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Long-term effects of rice establishment methods on rice productivity and nutrients uptake in *Vertisols* of Chhattisgarh plain

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Abstract
The farmer field study was carried out during 2016-17 at village Saida, Takhatpur Tehsil in Bilaspur district of Chhattisgarh to evaluate the "Long term effects of rice establishment methods on soil properties and rice productivity in *vertisols* of Chhattisgarh plain". The trial was laid out in Randomized block design with twelve replication and three treatments under rice based cropping system in *Vertisols*. The study was focused on the effect of long-term rice establishment methods on rice productivity and nutrients uptake in *vertisols* were evaluated after harvest of rice crop. This study was undertaken to assess the rice productivity and nutrients uptake under various rice establishment methods. Nitrogen, Phosphorus and Potassium content in grain and straw were non significantly increased with transplanting method followed by broadcasting-biasi and direct seeded (Line Sowing) methods. The higher grain yield of rice was found in transplanted rice (4404 kg ha^{-1}) followed by broadcast-biasi (3825 kg ha^{-1}) and direct seeded rice (3417 kg ha^{-1}). The higher straw yield was recorded in transplanting method (4975 kg ha^{-1}) while the lower straw yield was recorded in direct seeded method (3904 kg ha^{-1}). The method of establishment plays an important role in growth development and yield of rice. Similar results were observed in nitrogen, phosphorus and potassium uptake by grain and straw.

Keywords: Long term effect of rice establishment, Transplanted rice, Direct seeded rice, Brushing method of rice, tillage, Rice, nutrient content and uptake

Introduction
Rice is one of the chief grains of India and every day millions of Indians find ease in it. With high carbohydrate content, it is known to provide instantaneous energy, and is a staple that is consumed by the preponderance of India's population. Our country has biggest area under rice cultivation, as it is single of the foremost food crops and provides food security and source of revenue for the peoples of country and occupies an area out of the 44.1 m ha area an annual production of 105.48 million tones and productivity of 2.39 tonnes/ ha of rice (Annual Report 2016-17) [1]. Under puddle condition rice cultivation has occupies 24 m ha, about 56% of the area (Anonymous, 2005) [2]. It's also the world most important cereal crop is grown over an area of 153 m ha a global level and constitutes the staple diet for over 40% of the world population including around 85% of the Asian population. Presently in Chhattisgarh, about 75 percent area is under broadcasting, 15-17 percent under transplanting and 8-10 percent area is covered by direct drilling method of rice seeding.

Transplanting has been the most important and common method of crop establishment under favourable rainfed and irrigated lowland in Tropical Asia. In India, 44 percent of rice area (19.6 million ha) is under transplanting in irrigated lowland. This practice provides several benefits to rice, such as weed control, ease of transplanting, decrease in deep percolation losses of water and nutrients and improved to nutrient availability (Sharma *et al*., 1985) [9]. Although puddling is known to be beneficial for growing rice it can adversely affect the growth and yield of subsequent crop.

Under broadcast Biasi method, rice seeds are broadcast in a ploughed field immediately after the onset of monsoon. After about 30 to 45 days when sufficient water is impounded in the field, the fields are ploughed in the standing crop. This is called Biasi or bushening. The uprooted seedlings are transplanted (in situ transplanting) after Biasi, which is called Chalai in local language. In this method of rice cultivation which is generally practiced for the control of weeds in direct seeded shallow lowland rice in various forms in the different parts of Indian farmers, particularly in Chhattisgarh, Orrisa, Madhya Pradesh and Bihar, and to a smaller area in West Bengal, Assam and Utter Pradesh for optimization of stand.

The intercultural practices in water stagnant paddy crop are followed in many countries and named with different terms. Like 'Gogarancah' in Indonesia, 'Kakularf' in Shri Lanka and 'Sabog Tanim' in Phillipines. In our country and Bangladesh, it's an age old practice and known as Aus, Beausani or Biasi (Fujisaka., *et al*, 1993) [6].

In India direct seeded rice has grown in the area of 7.2 M ha. In Chhattisgarh, rice occupies average of 3.77 million ha with the productivity of the state ranging between 1.2 to 1.6 t/ha depending upon the rainfall and the production is 8.58 MT. Direct seeding of rice eliminates the need of nursery raising and subsequent labour intensive transplanting thus reducing cost of cultivation and is now fast replacing traditionally transplanted rice (Balasubramanian and Hill, 2000) [4]. The present study was focus on evaluating the long term effects of rice establishment methods on chemical properties and rice productivity in vertisols of Chhattisgarh plain.

Materials and Methods

A farmer's field experiment was conducted at Village-Saida, Takhatpur, Bilaspur District during 2016-17 on a *vertisoils* under categories marginal, medium and resourceful farmer, on the basis of survey out of 50 farmers total 36 farmers selected for research purpose and samples were collected from selected farmers field. The three treatment of rice establishment method studied *viz*. (a) Transplanting (b) Broadcast-Biasi (c) Direct seeding (Line sowing) with twelve replications in randomized block design. Bilaspur district was considered as strata and single village was selected by using Simple Random Sampling without Replacement (SRSWOR). From selected village 36 farmers *viz*. large (>3ha), medium (1-3 ha) and small (<1ha) were selected for sampling and other basic information about the farmers were collected. From each selected farmer field standard procedure of sampling was followed and sampled fields were positioned as latitude longitude by using GPS. The soil of experiment fields was clay in texture having slightly acidic to slightly alkaline pH, low in nitrogen, medium phosphorus and potassium medium to high. The available iron, manganese, zinc and copper content of the experimental field were sufficient. Data obtained from all observation were statistically analysed by applying Randomized block design (RBD).

Results and Discussion

Rice yield

It is evident from the data Table 1 that transplanting method of rice produced significantly higher grain yield. The highest grain yield of rice was found in transplanted rice (4404 kg ha^{-1}) followed by broadcast-biasi (3825 kg ha^{-1}) and direct seeded rice (3417 kg ha^{-1}). The higher straw yield was recorded in transplanting method (4975 kg ha$^{-1)}$ while the lower straw yield was recorded in direct seeded method (3904 kg ha^{-1}). The method of establishment plays an important role in growth, development and yield of rice. The proper and uniform density of plant stand under transplanting is the key to increase the grain yield of rice than direct seeding and broadcast biasi method of rice seeding. Puddling has great significance in rice establishment method because it facilitates in increasing the availability of nutrient, ensure better plant establishment and control of weed (Shukla *et al.* 2016; Gathala *et al*. 2011; Samra and Dhillon, 2000) [10, 7, 8].

Table 1: Long term effects of rice establishment methods on grain and straw yield.

Treatments	Yield (Kg ha^{-1})	
	Grain	Straw
Transplanting	4408	4975
Broadcasting-Biasi	3825	4370
Direct seeded (LS)	3417	3904
CD at 5%	251	231

Nitrogen content in grain and straw

Data presented in table 2 indicated that nitrogen content in grain and straw were non-significantly by effect of different long-term rice establishment methods. The percent nitrogen content in grain was recorded to be 1.24, 1.22 and 1.21% under transplanting, broadcast-biasi and direct seeded methods respectively. The percent nitrogen content in straw was recorded to be 0.40, 0.38 and 0.37% under transplanting, broadcast-biasi and direct seeded methods respectively. Negligible change was recorded in nitrogen content in grain and straw as influenced by rice cultivation methods. Highest N content were obtained in transplanting method and the lowest in direct seeded method.

Table 2: Long term effects of rice establishment methods on nutrient content (%) in grain and straw.

Treatments	N (%)		P (%)		K (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Transplanting	1.24	0.40	0.34	0.09	0.24	1.68
Broadcasting-Biasi	1.22	0.38	0.32	0.08	0.23	1.64
Direct seeded (LS)	1.21	0.37	0.31	0.08	0.23	1.62
CD at5%	NS	NS	NS	NS	NS	NS

Phosphorus content in grain and straw

Data presented in table 2 indicated that phosphorus content in grain and straw were non-significant by effect of different long term rice establishment methods. The percent phosphorus content in grain was recorded to be 0.34, 0.32 and 0.31% under transplanting, broadcast-biasi and direct seeded methods respectively. The percent phosphorus content in straw was recorded to be 0.09, 0.08 and 0.08% under transplanting, broadcast-biasi and direct seeded methods respectively.

Potassium content in grain and straw

Data presented in table 2 indicated that potassium content in grain and straw were non-significant by effect of different long term rice establishment methods. The percent potassium content in grain was recorded to be 0.24, 0.23 and 0.23% under transplanting, broadcast-biasi and direct seeded methods respectively. The percent of potassium content in straw was recorded to1.68, 1.64 and 1.62% under transplanting, broadcast-biasi and direct seeded methods respectively.

Similar results was obtained by Talla and Jena (2014) [11] that the N content of grain is two times higher than straw, phosphorus content in the grain was observed to be more than two fold to that of straw and straw recorded four to five times higher potassium content than the grain under different rice establishment methods.

Nitrogen accumulation in grain and straw

Data presented in Table 3 show that nitrogen accumulation in

grain and straw at harvest also increased significantly due to different rice establishment methods. The highest N-accumulation in grain was recorded to be 54.58, 46.73 and 41.49 Kg/ha^{-1} under transplanting, broadcast-biasi and direct seeded methods respectively. Similar trend was also recorded in straw N-accumulation which was 20.42, 16.52 and 14.60 under transplanting, broadcast-biasi and direct seeded methods respectively.

Table 3: Long term effects of rice establishment methods on yield and nutrients uptake by grain and straw.

Treatments	N (Kg ha.$^{-1}$)		P (Kg ha.$^{-1}$)		K (Kg ha.$^{-1}$)	
	Grain	Straw	Grain	Straw	Grain	Straw
Transplanting	54.58	20.42	14.81	4.27	10.70	83.70
Broadcasting-Biasi	46.73	16.52	12.38	3.57	8.83	71.75
Direct seeded (LS)	41.49	14.60	10.73	3.25	7.80	63.38
CD at5%	3.02	1.69	1.01	0.34	0.69	4.37

Phosphorus accumulation in grain and straw

Data presented in Table 3 show that phosphorus accumulation in grain and straw at harvest also increased significantly due to different rice establishment methods. The highest P-accumulation in grain was recorded to be 14.81, 12.38 and 10.73 Kg ha^{-1} under transplanting, broadcast-biasi and direct seeded methods respectively. Similar trend was also recorded in straw P-accumulation which was 4.27, 12.38 and 10.73 under transplanting, broadcast-biasi and direct seeded methods respectively. The highest P-accumulation of rice grain was found in transplanted rice (14.81 kg ha^{-1}) followed by broadcast-biasi (12.38 kg ha^{-1}) and direct seeded rice (10.73 kg ha^{-1}). The higher P-accumulation of rice straw was recorded in transplanting method (4.27 kg ha$^{-1)}$ while the lower was recorded under direct seeded method (3.25 kg ha^{-1}).

Potassium accumulation in grain and straw

Data presented in Table 3 show that potassium accumulation in grain and straw at harvest also increased significantly due to different rice establishment methods. The highest K-accumulation in grain was recorded to be 10.70, 8.83 and 7.80 Kg ha^{-1} under transplanting, broadcast-biasi and direct seeded methods respectively. Similar trend were also recorded in straw K-accumulation which was 83.70, 71.75 and 63.38 under transplanting, broadcast-biasi and direct seeded methods respectively. The higher K-accumulation of rice grain was found in transplanted rice (10.70 kg ha^{-1}) followed by broadcast-biasi (8.83 kg ha^{-1}) and direct seeded rice (7.80 kg ha^{-1}). The highest K-accumulation of rice straw was recorded in transplanting method (83.70 kg ha$^{-1)}$ while the lowest was recorded under direct seeded method (63.38 kg ha^{-1}). Similar results were obtained by Talla and Jena (2014) [11] that the grain and straw NPK nutrients uptake was recorded by SRI, which was statically at par with transplanting, but it is significantly different with remaining crop establishment methods. Chander and Pandey (1997) [5] also reported that that nitrogen (112.8 kg ha-1), phosphorus (17.0 kg ha-1) and potassium (172.3 kg ha-1) uptake by rice were significantly higher under transplanting than direct seeded rice under puddle condition.

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