Effect of crop establishments methods and nutrient managementon Productivity and Profitability of Rice (*Oryzasativa* L.)

ABSTRACT

A field experiment was conducted at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh,with a view to compare the production potential under different crop establishment methods and nutrient management and also to find out the economic viability of this cultivar for soil quality. The treatments comprised of Main Plot Puddled TransplantedRice(C_1), Un-puddledTransplantedRice(C_2) and Raised-BedPlanting(C_3) Sub PlotControl(N_1), 100%NPK (150:75:60) (N_2), 50%RDN+ FYM @15ton ha^{-1} (N_3), 50%RDN+vermicompost@ 5tonha^{-1}(N_4),50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1} (N_5) and50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20Kgha^{-1} (N_6).Results revealed that crop establishment methods treatment C_1 (Puddled TransplantedRice) and Nutrient management N_6(50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20Kgha^{-1}) exhibited significant influence on yield attributes and yields of rice as compared to the application of Un-Puddled TransplantedRice and Control treatment.

Keywords: Rice, FYM, Verimcompost, Bio-stumulant,production potential, profitability

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop and a staple food for one third of the world population. In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. To safeguard and sustain the food security in India, it is quite important to increase the productivity of rice under limited resources, especially water. It contains 7-8% protein, 3% fat and 3% fiber. 100 gms of uncooked rice contains 80.40 gms of carbohydrates, of which 63.6% is starch, however, when rice is cooked, the starch content drops dramatically. It occupies 162.97 mha of area, producing 495.03 million tonnes of rice with an average productivity of 3.04 t/ha in the world. In India, rice occupies an area of 43.79 mha with production and productivity of 116.42 mt and 2.65 t/ha, respectively (**Anonymous, 2019**). The major rice growing states in India are West Bengal, Uttar Pradesh, Assam, Bihar, Orissa and Madhya Pradesh. Uttar Pradesh is the 2nd largest rice growing state only after West Bengal in the country, in which rice is grown over an area of 5.75 mha with a production of 15.54 mt and the productivity of 2.70 t/ha (**Anonymous, 2019**). About 63 per cent of total rice area is situated in Uttar Pradesh, Bihar, West Bengal, Assam, Orissa and Madhya Pradesh. Demand for rice is going to increase every year and it is estimated that by year 2025 the requirement would be 140 mt. In India out of total rice, Basmati rice is grown on an area of 2.12 mha producing 8 mt of Basmati rice with an average productivity of 3.77 t/ha. Out of this 8 mt, 4 mt is exported and remaining 4 mt is used for domestic purpose. (**Anonymous, 2018**).

Conservation farming practices including tillage practices that are important for rice. Tillage practices increase yield water productivity and nutrient availability to plant. Tillage affects the organic carbon content of soil, bulk density of soil, aeration etc. Various tillage practices were found to exert a significant influence on soil disturbances, aggregate stability, and organic. In Asia, rice is commonly grown by transplanting seedlings into puddle soil (land preparation with wet tillage). Puddling benefits rice by reducing water percolation losses, controlling weeds, facilitating easy seedling establishment, and creating anaerobic conditions to enhance nutrient availability, but repeated puddling adversely affects soil physical properties by destroying soil aggregates, reducing permeability in subsurface layers, and forming hard-pans at shallow depths. Tillage practices greatly influence the soil physical properties which in turn affects the soil structure. Soil physical properties and conservation tillage are influenced by surface and internal drainage, nature and amount of clay, climate, drainage, physiographic, vehicular traffic, soil and crop management systems.

Crop establishment is a sequence of events that includes seeding, seed germination, seedling emergence, and development to the point where seedlings can be expected to grow to maturity **(Jat *et al*., 2010).** Rice production methods in any area are determined by the environment, ecology, and socioeconomic conditions of that area. In lowland areas, the majority of people use techniques such as conventional transplanting after puddling, whereas in upland areas, DSR is used **(Chauhan *et al.*, 2017).** Conventional transplanting methods on puddled soil account for about 77 percent of global rice production **(Chakraborty *et al*., 2017; Xu et al., 2019).** The traditional rice crop transplanting system (TPR) necessitates a huge quantity of labour, water, capital, and energy, and as a result, it has become less profitable in recent years due to a scarcity of these resources **(Chakraborty *et al*., 2017).** According to Tuong and Bouman, producing 1kg of rice in a conventional transplanted system (TPR) requires about 2500 L (average) of water **(Tuong and Bouman, 2003).**

The Raised bed techniques offer a useful option to reduce the limitations of transplanted paddy. It also offers the advantage of faster and easier planting, ensure proper plant population and reduce labour. Raised beds are formed by moving soil from the furrows to the area of the bed, thus raising its surface level. The furrows serve as irrigation channels, drains and traffic lanes. Generally, two to six rows are planted on the top of each bed for rice crop **(Naresh *et al*., 2011).** Raised bed dimensions and configurations vary with soil type and available machinery. The ability of the soil to 'sub' (*i.e.* allow the lateral movement of irrigation water into the centre of the bed) is a key determinant of bed dimensions. For sandy loam soils that sub easily, growers use bed widths at 1.37 m centres for all crop types like rice, wheat. Soils do not sub as well; narrower beds at 0.67 m centres are frequently used. Bed height may also vary with soil conditions and field slope. Higher beds are frequently used on soils that sub well and have flatter grades and longer run lengths, while beds of a lower height are used on steeper graded fields. The flat top of the bed varies from 0.37 to 1.07 m in width. Furrow irrigation used with raised beds requires growers to adopt a whole-farm planning approach to deal with drainage water and the integration of on farm drains and drainage water recycling systems, to increase both water use efficiency and drainage water quality control **(Beecher *et al*., 2005).**

A number of studies have been conducted to quantify the water footprint of a large variety of different crop products and crops (**Chapagain and Orr 2009**). These studies provided a broad-brush to the global picture since the primary focus of these studies was to establish a first estimate of global virtual water flows and/or national water footprints. More recently, though a few studies have separated global water consumption for crop production into green and blue water with a better spatial resolution (**Liu and Yang 2010; Hanasaki*et al*. 2010; Naresh *et al.*, 2017**) but still information on water footprints based on inflow and outflow of water at farm level under different management practices arelacking.

The stagnation in production and profitability of food grains for the past few years has become a matter of concern and is posing serious threat to our national food security soil health degradation has emerged as a major factor responsible for the stagnation in agricultural production. The degradation of soil health in many intensively cultivated areas is manifested in terms of loss of soil organic matter, depletion of native soil fertility due to imbalanced and non-scientific use of fertilizer, which is now one of the major constraints in improving crop productivity.

An integrated use of both organic manures and chemical fertilizers has emerged as a promising option not only for maintaining higher productivity but also for providing maximum stability to crop production in intensive farming systems. The interactive advantages of combining organic and inorganic sources of nutrients in integrated nutrient management have proved superior to the use of each component separately. Judicious use of organic manures, such as farmyard manure, green manuring and rice straw along with chemical fertilizers improves soil physical, chemical and biological properties and enhance productivity in both the reasons. It is essential to identify such practices which bring more sustainability to the production system, beside improving the productivity of the system and soil health (**Urkurkar*et al.*, 2010**).

Long-term studies indicated that supplying of plant nutrients only through chemical fertilizers lead to depletion of SOM and declined the soil productivity **(Singh *et al.* 2001).** Therefore, to maintain soil health for long-term sustainability of crop production system application of organic manures, compostalong with fertilizers have commonly been advocated. Whereas farmyard manure increased nutrient availability as compared to the chemical fertilizers application **(Babhulkar*et al.*, 2000).** Depletion of soil fertility because of the use of high analysis fertilizers renders the deficiency of macronutrients particularly N. Increasing productivity of rice will continue to be a major challenge because the demand of the growing population needs to be met with a limited area of arable land. Fertilizer N has contributed immensely to the current level of productivity and will play a key role in the future rice production. Nutrients supplied exclusively through chemical sources, though enhances yield initially, but the yields are not sustainable over the years. Even the introduction of high yielding varieties and intensive cultivation with excess and imbalanced use of chemical fertilizers and irrigation showed reduction in the soil fertility status and yield by 38 per cent of rice crop **(Singh *et al.*, 2001).**

Using judicious combination of chemical and organics for achieving enhanced and sustainable production by adopting integrated nutrient supply is imperative **(Kumar *et al.*, 2013).** Integrated use of organics and fertilizers for improving the long-term productivity of rice-wheat cropping system (**Bhandari *et al.*, 2002**) and the profitability of organic sources such as straw and FYM when used as a complementary dose to inorganic N, P and K in intensive rice- rice systems (**Dawe *et al.*, 2003**). The combined use of mineral fertilizers, FYM and vermi-compost which may resolve the practical limitation of input availability, but which may also benefit crop N synchrony and N loss reduction through interactive effects between both types of inputs. The interactive advantage of combining organic and inorganic sources of the nutrients in integrated nutrient management system has proved superior to the use of its each component separately besides, restoring soil fertility and crop productivity. This approach may also help to check the emerging deficiency of nutrients other than N, P and K and favourably affects physical, chemical and biological environment of the soil.

Material and Methods

TheexperimentwascarriedoutatCropResearchCentre,Sardar VallabhbhaiPatelUniversityof Agriculture and Technology, Meerut (U.P.) to study the influence of different crop establishment methods and nutrient management on water productivity and profitability of rice in Split Plot Design (Table 1), replicated three times.

Themaximum andminimumtemperaturesrecordedwere41.3°Cand15.8°Cduringthecropgrowthperiod. Relativehumidityranges between 44.1-95.2% during cropgrowthperiod. The area receives mean annual rainfall between 587.6-369.8 mm. The soil of the experimental field was sandy loam in texture, lowin availablenitrogen (180.4 kg ha^{-1}) andorganiccarbon (0.45%),mediuminavailable phosphorous (15.7 kg ha^{-1})andpotassium(280.0 kg ha^{-1})andslightlyalkaline (pH 7.8)inreaction with electrical conductivity of 0.25dSm^{-1}. The crop variety Pusa Basmati-1was sown on June20&23, 2022& 2023and harvested on 20&25October 2022 & 2023.The seed rate was 30 kg ha^{-1}. Therecommendeddoseofnitrogen(80 kgha^{-1})wasapplied intwoequalsplit,thehalf as basal and the remaining half was top dressed 2 times at the time of first and secondirrigation. The whole quantity of potassium (40 kg ha^{-1}) was applied as basal dose throughMurate of Potash at 8-10 cm depth along with half dose of nitrogen prior to sowing. Phosphorouswasappliedas basaldose(60kgha^{-1})throughDAP. Vermicompost (5 t ha^{-1})andBio-stumulant G (20 kg ha^{-1})wereappliedinthefieldaspertreatments andwas thoroughlymixedatthetimeofsowing. One thinning was done after 30 days of sowing to maintain a plant to plant distance of about 20 cm. Weeding and hoeing operation were performed manually after first and second irrigation at proper soil moisture condition of the soil. At the harvest, number of grains panicle^{-1}, 1000 grains weight, seed yield and straw yield were calculated. Economics of treatments were computed on the basis of prevailing market price of inputs and outputs under each treatment. The total cost of cultivation of crop was calculated on the basis of different operations performed and materials used for raising the crop including the cost of fertilizers and seeds. The cost of labour incurred in performing different operation was also included. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $P<0.05$ level of probability using t-test and calculating CD values.

Result and Discussion

Effect of different crop establishment methods and nutrient management on yield attributes of rice

Yield attributes *viz.*, Panicle length, Number of panicle, Number of grainspanicle^{-1}and weight of 1000 grains of rice were affected significantly by various treatments involving different establishment methods and nutrient management (Table 1 and Fig 1).

Table 1 Effect of different crop establishment methods and nutrient management on yield attributes characters of rice

Treatments		Yield attributes							
		Panicle length (cm)		No. of panicle		No. of grain per panicle		1000 grain weight (g)	
		2022	2023	2022	2023	2022	2023	2022	2023
(A) Crop establishment methods									
Puddled TransplantedRice	C_1	24.8	25.3	134.1	137.5	149.1	152.6	23.6	23.7

Un-puddledTransplantedRice	C_2	22.5	23.0	127.7	130.9	137.5	140.8	20.2	20.3
Raised-BedPlanting	C_3	22.9	23.4	130.5	133.7	139.9	143.3	22.1	22.2
SE(m)±		***0.15***	***0.16***	***0.53***	***0.54***	***0.76***	***0.78***	***0.25***	***0.25***
C.D.(P=0.05)		***0.52***	***0.55***	***1.83***	***1.87***	***2.61***	***2.69***	***0.86***	***0.87***
(B) Nutrient Management									
Control	N_1	21.3	21.7	112.2	115.1	138.4	141.8	20.1	20.2
100%NPK (150:75:60)	N_2	22.8	23.2	132.5	135.8	140.7	144.2	21.5	21.6
50%RDN+ FYM @15 ton ha^{-1}	N^3	23.6	24.1	131.8	135.2	143.2	146.6	22.7	22.5
50%RDN+vermicompost@ 5 $tonha^{-1}$	N_4	23.8	24.3	134.9	138.3	143.6	147.1	22.5	22.8
50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}	N_5	24.3	24.9	135.7	139.1	144.1	147.5	23.2	23.4
50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20$Kgha^{-1}$	N_6	25.3	25.8	137.4	140.8	144.9	148.5	23.5	23.6
SE(m)±		***0.44***	***0.46***	***1.47***	***1.51***	***1.38***	***1.41***	***0.47***	***0.48***
C.D. (P=0.05)		***1.27***	***1.31***	***4.22***	***4.32***	***3.94***	***4.03***	***1.36***	***1.38***

From the given data (Table 1) it can be inferred that crop establishment methods the maximum panicle length(24.8 &25.3 cm) were produced in the treatment C_1(Puddled TransplantedRice) followed byC_3(Raised-BedPlanting). Among the nutrient management treatment the maximum panicle length (25.3 & 25.8) recorded in N6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20$kgha^{-1}$), which was at par with N5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}). However, the lowest paniclelength(22.5, 23.0&21.3, 21.7) was recorded in treatment C2 (Un-puddledTransplantedRice) N_1 (Control), which was significantly lower than rest of the other treatments. The results were in accordance with those reported by**Kumar and Chandra, (2013), Naresh *et al.* (2014**) **and Chandankute*et al.* (2015).**

Significantly higher number of panicle (134.1&137.5) was recorded under crop establishment methods in treatment C_1(Puddled TransplantedRice) followed by C_3 (Raised-BedPlanting).Treatment C_2(Un-puddledTransplantedRice) recorded the lowest number of panicle(127.7&130.9). Among the nutrient management treatment, the maximum number of panicle (137.4 & 140.8) recorded in N_6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 $Kgha^{-1}$), which was at par with N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}) and N_4 (50%RDN+vermicompost@ 5 $tonha^{-1}$). It might be due to increased and prolonged availability of nutrients from integrated use of vermicompostand Bio-stumulant G, which ultimately resulted in rapid cell multiplication and cell elongation under sufficient nutrient supply. The results were in accordance with those reported by **Jnanesha and Kumar, (2017), Pandey *et al*. (2018) andYogeswari and Porpavai (2018).**

It is evident from the data that under crop establishment methods the significantly higher number of number of grains panicle^{-1} (149.1&152.6) were produced in treatment C_1 (Puddled TransplantedRice) followed byC_3 (Raised-BedPlanting). Treatment C_2recorded lowest number of grains panicle^{-1}(137.5&140.8). Among the nutrient management treatment, the maximum number of grains panicle^{-1} (144.9 & 148.5) recorded in N_6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 Kgha^{-1}), which was at par with N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}), N_4 (50%RDN+vermicompost@ 5 tonha^{-1}) and N_3 (50%RDN+ FYM @15 ton ha^{-1}) during 2022 and 2023. Adequate nutrients availability to the crop as a result of increment in photosynthesis as well as growth led to increase in the number of grains panicle^{-1}. These findings were almost similar to the results reported by **Sah *et al*. (2019)and Kumar *et al*. (2019).**

Crop establishment methods, the maximum 1000- grain weight (23.6&23.7 g) was recorded in C_1(Puddled TransplantedRice) followed by C_3 (Raised-BedPlanting), whereas the lowest 1000- grain weight (20.2&20.3 g) was recorded in C_2 (Un-puddledTransplantedRice).Among the nutrient management treatment, the maximum 1000-grain weight (23.5 & 23.6) recorded in N_6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 Kgha^{-1}), which was at par with N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}), N_4 (50%RDN+vermicompost@ 5 tonha^{-1}) and N_3 (50%RDN+ FYM @15 ton ha^{-1}) during 2022 and 2023. The nutrient management application of vermicompost,FYM and Bio-stumulant G might increase availability of plant nutrients which result into better nourishment of plants and the formation of bold seeds, ultimately increased weight of grain. The results were similar to the findings reported by**Khan *et al*. (2009) and Mouriya*et al*. (2013).**

Effect of different crop establishment methods and nutrient managementon Productivity

Data with regard to the effect of crop establishment methods and nutrient management on grain yield, straw yield, biological yield and harvest index of rice crop are mentioned in Table 2 and depicted in Fig 2.

Table 2Effect of different crop establishment methods and nutrient management on yield and harvest index of rice

Treatments		Yield (q ha^{-1})`						Harvest index (%)	
		Grain		Straw		Biological			
		2022	2023	2022	2023	2022	2023	2022	2023
(A) Crop establishment methods									
Puddled TransplantedRice	C_1	44.19	46.01	67.31	70.13	111.50	116.14	39.63	39.28
Un-puddledTransplantedRice	C_2	38.46	40.04	60.58	63.12	99.04	103.16	39.30	38.60
Raised-BedPlanting	C_3	42.07	43.79	65.04	67.77	107.11	111.56	39.04	39.02
SE(m)±		***0.83***	***0.86***	***0.93***	***0.97***	***1.15***	***1.20***	***0.57***	***0.56***
C.D.(P=0.05)		***2.87***	***2.98***	***3.23***	***3.35***	***3.98***	***4.15***	***NS***	***NS***
(B) Nutrient Management									
Control	N_1	27.94	29.08	54.73	57.02	82.67	86.11	33.86	33.84
100%NPK (150:75:60)	N_2	42.56	44.30	64.25	66.95	106.82	111.26	39.83	39.81
50%RDN+ FYM @15 ton ha^{-1}	N^3	43.16	44.92	66.25	69.03	109.41	113.96	39.19	39.18
50%RDN+vermicompost@ 5 tonha^{-1}	N_4	45.16	47.02	68.58	71.46	113.75	118.48	39.68	39.66
50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}	N_5	47.26	49.20	69.26	72.17	116.53	121.37	40.59	40.57
50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20Kgha^{-1}	N_6	48.78	50.72	70.07	73.01	118.85	123.80	40.95	40.92
SE(m)±		***1.30***	***1.35***	***1.66***	***1.72***	***2.19***	***2.28***	***0.90***	***0.89***
C.D. (P=0.05)		***3.72***	***3.87***	***4.74***	***4.93***	***6.26***	***6.52***	***2.57***	***2.55***

Among the various crop establishment methods, the treatment C_1 (Puddled Transplanted Rice) exhibited significantly higher grain yield (44.19& 46.01 q ha^{-1}), which was statistically at par withC_3(Raised-Bed Planting).Treatment C_2(Un-puddledTransplantedRice) recorded lowest grain yield of 38.06&40.04 q ha^{-1}. About 14.8&14.9% increase in seed yield was recorded by C_1 (Puddled Transplanted Rice) over treatment C_2 (Un-puddled Transplanted Rice) during 2022&2023. Among the nutrient management treatment, the highest grains yield (48.78 & 50.72) recorded in N_6

(50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 Kgha^{-1}), which was at par with N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}) and N_4 (50%RDN+vermicompost@ 5 tonha^{-1}) during 2022 and 2023. The maximum grain yield was recorded due to integrated application of vermicompost, FYM and Bio-stumulant G. This might be due to slow release of nutrient from vermicompost and FYM leading to reduced loss of nitrogen and efficient use of Macro and micronutrients. The production of growth promoting and antifungal substances by Bio-stumulant G and nitrogen fixation was possibly the reason for higher yields.

In the same way, straw yield of rice (Table 2) was significantly influenced by different crop establishment methods and nutrient management treatments. Results revealed that the differences in straw yield were found significant due to different treatments. Under crop establishment methods significantly higher straw yield 67.31&70.13q ha^{-1} was recorded under C_1 (Puddled TransplantedRice), it was statistically at par with C_3. The lowest straw yield (60.58&63.12 q ha^{-1}) was recorded in C_2 (Un-puddledTransplantedRice). Among the nutrient management treatment, the highest straw yield (70.07 & 73.01) recorded in N_6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 Kgha^{-1}), which was at par with N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}), N_4 (50%RDN+vermicompost@ 5 tonha^{-1}) and N_3 (50%RDN+ FYM @15 ton ha^{-1}) during 2022 and 2023. The lowest straw yield recorded in N_1 (Control) treatment. Similar trend was observed in Biological yield, under crop establishment methods, the maximum harvest index (39.63&39.28%) was recorded in C_1. The lowest harvest index recorded with C_3 (Un-puddledTransplantedRice) plot. Among the nutrient management treatment, the highest harvest index (40.95 & 40.92) recorded in N_6 (50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 Kgha^{-1}) followed by N_5 (50%RDN+ FYM @15 ton ha^{-1} + Bio-stumulant G @ 20Kg ha^{-1}), N_4 (50%RDN+vermicompost@ 5 tonha^{-1}) and N_3 (50%RDN+ FYM @15 ton ha^{-1}) during 2022 and 2023. The increase in straw yield was mainly due to increased growth attributing characters like plant height and grains panicle^{-1}. The use of organic manure like vermicompost, FYM and Bio-stumulant G in conjunction with macro and micronutrients had profound effect on vegetative growth due to improved nutrients availability in the soil for longer time with progressive decompositions of FYM. These findings are in conformity with the results of **Chandankute*et al.* (2015), Rahman *et al.* (2019) and Bhandari *et al.* (2020).**

Conclusion

All the growth, yield attributes and yield of rice improved with the application of crop establishment methods and nutrient management achieved maximum value with Puddled TransplantedRice and 50%RDN+vermicompost@5ton ha^{-1}+ Bio-stumulant G@20 $Kgha^{-1}$. Application of micronutrients not only improves the content of N in grain and straw but also improve the content of P and K. A common fertilizer dose of NPK with micronutrients able to maintain the soil fertility while improving the micronutrients availability in soil.

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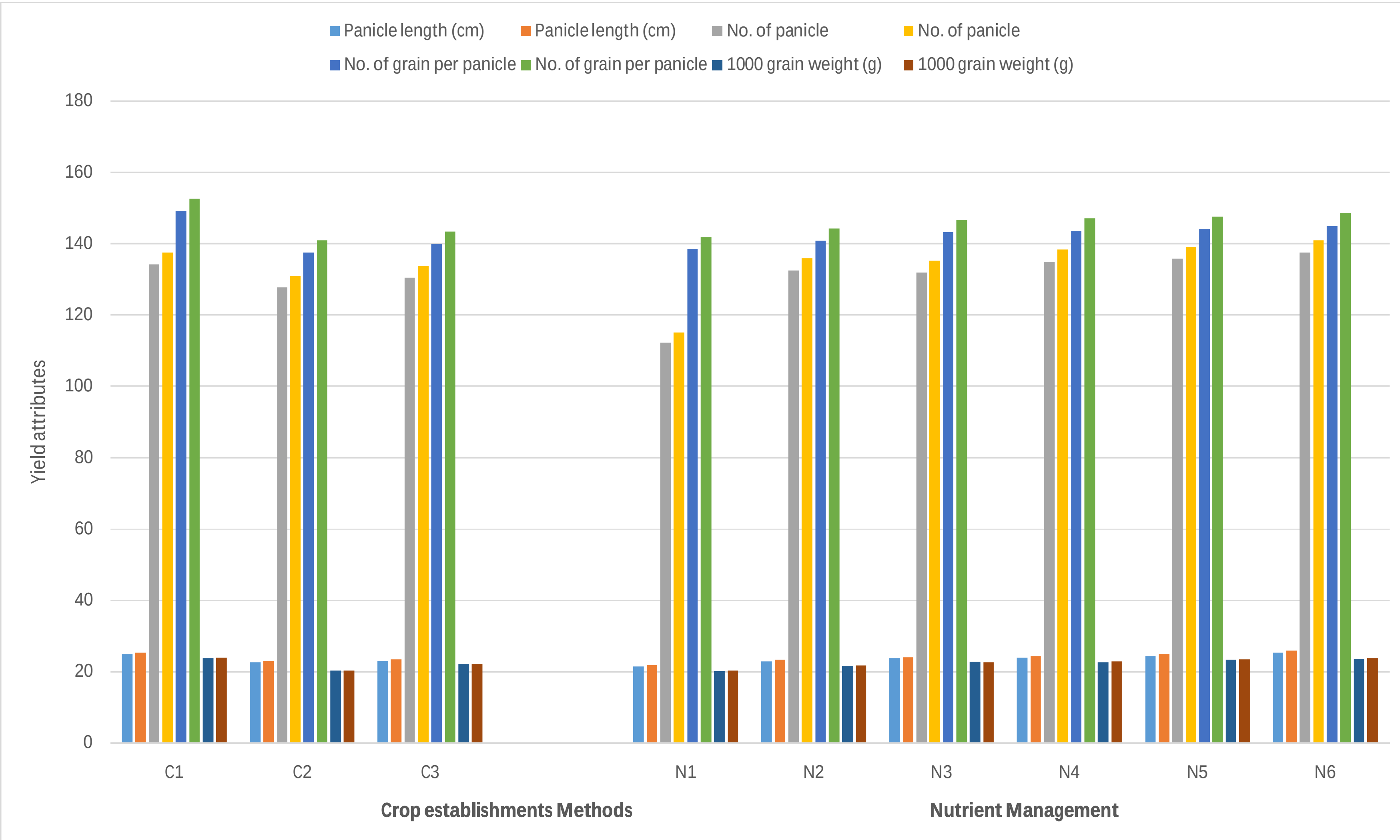

Figure 1:Effect of different crop establishment methods and nutrient management on yield attributes of rice

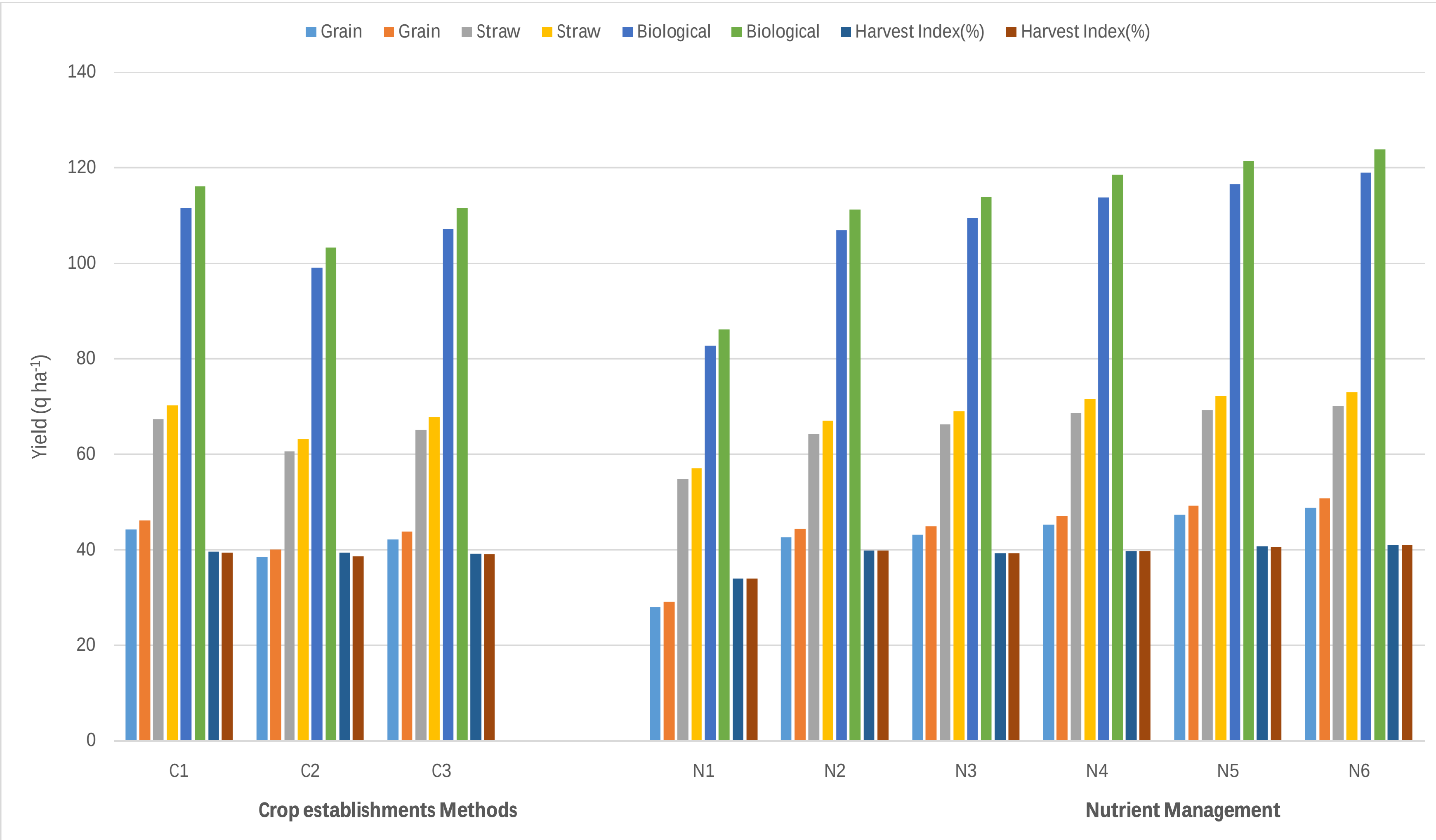

Figure 2:Effect of different crop establishment methods and nutrient management on yield and harvest index of rice

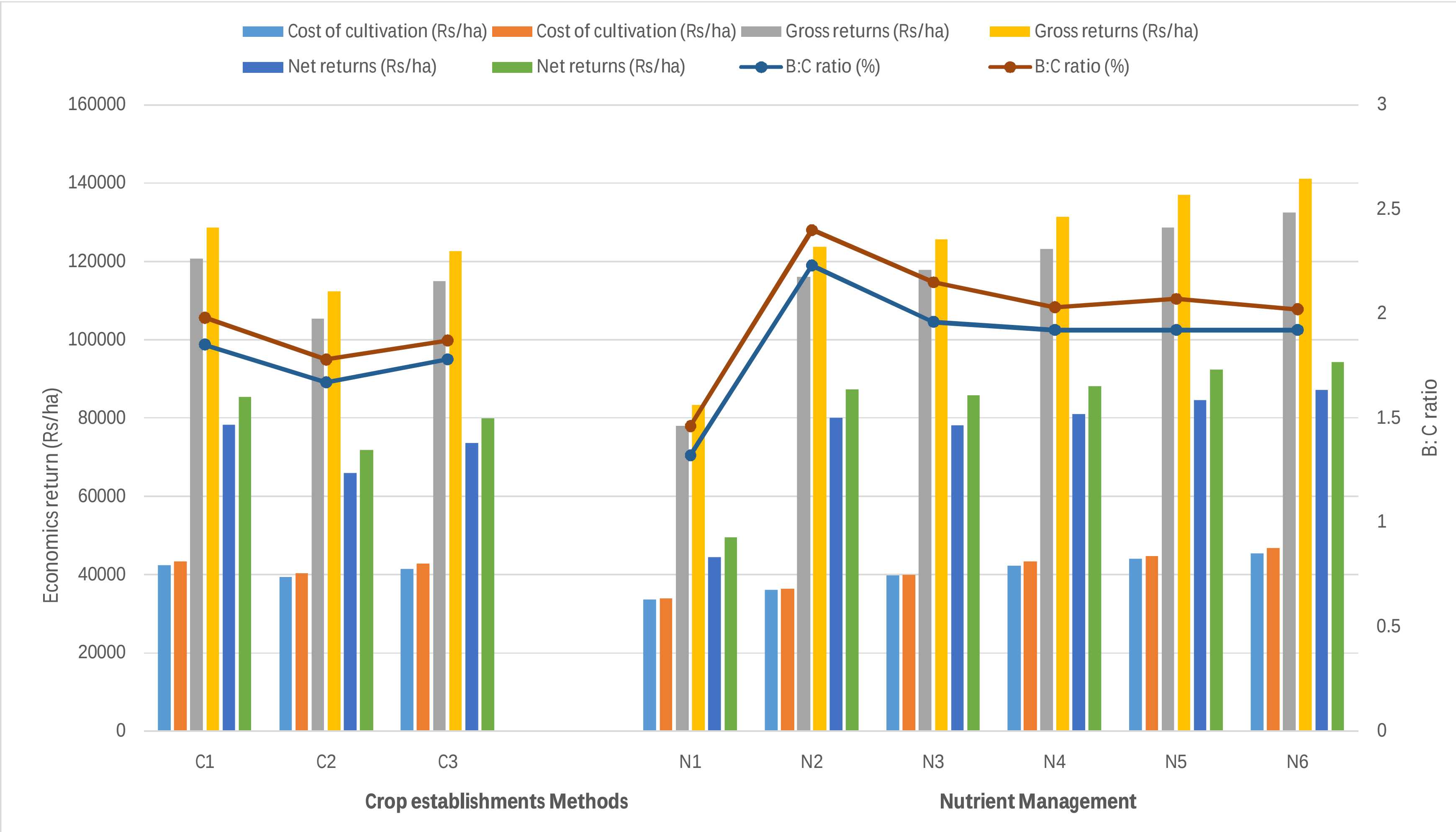

Figure 3:Economics of rice as effect of different crop establishment and nutrient management

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