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Effect of nutrient management and rice establishment on root cec of rice under normal & delay planting condition during summer

RG Goswami and RK Bajpai

Abstract
A field experiment was conducted on a deep black clay loam (*Vertisols*) soil at research cum Instructional farm, Department of Soil Science and Agril. Chemistry, IGKV, Raipur (C.G) during *Summer* seasons, 2017 to study the Effect of nutrient management and rice establishment on Root CEC of rice under normal & delay planting condition during Summer. The experiment comprises various nutrient management as different source of N fertilizers and rice establishment method laid out in Strip plot design with four replications. The details of the treatments were; four level of nutrient management, seven level of rice establishment and two level of planting time. The result of the experiment revealed that, Root CEC at 30 DAT of T_1N_3-MBDS(L) + USG (42.75 meq 100^{-1}g) which was statistically higher than all other interaction and T_7N_4-SRI + Neem cake coated urea (20.75 meq 100^{-1}g) had the minimum Root CEC at 0-20 and 20-40 cm depth respectively under Summer- NP and highest in T_1N_3-MBDS (L)+ USG (50.00 meq 100^{-1}g) and lowest in T_2N_1- MBDS (S) + Control (23 meq 100^{-1}g) & T_5N_1- FRBT(M) + Control (21 meq 100^{-1}g) at 0-20 and 20-40 cm depth respectively under DP. Similarly the higher Root CEC was found in T_5N_3-FRBT (M) + USG (45.50 meq 100^{-1}g) under NP and minimum under T_2N_1-MBDS (S) + Control (23.75 meq 100^{-1}g) under DP at 0-20 depth respectively at stage of maximum flowering. It was also reported that Root CEC was positively significantly influence by the interaction of (establishment method x nutrient management) under 0-20 and 20-40 cm depth at 30 DAT and maximum flowering condition under both *i.e.* normal and delay planting condition.

Keywords: Nutrient management, establishment, planting time, root CEC, FRBT and USG

Introduction
Rice (*Oryza sativa* L.) is the most important and extensively cultivated food crop that has been referred as “Global Grain” because of its use as prime staple food in about 100 countries of the world. Its cultivation is of immense importance to food security of Asia, where > 90 % of the global rice is produced and consumed. Rice provides 32-59% of the dietary energy and 25-44% of the dietary protein in 39 countries. In India, it accounts for >40% of food grain production, providing direct employment to 70% people in rural areas (New Delhi, 2012).

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planets human population. Globally, rice is the second most widely consumed cereal next to wheat and it has occupied an area of 163.2 million hectares, with a total production of 719.7 million tonnes (Anonymous, 2014a) [1]. Rice provides about two-third of the calorie intake for more than two billion people in Asia and a third of the calorie intake of nearly one billion people in Africa and Latin America (Shastry *et al.*, 2000) [12]. Hence, there is a need to increase the productivity of rice.

Chhattisgarh popularly known as “Rice Bowl of India” occupies an area around 4.95 million ha. With the share in rice production in India 3.39% with production 7.58 million tons in CG and productivity 1532 Kg/ha. (IGKV, Raipur, 2013) which is lower than national average. In Summer season it occupies an area of around 3.68 million hectares with production of 8.20 million tones which contributes 8.65 and 6.30% to all India, respectively and productivity of 2020 kg ha-1 in 2013-14 (Anonymous 2015) [2]. Productivity with SRI method is 6 to7 tonnes of rice/ha. Compare to usual yields of 2 to 4 tonnes/ha with farmers practices.

The estimation of nutrient content in soil profiles will provide the Information regarding the status and nature of removal or uptake pattern of different nutrients by the growing plants root as well as the nature of the movements of various nutrients within the soil profile. Many factors are responsible for increasing yield and quality of crop.

Among these proper and balanced application of fertilizers is one of the most important factor contributing towards higher productivity, and good health of the soil. The organic manures improve the soil health and there by enhance the crop yield per unit of applied nutrient.

Common establishment methods for rice cultivation are broadcasting, dry seeding, transplanting, dibbling and drilling. The aim of investigation that is there any possibility of raising the rice nursery with different sizes of plastic tray with enriched FYM and compare the performance of rice with normal and SRI method of rice cultivation along with dibbling of mud ball with different nutrient management practices.

One alternate technique of raising nursery for transplanting of rice seedling is to make different sizes of FYM root ball and mud ball grow them in different volumes of Plastic tray with soil and FYM mixture or soil and FYM mixture enriched with P and K fertilizer. Keeping this in view an experiment is proposed to effect of nutrient management and rice establishment on root CEC of rice under normal & delay planting condition during Summer with following objectives: To find out the root cationic exchange capacity at 30 DAT and maximum flowering stage under different optimum management practices.

Materials and Methods

Experimental site Geographical situation

The experiment was carried out in typical rice growing clay loam soil at the Research farm, Department of Soil Science and Agricultural Chemistry, IGKV, Raipur. Raipur is situated at 21^0 4' North Latitude and 76^0 3' East Longitude with the altitude of 293 meter above mean sea level. The Research cum Instructional farm of Indira Gandhi Agricultural University, Raipur is situated on National highway No. 6 in Eastern part of Raipur city and located between 20^0 4' North latitude and 81^0 39' East longitudes with an altitude of 293 m above mean sea level.

Climate and weather parameter

The region comes under dry and sub-humid climatic condition. The average annual rainfall of the area is 1400-1600 mm. The weather data during experimental period was collected from the meteorological observatory located at Labhandi (Indira Gandhi Agriculture University), Krishak nagar, Raipur. Major amount of precipitation occurs between June and December (about 5-6 Months) which is the main rice growing season. The hottest and coolest months are May and December, respectively. The detail weekly mean meteorological data recorded from meteorological observatory during the crops period.

The weekly mean maximum temperature during the crop growth period ranged from 27.2ºC to 44.5ºC with an average of 36.1ºC during Summer-2017 and 27.2ºC the weekly mean minimum temperature 8.6ºC to 29.5ºC with an average 21.4ºC.The mean relative humidity ranged from 34% to 90.0% with an average of 63.2% during summer 2017. The total rainfall received during the crop growth period was 193.5 mm received in 14 rainy days during. The weekly mean sunshine hours varied from 2.4 to 10.3 hours with an average of 8.1 hours per day and mean evaporation ranged from 10 to 88.2 mm with an average of 43.11 mm per day. The mean wind speed ranged from 1.2 to 7.7 km hr^{-1} an average of 4.0 km hr^{-1} during summer.

Land Preparation

The dried field was ploughed by cultivator followed by rotavator for making pulverized the soil of plot. The strip for direct seeded mud ball (Small and Large) was firstly prepared among the all strip and mud ball was directly dibbled in line at 25 x 25 cm distance without paddling the field (Fig.1).

Fig 1: Different size of Mud ball

Planting materials, design and plot size

Rajeshwari (IGKV R-I) was used as a planting materials which was developed by IGKV, Raipur. The experiments were laid out in Strip plot design with four replication. The plot size was 67m × 36m (2412 m^2).The Net plot size of each plot of experimental area was 3m x 2m and distance between replication to replication and plot to plot were 1.5m and 0.5m, respectively.

Showing of Nursery

All type of nursery was showed in same date like normal or conventional type of nursery and alternative method of nursery showed in 3 different volumes of plastic trays *i.e.* Small size (14.3 cm^3), Medium size (55.4 cm^3) and Large size (131.4 cm^3) showed in Fig. 2 nursery showing in plastic tray firstly filled the embed hole of tray by FYM & Soil (3:1) enriched by P &K and in take a 2-3 number of paddy seed in each hole and then covered by mixture after that frequently irrigation should be given by hajara. Healthy, matured and viable seeds were used for sowing of nursery. The seed bed was prepared and the seed was showed in a line in seed bed for normal & SRI transplanting.

Fig 2: Different volumes of plastic seedling tray

Transplanting

Seedlings were carefully uprooted from seedling nursery bed and plastic seedling tray and transplanted in the plots. Among the all types of nursery *i.e.* For normal transplanting, SRI, Root balls (S), Root ball (M) and Root ball (L), the 4 types of nursery for SRI, Root balls (S), Root ball (M) and Root ball (L) were transplanted of 12-14 days old seedling in puddle strips at 25 x 25 cm spacing similarly Pre-germinated seeds of respective varieties were sown in the wet seedbed and proper care was taken to raise the seedlings in seed bed. The 18-20 days old seedling was transplanted in puddle strip with two seedlings in each hill, maintaining the spacing with 20 cm × 10 cm on the well puddle plots.

Experimental treatment detail:

The experiment was consisted on four level of Nutrient management N_1- Control; N_2- Recommended dose of fertilizer; N_3-N-through urea super granule; N_4-N-through Neem cake coated urea ; 7 level of method of rice establishment *i.e.* T_1- Mud ball direct seeded(L); T_2- Mud ball direct seeded (S); T_3- Normal transplanting; T_4- FYM root ball (S); T_5- FYM root ball (M); T_6- FYM root ball (L); T_7- SRI and two level of planting date *i.e.* Normal planting and 15 day delay planting.

Statistical analysis

All the collected data on different parameters were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C computer package program and mean differences adjusted by Least Significant Difference (LSD) test at 5% level of significance.

Results and Discussion

Root CEC (meq 100^{-1}g) at 30 DAT

The data as shown in Table 1, Table 2 and Fig.3, Fig.4 revealed that Root CEC (meq 100^{-1}g) under Summer-2017. The maximum Root CEC at 30 DAT (42.75 & 37.25 meq 100^{-1}g) was found under T_1N_3 (MBDS (L)+USG) which was significantly higher than all interaction and T_2N_1 (21.75 meq 100^{-1}g), T_7N_4 (20.75 meq 100^{-1}g) had the minimum Root CEC under NP during summer and the higher Root CEC (50 & 47.25 meq 100^{-1}g) was found in MBDS (L)+ USG (T_1N_3) and lowest 23 meq 100^{-1}g in MBDS (S) + Control (T_2N_1) & 21 meq 100^{-1}g in T_5N_1 at 0-20 and 20-40 cm depth respectively under DP during summer. Over all the Root CEC at 30 DAT at 0-20 cm and 20-40 cm depth was significantly affect by rice establishment and nutrient management and root CEC was found high at 0-20 cm depth as compression to 20-40 cm depth under NP and DP. It may be due to soil compaction, which were increases by increasing depth of soil and soil compaction resulted due rice cultivation creates poor soil aeration that restricts root proliferation which results in poor crop growth. Its reported that the root zone of rice crop shown oxygen stress immediately after irrigation. it also restricted water movement that resulted in poor root development leading to reduction in movement of nutrient in depth of soil so that's why root CEC was reduce with increases of depth. Similar results were reported by Sharma *et al.* 2016 [11]. Similar type of work reported by Kalaiyarasi (2009) [6], Satyanarayana *et al.* (2007) [10], Thakur *et al.* (2010) [15] and Islam *et al*. (2009) [4].

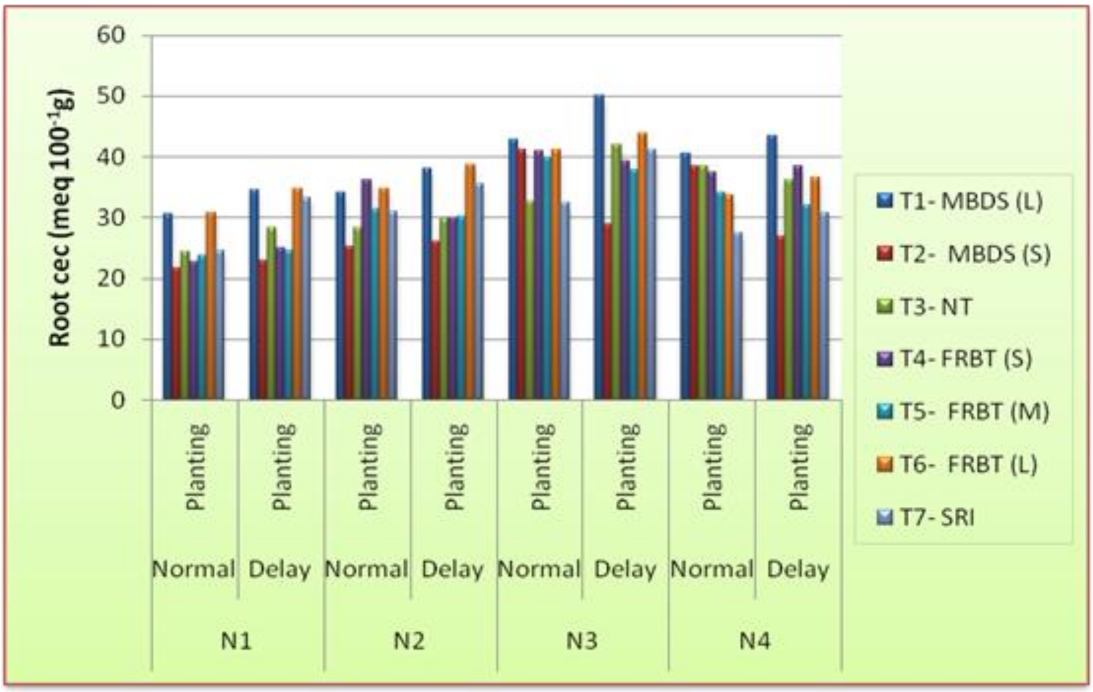

Fig 3: Effect of rice establishment and nutrient management on Root CEC at 30 DAT at 0-20 cm depth during *Summer* -2017

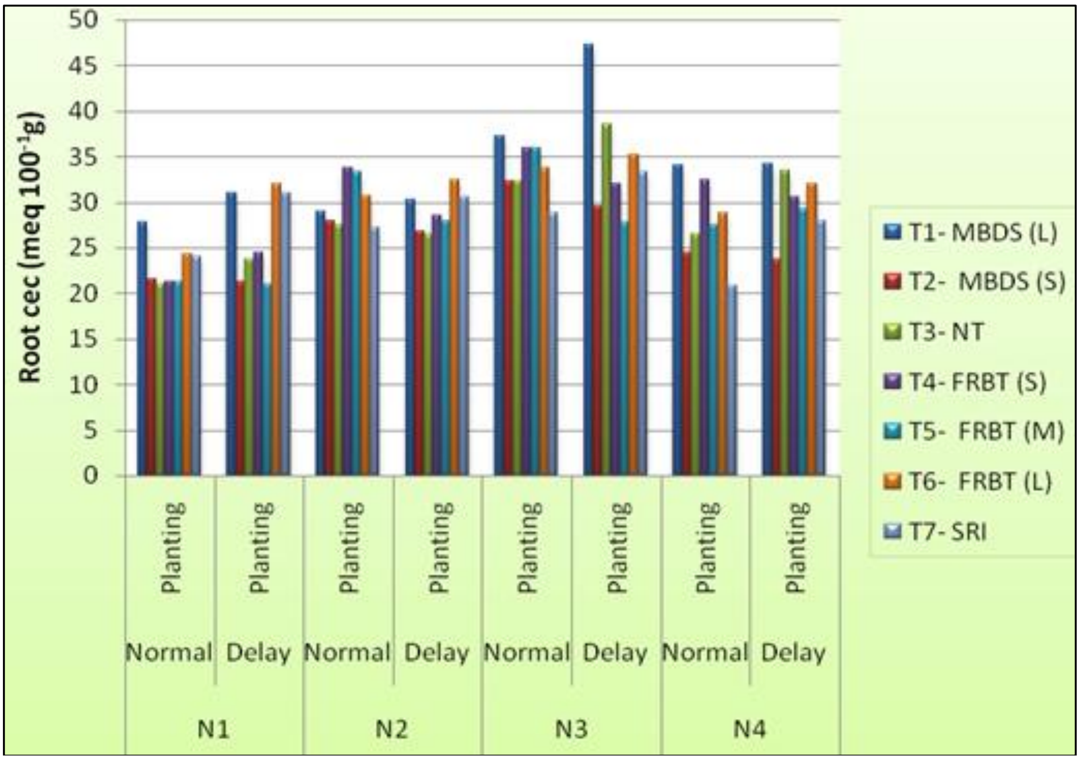

Fig 4: Effect of rice establishment and nutrient management on Root CEC at 30DAT at 20-40 cm depth during *summer* 2017

Table 1: Effect of rice establishment and nutrient management on Root CEC (meq 100^{-1}g) at 30 DAT at 0-20 cm depth under *Summer-2017*

Treatments	N_1		N_2		N_3		N_4	
	NP	DP	NP	DP	NP	DP	NP	DP
T_1- MBDS (L)	30.50	34.50	34.00	38.00	42.75	50.00	40.50	43.50
T_2- MBDS (S)	21.75	23.00	25.25	26.00	41.25	29.00	38.50	26.75
T_3- NT	24.25	28.25	28.25	29.75	32.75	42.00	38.50	36.25
T_4- FRBT (S)	22.75	25.00	36.25	30.00	41.00	39.25	37.50	38.50
T_5- FRBT (M)	23.75	24.50	31.50	30.25	40.00	37.75	34.00	32.00
T_6- FRBT (L)	30.75	34.75	34.75	38.75	41.25	43.75	33.75	36.50
T_7- SRI	24.50	33.25	31.00	35.50	32.50	41.25	27.50	30.75
Mean	25.46	29.04	31.57	32.61	38.79	40.43	35.75	34.89
			Establishment method (T)		*Nutrient management (N)*		*Interaction (TX N)*	
CD (0.05)	*NP*		4.36		4.07		5.26	
	DP		3.06		2.31		3.07	

Table 2: Effect of rice establishment and nutrient management on Root CEC (meq 100^{-1}g) at 30 DAT at 20-40 cm depth under *Summer-2017*

Treatments	N_1		N_2		N_3		N_4	
	NP	DP	NP	DP	NP	DP	NP	DP
T_1- MBDS (L)	27.75	31.00	29.00	30.25	37.25	47.25	34.00	34.25
T_2- MBDS (S)	21.50	21.25	28.00	26.75	32.25	29.50	24.50	23.75
T_3- NT	21.00	23.75	27.50	26.50	32.25	38.50	26.50	33.50
T_4- FRBT (S)	21.25	24.50	33.75	28.50	36.00	32.00	32.50	30.50
T_5- FRBT (M)	21.25	21.00	33.25	28.00	36.00	27.75	27.50	29.25
T_6- FRBT (L)	24.25	32.00	30.75	32.50	33.75	35.25	28.75	32.00
T_7- SRI	24.00	31.00	27.25	30.50	28.75	33.25	20.75	28.00
Mean	23.00	26.36	29.93	29.00	33.75	34.79	27.79	30.18
			Establishment method (T)		*Nutrient management (N)*		*Interaction (TX N)*	
CD (0.05)	*NP*		4.31		4.42		NS	
	DP		4.36		1.48		4.18	

NOTE: T_1- Mud ball direct seeded(L); T_2- Mud ball direct seeded (S); T_3- Normal transplanting; T_4- FYM root ball (S); T_5- FYM root ball (M); T_6- FYM root ball (L); T_7-SRI ; N_1- Control; N_2- Recommended dose of fertilizer; N_3-N-through urea super granule; N_4-N-through Neem cake coated urea ; NP- Normal planting ; DP- Delay planting

Root CEC (meq 100^{-1}g) at Maximum flowering

The data as shown in Table.3, Table.4 and Fig.5, Fig.6 revealed that Root CEC (meq 100^{-1}g) under Summer-2017. The maximum Root CEC was found (45.50 meq 100^{-1}g) in T_5N_3 & 40.25 meq 100^{-1}g in T_4N_4, which was significantly higher than all interaction and T_3N_1 (28.25 meq 100^{-1}g), T_7N_1 (26.25 meq 100^{-1}g) had the minimum root cec under NP during summer and the higher Root CEC (42.25 in T_5N_3 & 37.75 meq 100^{-1}g under T_4N_4 treatment) and lowest 23.75 meq 100^{-1}g in MBDS (S) + Control (T_2N_1) & 25.25 meq 100^{-1}g in T_7N_1 at 0-20 and 20-40 cm depth respectively under DP during summer. Over all the Root CEC at maximum flowering at 0-20 cm and 20-40 cm depth was significantly affect by rice establishment and nutrient management and root CEC was found high at 0-20 cm depth as compression to 20-40 cm depth in both season under NP and DP. It was also found that Root CEC increases gradually at 30 DAT to maximum flowering condition and Root CEC was found higher in case of maximum flowering as compression to 30 DAT. It may be due to because the activity of nutrient N, K and H^+ ion in root hair are gradually increases from tillering stage to maximum flowering condition after that the activity of ion in root hair are decreases till the harvest. The results are agreement with the earlier finding of Sharma *et al.* 2016 [11]. The increasing source of NPK fertilizer significantly increased root CEC of rice is associated with varying levels of N and P, which justify the fact that better P availability increased number as well as length of root hairs which were more active and possessed more pectic substance and directly increased root CEC (Mahanta, 2008) [7]. The increase in root CEC with increasing levels of N has also been reported by Singh and Ram, 1976 [14]. However, the application of P and K had little effect on the root Cation exchange capacity of both rice. similar report was reported by Singh *et al.* (1997) [13], Iswandi *et al.* (2011) [5], Kalaiyarasi (2009) [6], Raju and Sreenivas (2008) [8], Thakur *et al.* (2010) [15], Fageria *et al.* (2011) [3], Satyanarayana *et al.* (2007) [10], Sahoo *et al.* (2015) [9].

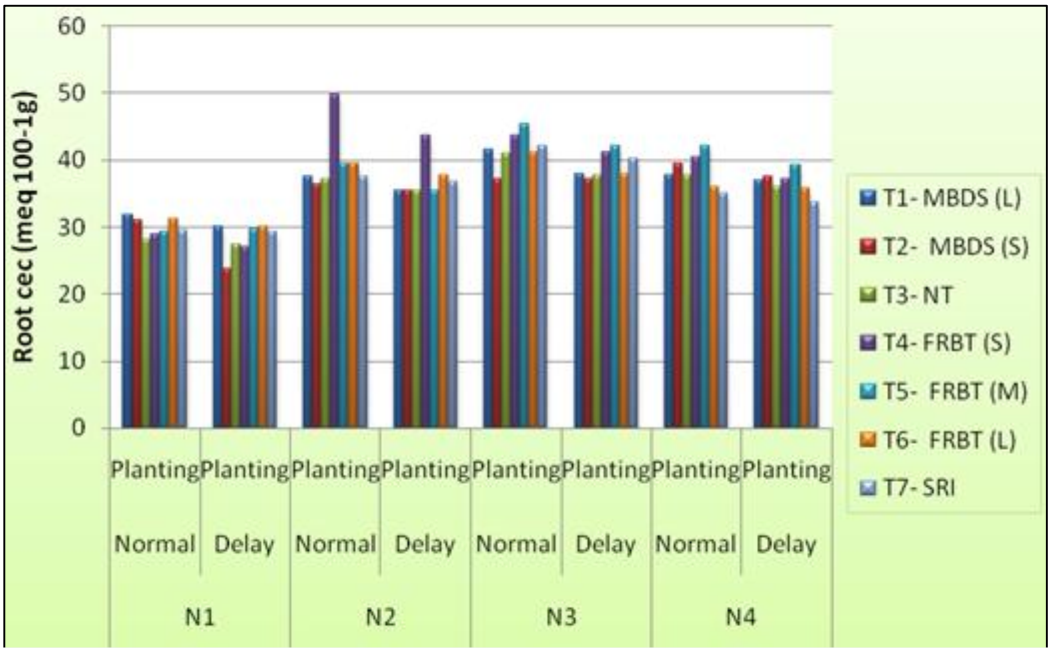

Fig 5: Effect of rice establishment and nutrient management on Root CEC at maximum flowering at 0-20 cm depth during *Summer* 2017

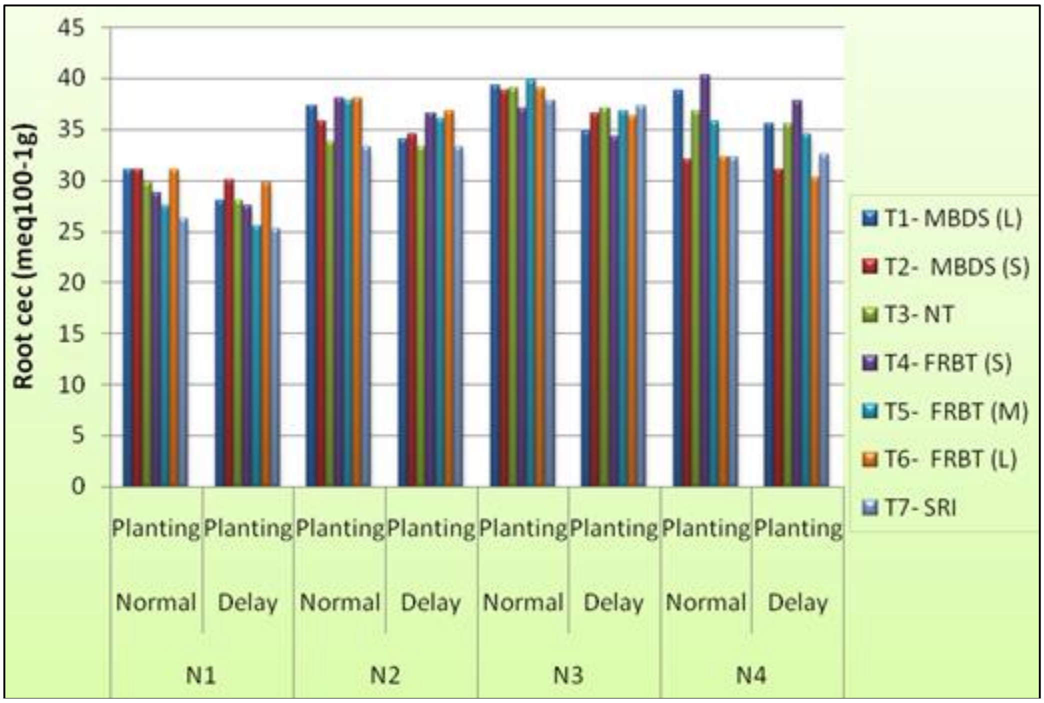

Fig 6: Effect of rice establishment and nutrient management on Root CEC at maximum flowering at 20-40 cm depth during *Summer* -2017

Table 3: Effect of rice establishment and nutrient management on Root CEC (meq 100^{-1} g) at maximum flowering at 0-20 cm depth under *Summer-2017*

Treatments	N_1		N_2		N_3		N_4	
	NP	DP	NP	DP	NP	DP	NP	DP
T_1- MBDS (L)	31.75	30.00	37.50	35.50	41.50	38.00	37.75	37.00
T_2- MBDS (S)	31.00	23.75	36.50	35.50	37.25	37.25	39.50	37.50
T_3- NT	28.25	27.50	37.25	35.50	41.00	37.75	37.75	36.00
T_4- FRBT (S)	29.00	27.00	42.75	41.75	43.75	41.25	40.50	37.25
T_5- FRBT (M)	29.25	29.75	39.50	35.50	45.50	42.25	42.25	39.25
T_6- FRBT (L)	31.25	30.00	39.50	37.75	41.25	38.00	36.00	35.75
T_7- SRI	29.50	29.25	37.50	36.75	42.25	40.25	35.00	33.75
Mean	30.00	28.18	38.64	36.89	41.79	39.25	38.39	36.64
			Establishment method (T)		*Nutrient management (N)*		*Interaction (TX N)*	
CD (0.05)	*NP*		2.81		2.06		3.42	
	DP		2.28		2.20		3.15	

Table 4: Effect of rice establishment and nutrient management on Root CEC (meq 100^{-1} g) at maximum flowering at 20-40 cm depth under *Summer-2017*

Treatments	N_1		N_2		N_3		N_4	
	NP	DP	NP	DP	NP	DP	NP	DP
T_1- MBDS (L)	31.00	28.00	37.25	34.00	39.25	34.75	38.75	35.50
T_2- MBDS (S)	31.00	30.00	35.75	34.50	38.75	36.50	32.00	31.00
T_3- NT	29.75	28.00	33.75	33.25	39.00	37.00	36.75	35.50
T_4- FRBT (S)	28.75	27.50	38.00	36.50	37.00	34.25	40.25	37.75
T_5- FRBT (M)	27.50	25.50	37.75	36.00	39.75	36.75	35.75	34.50
T_6- FRBT (L)	31.00	29.75	38.00	36.75	39.00	36.25	32.25	30.25
T_7- SRI	26.25	25.25	33.25	33.25	37.75	37.25	32.25	32.50
Mean	29.32	27.71	36.25	34.89	38.64	36.11	35.43	33.86
			Establishment method (T)		*Nutrient management (N)*		*Interaction (TX N)*	
CD (0.05)	*NP*		2.42		1.80		3.04	
	DP		NS		2.00		3.13	

NOTE**:** T_1- Mud ball direct seeded(L); T_2- Mud ball direct seeded (S); T_3- Normal transplanting; T_4- FYM root ball (S); T_5- FYM root ball (M); T_6- FYM root ball (L); T_7-SRI ; N_1- Control; N_2- Recommended dose of fertilizer; N_3-N-through urea super granule; N_4-N-through Neem cake coated urea ; NP- Normal planting ; DP- Delay planting

Conclusion

Root CEC was positively significantly influence by the interaction of (T x N) under 0-20 and 20-40 cm depth at 30 DAT and maximum flowering condition under both planting time. Highest Root CEC was recorded (50 & 47.25 meq 100^{-1}g) in MBDS (L) + USG (T_1N_3) at 0-20 and 20-40 cm respectively at 30 DAT under DP during summer. Overall concluded from the result Root CEC increases gradually at 30 DAT to maximum flowering condition and Root CEC was found higher in case of maximum flowering as compression to 30 DAT.

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