	-73.99
M_2T_3	256.50	30.25	39.00	325.75	128.57	197.18	189.27	-7.91	-67.23
M_2T_4	256.50	30.25	41.00	327.75	116.20	211.55	192.23	-19.32	-64.27
M_2T_5	256.50	0.00	0.00	256.50	37.46	219.04	227.01	+7.97	-29.49

Note: M_1: Mugadsiri, M_2: Mugadsugandha; T_1: RPP (as per UASD), T_2: Soil Test Crop Response, T_3: Rice Crop Manager, T_4: Nutrient Expert, T_5: control (No NPK, FYM

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