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Effect of Planting Techniques, with Organic Manure and Inorganic Fertilizers on Productivity, Soil Organic Pools and Profitability in Rice (*Oryza Sativa* L.) in Inceptisol

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Abstract

Appropriate fertilizer application is an important management practice to improve soil fertility and quality in the inceptisol soil regions of western Uttar Pradesh. Exploiting the production potential of high yielding rice varieties through agronomic management is one of the alternatives to feed the ever growing population. For this, fertilizers from different sources and modern planting techniques have contributed substantially to the spectacular increase in rice yield and to improve soil properties. In order to study the effect of planting techniques and integrated nutrient management in rice. A field experiments was conducted at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (Utter Pradesh) during Kharif *2018. The experiment was laid out in split plot design with three replications. The treatment consisted of three planting techniques P_1- reduced tillage transplanted rice (RT- TPR), P_2- furrow irrigated raised bed (FIRB), and P_3- conventional till puddled transplanted rice (CT- TPR) and five fertility levels (F_1- control, (no fertilizer), F_2- RDF (150-60-40 kg NPK/ha), F_3- 125%RDF, F_4-150% RDF and F_5- RDF + 25 kg $ZnSO_4$ in this way there were 15 treatment combinations. The values of growth contributing characters viz. plant height (cm), number of tillers m^{-2}, dry matter accumulation (g m^{-2}), and yield attributes like number of panicles m^{-2}, length of panicle (cm), number of panicle^{-1}, grain weight panicle^{-1}, test weight (g), grain and straw yield (q ha^{-1}) of rice were increasing significantly with conventional puddled transplanted method (P_1) followed by FIRB transplanted method (P_2) and significantly superior over rest of the treatments. In case of fertility levels, the growth characters like plant height (cm), number of tillers m^{-2}, dry matter accumulation (g), yield attributes number of panicle m^{-2}, length of panicle, grain weight panicle^{-1}, test weight (g), grain and straw yield (q ha^{-1}) of rice were maximum under F_3 (125%RDF) which was at par with F_4 (150% RDF) during course of investigation. Higher nutrient uptake (NPK) by grain and straw as well as total uptake were recorded under RT-TPR followed by FIRB-TPR and CT-TPR. Similarly, higher nutrient uptake by grain and straw was recorded with 125% RDF. The maximum gross return and net return were noted under P_2 (furrow irrigated raised beds transplanted rice) with F_3 (125%RDF) [P_2F_3], application. The highest benefit cost ratio were recorded with FIRB-TPR method with (125% RDF) treatment (P_2F_3) followed by CT-TPR with (150% RDF) (P_3F_4) they proved more remunerative then other treatment combinations. CT-TPR used higher amount of water than FIRB-TPR, with water saving of 14.5% in FIRB-TPR. Significantly higher water productivity was recorded in FIRB-TPR as compared to CT-TPR.*

Keywords: Organic and inorganic fertilizers, Soil fertility, Productivity, Profitability

Introduction

Rice is one of the most important cereal crops of kharif season. Rice is cultivated world-wide over an area of about 161.5 million ha^{-1} with an annual production of about 751.9 million tonnes (FAO, 2017). In India rice is cultivated over an area of about 43.38 million hectares with an annual production of about 104.32 million tonnes and the productivity of 2.40 tonnes ha^{-1} (Anonymous, 2016). In India, it accounts

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for more than 40% of food grain production, providing direct employment to 70% people in rural areas. Utter Pradesh is an important rice growing state in the country. The area and production of rice in this state is about 15.98 million hectares and 14.64 million tonnes respectively with an average production of 2.45 tonnes (FAS 2014-15). Production of rice rank second among the food grain and half of the world population receiving the highest (26.2%) calories intake from it in the developing countries of their dietary protein (FAO, 2009). Rice is an excellent source of carbohydrate and to a certain extent it provides protein to regular human diet. So it is used as staple food crop by about half of the world population and eaten as cooked rice and also used for various preparations inhabiting in the humid tropics and subtropics. Further, rice has commercial and industrial importance also beside grains. Rice straw and rice hulls are used as fodder, mulching, packing and as insulation material etc. Hence, the importance of rice crop in the country can't be negated.

Aerobic rice increases the productivity per unit area with proactive interactions between the plant, soil, water and nutrient. Building up of soil organic matter and acceleration of microbial activity to increase the nutrient availability and uptake are the strategy of research. Hence supply, availability and uptake of nutrients, changes in the soil profile and the changes occurring in the soil and crop scenario in aerobic rice under organic manure and inorganic fertilizer applications have been studied. For maintenance of soil fertility and productivity, nourishing the soil by addition of organic manures apart from nutrient supply through fertilizers in right amount and proper balance is necessary to get higher production on sustainable basis (Inderjeet et al., 2014). Tripathi et al. (2013) reported that response of rice to nutrient supply by organic and inorganic fertilizer is universal but may vary with locations, soil and fertilizer types. Organic supply of nutrients at the peak period of absorption also provide micro nutrients and modify soil-physical behaviour as well as increase the efficiency of applied nutrients (Pandey et al., 2007). The combined use of organic and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also has been fund to sustain large scale productivity goals (Yadav and Meena 2014). Crop fertilization refers to fertilizer application according to the crop demands, while soil fertilization is targeted to replenish its fertility level.

It is estimated that the NPK removal by crops in India was about 28 million tons against the fertilizer consumption of 18 million tonnes creating a gap of 10 million tonnes in 2000 (Tiwari, 2002). The higher the grain yield targeted, the greater the amount of nutrient required for rice plant. It is reported that the nutrient use efficiency of N, P and K is 30-50, 15- 20 and 60-70 per cent, respectively (Pathak, et al., 2002). Further the NPK ratio of 4:2:1 considered optimum but in reality a wide ratio of 10:2.9:1 is prevalent in the country (Tandon, 2001). Using organic sources such as FYM, vermin-compost, and green manuring deserves priority for sustained production and better resource utilization in integrated nutrient management. INM technology is sustainable as compared to modern chemical farming as the farmer relies more on organic sources (Singh et al., 2001). Addition of organic manure improves overall physical condition of the soil which is very essential under aerobic condition. Animal manures are valuable sources of nutrients and yield-increasing effect of manure is well established (Wakene et al., 2005). Organic matter in the soil improves soil physical conditions by improving soil structure, increases water holding capacity, and improves soil structure and aeration, as well as regulating the soil temperature.

Soil tillage is among the important factors affecting soil properties and crop yield. Among the crop production factors, tillage contributes up to 20% (Khurshid et al., 2006) and affects the sustainable use of soil resources through its influence on soil properties (Lal and Stewart, 2013).The judicious use of tillage practices overcomes edaphic constraints, whereas inopportune tillage may cause a variety of undesirable outcomes, for example, soil structure destruction, accelerated erosion, loss of organic matter and fertility, and disruption in cycles of water, organic carbon, and plant nutrient (Lal, 1993). Reducing tillage positively influences several aspects of the soil whereas excessive and unnecessary tillage operations give rise to opposite phenomena that are harmful to soil. Therefore, currently there is a significant interest and emphasis on the shift from extreme tillage to conservation and no-tillage methods for the purpose of controlling erosion process (Iqbal et al., 2005). Conventional tillage practices cause change in soil structure by modifying soil bulk density and soil moisture content. In addition, repeated disturbance by conventional tillage gives birth to a finer and loosesetting soil structure while conservation and no-tillage methods leave the soil intact (Rashidi and Keshavarzpour, 2007). This difference results in a change of characteristics of the pores network. The number, size, and distribution of pores again control the ability of soil to store and diffuse air, water, and agricultural chemicals and, thus, in turn, regulate erosion, runoff, and crop performance (Khan et al., 2001). Losses of soil organic C (SOC) and deterioration in other properties exaggerated where conventional tillage was employed (Powlson et al., 2012). With time, conservation tillage, on the other hand, improves soil quality indicators (Plaza et al., 2013) including SOC storage (Sharma et al., 2013). So, the present investigation "Effect of planting techniques, with organic manure and inorganic fertilizers on productivity, soil organic pools and profitability in rice in Inceptisol" was undertaken to meet the urgent need of the farmers of western Uttar Pradesh.

Materials and Methods

The experiment was laid out during Kharif 2018 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (290 04', N latitude and770 42' „E longitude a height of 237 m above mean sea level), Uttar Pradesh Province, India. The region has a semi-arid sub-tropical climate with an average annual temperature of 16.8 0C. The highest mean monthly temperature (38.9 ^{0}C) is recorded in May, and the lowest mean monthly temperature (4.5^{0}C) is recorded in January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which about 80% is received during the monsoon period. The predominant soil at the experimental site is classified as Typic Ustochcrept. Soil samples for 0–15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction. A detail was reported in Table 1. The experimental was laid out in Split plot design (SPD) where 30 treatments were replicated three times. In all, there were 30 treatments included in the experiment in main plot and sub plot. The detail of treatments with their symbols three planting techniques [(P_1- reduced till transplanted rice (RT-TPR)], P_2- furrow irrigated raised beds transplanted rice (FIRB-TPR) and P_3- conventional puddled transplanting (CT-TPR) and five fertility levels practices [(F_1- control, (no fertilizer), F_2- RDF (150-60-40 kg NPK/ha), F_3- 125%RDF, F_4-150% RDF, and F_5- RDF25 kg $ZnSO_4$]. A common procedure was followed in raising seedlings in the seedbed. The

Table 1: Physico-chemical properties of the experimental field Soil

Soil parameters/characteristics	Value obtained	Method adopted
A. physical properties		
Sand (%)	53.16	Hydrometer method (Piper, 1966)
Clay (%)	17.64	„
Silt (%)	27.93	„
Textural classes	Sandy loam	Triangular basis
B. Physical costants		
Field capacity (%)	27.03	Field method Dastane, 1967)
Permanant wilting point (%)	11.32	
Bulk density (mg/m^3)	1.51	Coe sampler method (Piper, 1966)
C. Chemical composition		
Available N (kg ha^{-1})	244.5	Alakaline potassium permanganate method (Subbiah and Asija, 1956)
Available P (kg ha^{-1})	12.3	Olsen's method (Jackson, 1973)
Available K (kg ha^{-1})	201.8	1N NH4OAC extraction method (Jackson, 1973)
Organic carbon (%)	0.51	Walkley and Black wet oxidation (Jackson, 1973)
pH (soil:Water (1:2.5)	7.6	Electrode pH meter suspension method (Page et al., 1982)
Electrical conductivity (dSm^{-1})	0.22	Conductivity meter suspension method (Page et al., 1982)

seedbed was prepared by puddling with repeated ploughing followed by laddering. Weeds were removed and irrigation was gently provided to the bed as and when necessary.

In conventional-till puddle transplanted rice (CT-TPR) land was ploughed, puddle and levelled and 21-day-old seedlings were manually transplanted at a hill spacing of 20x10 cm with two seedling hill-1 and for reduced till (un-puddle) transplanted rice (RT- TPR) 1-2– dry tillage followed by planking/ levelling and pounding water but without puddling; 21-dayold seedlings were transplanted in rows. Transplanted rice on furrow irrigated raised beds (FIRB-TPR) a bed former-cum-zero-till drill is used to form 107 cm wide raised bed and 30 cm wide furrows in well prepared pulverized soil; 21-day old seedlings were transplanted in six rows at 20-cm spacing on the top of the raised beds. Plant-to-plant spacing was 10 cm to maintain the population equal to that of the conventional transplanted method. The specific quantity of each fertilizer was calculated on the basis of gross plot size and as per treatment taken per plot. The optimum dose of fertilizers was recorded for rice. The half quantity of nitrogen and full quantity of phosphorus and potassium were broadcasted in each plot during final field preparation as per layout drawn after the transplanting and sowing the fertilizer thoroughly in the field. The rest half dose of nitrogen was top dressed in two splits after first irrigation and second 45 DAT. For absolute controls, nothing was applied for entire crop season. The field observations on plant growth and development parameters, growth induces, and grain and biological yield were assess using standard procedures (Rana et al., 2014).

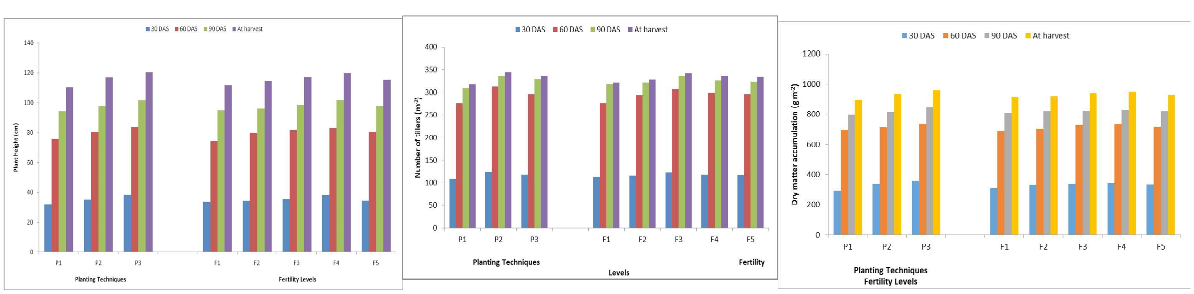
The crop was harvested manually by serrated edged sickles at physiological maturity when panicle had about 85% ripened spikelet and upper portion of spikelet look straw coloured. At the time of harvesting the grains were subjected to hard enough, having less than 16 per cent moisture in the grains. First of all, the border area was harvested. The harvesting of net plot area was done separately and the harvested material from each net plot was carefully bundled and tagged after drying for three days in the field and then brought to the threshing floor. The bundle of harvested produce of each net plot was weighed after sun drying for recording biological yield. Threshing of each bundle of individual plot was done manually by wooden sticks. The grain yield of individual plot after winnowing was weighed. The quantity of straw per plot was calculated by subtracting the weight of grains from biological produce. Yield of both grain and straw was expressed in q ha^{-1}.

Results and Discussion

Growth characters

Plant height

Plant height was significantly influenced by various planting techniques at all the stages of crop growth (Fig. 1a). Maximum plant height was recorded with the furrow irrigated raised beds transplanted rice (P_2) [FIRB-TPR] which was statistically at par with the conventional puddled transplanting method (CT-TPR) and significantly superior to rest of the treatments at all the stages of crop growth. Wider spacing particularly under in FIRB-TPR method recorded significantly taller plant than the closer spacing, due to the fact that under wider spacing, the plant gets sufficient space above the ground (shoot) and below the ground (root) to grow as well as the increased light transmission in the canopy, leading to greater plant height. At harvest, the tallest plants were recorded in FIRB-TPR. It might be due to more space, sunlight and nutrients available to wider spaced plants of WB-TPR than close spaced plants which facilitated the



(a) (b) (c)

Fig.1: Effect of different planting techniques and fertility level on (a) plant height (cm), (b) number of tillers (m^{-2}) and (c) dry matter accumulation (g m^{-2}) of rice

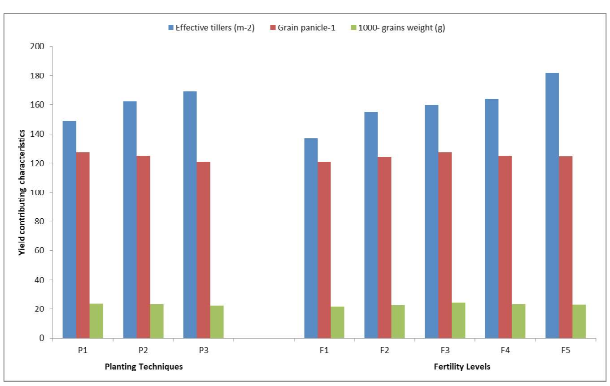
plants to attain more height. Shrirame et al. (2000) reported that the number of functional leaves and leaf area were higher under wider spacing, which increased the photosynthetic rate leading to taller plant.

Plant height influenced by integrated nutrient management was significant at 30 days of DAT of the crop (Fig. 1a). Significantly higher plant height was recorded where application of 150% RDF (F_4) through inorganic fertilizer was given and it remained at par with 125% RDF (F_3) plots. Plant height increased mainly due to adequate nutrient supply to the plant which resulted into rapid growth by good establishment of root and various metabolic processes and ultimately performed better mobilization of synthesized carbohydrates in to amino acid and protein which stimulated the rapid cell division and cell elongation. Finally, it resulted in to growth of plant faster as compare to other treatments tested during in course of investigation. The lowest plant height was recorded under control (no fertilizer) (F_1) at all growth stags. It might be due to poor availability of nutrient which caused poor growth and poor nutrient mobilization. Similar findings were recorded by Bhuyan et al. (2012) and Kumhar et al. (2016).

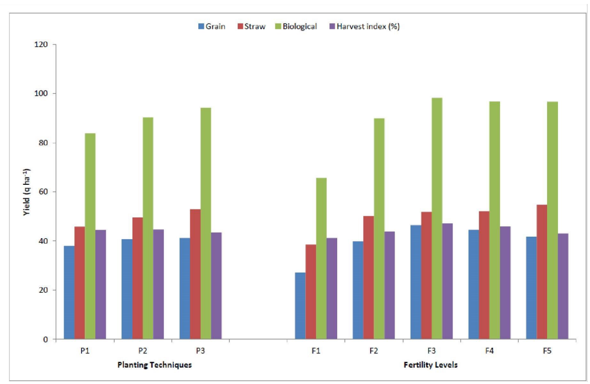
Number of tillers (m^{-2}) and Dry matter accumulation (g m^{-2})

The number of tillers was significantly affected by various planting techniques at different stages of crop growth (Fig. 1b). The highest numbers of tillers m^{-2} were recorded in FIRB-TPR (P_2) which was at par with conventional puddled transplanting method (CT-TPR) (P_3) at 30 days of transplanting. Significantly higher number of tillers was counted under FIRB-TPR technique as compared to rest of the treatments at 60, 90 and harvest stages except CT-TPR plots. The higher number of tillers $hill^{-1}$ might be due to better water management (Uphoff, 2003). Alternate wetting and drying maintaining a thin film of water that might open the soil for both oxygen and nitrogen and promoted the root growth during initial growth stages which ultimately increased tiller density (Thakur et al., 2010). Dry matter accumulation indicates towards the photosynthetic left behind after respiration. So it is the best indicator of growth of a crop. Among different tillage crop establishment methods CT-TPR [conventional till with puddled transplanted rice, (P_3)] accumulated more dry matter which was statistically at par with rice transplanted under furrow irrigated raised beds FIRB-TPR (P_2). However, the differences among P_2 and P_3 treatments were non-significant (Fig. 1c). Integrated nutrient management affected significantly higher number of tiller m^{-2} (Fig 1b). The significantly higher number of tiller m^{-2} was recorded with 150% RDF (F_4) through inorganic and organic fertilizer which at par with 125% RDF(F_3) as compared to rest of the treatment. It might be attributed to adequate nutrient availability which provided favourable condition for better synthesis of growth favouring constituents in plant system. The lower number of tillers was recorded under control (no fertilizer) (F_1) at all growth stages mainly due to inadequate nutrient supply system. The results of the present investigation are in close conformity with the findings of Ramesh et al. (2009), and Vivek et al. (2019).

Integrated nutrient management affected significantly the dry matter accumulation (gm^{-2}) at all



(a)



(b)

Fig.2: Effect of different planting techniques and fertility levels on (a) yield contributing characteristics and (b) grain yield (q ha^{-1}), Straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) of rice

growth stages 30, 60, 90 and harvest stages, as well. Higher dry matter accumulation was recorded fewer than 150% RDF (F_4) through inorganic and organic fertilizer which was at par with 125% RDF (F_3) and RDF+ 25 kg $ZnSO_4$ (F_5) Treatments. In the present study the fact was further elucidated as more dry matter accumulation were recorded in all those treatments where nitrogen supply was more. This low growth in these treatments may be due to low availability of plant nutrient which are necessary for the normal growth. Nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue build up for proper growth. Lower dry matter accumulation was recorded under treatment F_1 control (no fertilizer) at all growth stages mainly due to in adequate nutrient supply resulting in reduction in plant height, number of leaves, number of shoots/hill and nutrient absorption from the soil. Finally, it led to decline in photosynthesis activity which ultimately recorded lowest dry matter accumulation (Kumar et al., 2013).

Yield attributing characters

The data pertaining to yield attributes as influenced by nutrient management practices is depicted in Figure 2a. All the yield attributes viz., number of effective tillers m^{-2}, number of grain panicle^{-1} and test weight are the resultant of vegetative development of the crop which determine yield were influenced by fertilizers and inoculants.

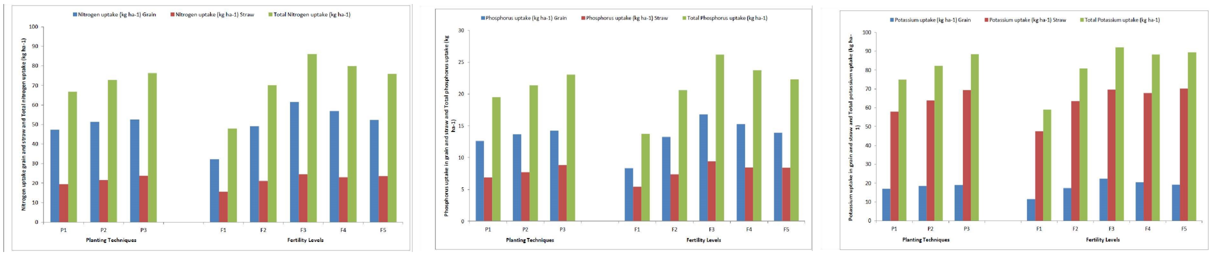
The maximum effective tillers m^{-2} was recorded with 100% RDF+ 25 kg $ZnSO_4$ ha^{-1} (F_5) treatment which was at par to 125% RDF (F_3) and 150%RDF (F_4) treatments which was significantly superior over other treatments. The maximum number of grain panicle^{-1} was observed and obtained with integrated 125% RDF treatment which was at par to 150% RDF treatment which was significantly superior to rest of the treatments. The effect of various treatments did not influence on test weight significantly. The increase in yield attributes was mainly due to increase in photosynthesis activity of leaves, translocation of photosynthesis from source to sink and nutrients uptake under higher nutrients availability. The minimum values of the entire yield attributes were observed in the treatment received no fertilizer "control" because plants did not get sufficient amount of nutrients which resulted in poor yield attributes. This was also evidenced by studies of Singh and Singh (2008), Kumar et al., (2010) and Sridevi (2011). Number of spikelet's panicle^{-1} is one of the most yield attribute. Similarly, the grain is fertilized; fully ripened ovule of spikelet in a panicle that ultimately contributes to grain yield. This excludes sterile spikelet's panicle^{-1}. The weight of individual grain calculated from 1000 grain weight (test weight) is an important yield attribute which provides information regarding the efficiency with grain filling process took place. Thousand grain weight (1000 grain weight), as it is called the test weight of the desired output, is referred to be considered as one of the most significant agronomic parameters ever trusted that contributes in having a reconnaissance over the possible production of a lot (grain yield).

Figure 2a advocated that the maximum yield attributes were recorded significantly superior in P_3 treatment as compared to all other treatments except P_2. Treatments P_1 and P_2 were at par with each other; however, P_1 treatment which recorded minimum yield attributes. Similar results were also noticed by Chopra and Chopra (2004).

Yield parameters

Yield is the resultant of coordinated interplay of growth characters and yield attributes. Grain and straw yield were influenced significantly by applying fertilizers and inoculants are depicted in Fig. 2b.

The maximum grain yield, straw yield and higher harvest index was recorded in treatment F_3 received 125% recommended NPK through fertilizers which was statistically at par to the treatment F_4 and was significantly superior over rest of the treatments. This might be due to adequate nutrient availability, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigour of the vegetative growth and yield attributes which resulted in higher grain and straw yield. The increase in yield was further attributed to better translocation of photosynthetic from source to sink due to higher uptake of NPK which are responsible for quick and easy translocation of photosynthetic. The better vegetative growth coupled with high yield attributes resulted in higher grain and straw of rice Sengar et al. (2000). Lowest grain and yield were recorded under control plots (no fertilizer). This was due to poor growth and metabolic process and lesser number of grain/panicle. The results are in accordance with Reddy et al. (2004). Figure 2b revealed that the grain and straw yield increased significantly with every successive increase in moisture supply by moisture retention and land configuration. Treatments P_2 and P_3 were at par with each other, however, they recorded significantly higher yield over rest of the treatments.



(a) (b) (c)

Fig. 3: Effect of different planting techniques and fertility levels on nitrogen uptake and total nitrogen uptake (a), phosphorus uptake and total phosphorus uptake (b) and (c) potassium uptake and total potassium uptake (kg ha^{-1}) of basmati rice

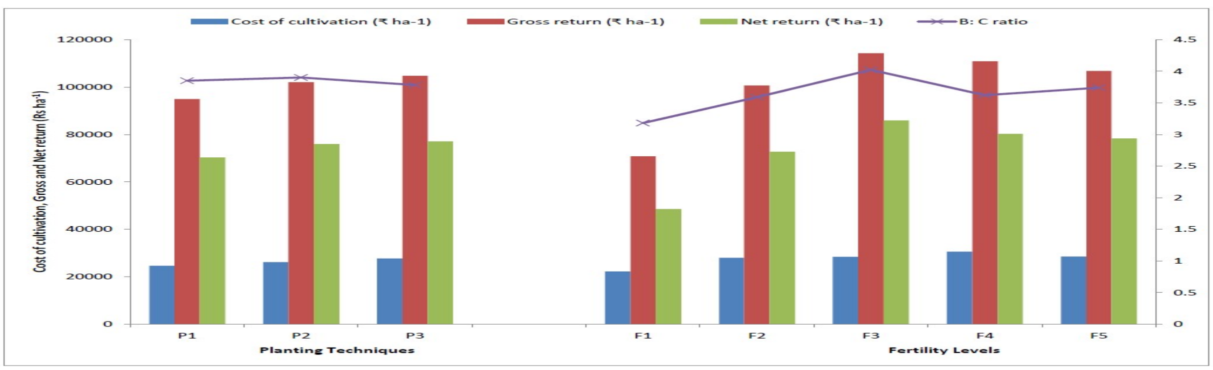


Fig. 4: Effect of planting techniques and fertility levels on economics of rice

Treatment P_1 (reduced till rice transplanted) recorded minimum yield. Similar results have been reported by Dhaka et al. (2007), Ingle (2007) and Ali et al. (2012).

Nutrient uptake

Nutrient uptake (N, P and K) by grain and straw as well as total uptake by the rice crop were recorded significantly higher with CT-TPR followed by FIRB-TPR and RT-TPR (Fig. 3a, 3b and 3c). Total uptake of N, P and K were recorded higher in CT-TPR as compared to FIRB-TPR and RT-TPR. Among the nutrient management practices, application of 125% RDF significantly improved NPK uptake by grain, straw and total uptake by rice crop as compared to other sources of nutrient management. This might be due to the initial quick availability of nutrient from inorganic source leading to an overall higher nutrient uptake (Das *et al*., 2010; Kumar et al., 2017).

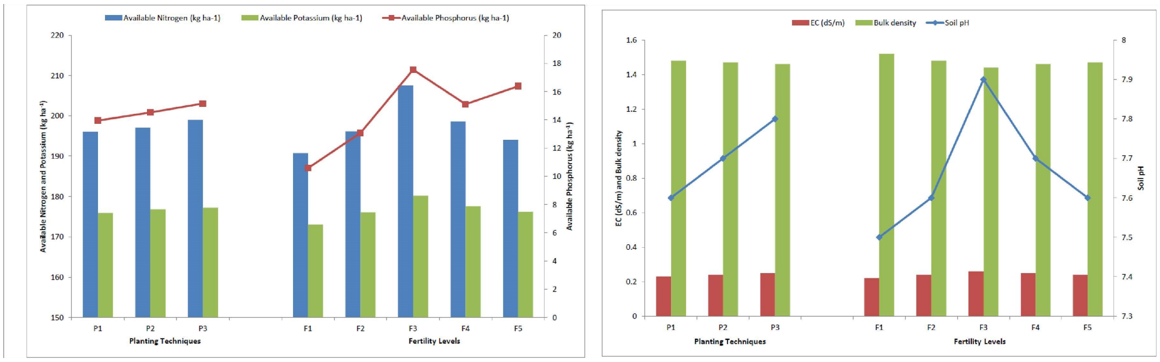
Economics

The data indicates the highest cost of cultivation (Rs. 38665) was observed in the treatment (P_3) conventional puddled transplanted rice followed by (P_2) transplanted rice on furrow irrigated raised beds. The lowest cost of cultivation (Rs.34619) observed in (P_1) transplanted rice after reduced tillage (Fig. 4). The highest net return (Rs.67665) was observed in the treatment (P_3) conventional puddled transplanted rice followed by (P_2) transplanted rice on furrow irrigated raised beds. The lowest net return (Rs.60291) was observed in (P_1) transplanted rice after reduced tillage. Similar results were also reported by Vivek et al. (2019), and Hossain (2014).

Higher crop productivity with lesser cost of cultivation could result in better economic parameters like net returns and B: C ratio. In the current study, application of 125% RDF (F_3) recorded the highest net return B: C ratio. The higher yield realized under the above treatment would be the reason for more economic return as against the cost of cultivation with higher net gain and benefit: cost ratio. The result was conformity with the findings of Rajkumar (2003), who also realized higher economic return due to integrated nutrient management practices.

Soil health

Different establishment methods did not show



(a) (b)

Fig. 5: Effect of different planting techniques and fertility levels on available NPK (kg ha-1) (a) and soil pH, EC and bulk density in soil (b) of basmati rice

any significant effect on soil fertility in terms of soil available N, K, BD and EC and P^H, whereas available P had significant effect which was recorded higher under RT-TPR followed by FIRB-TPR and CT-TPR (Fig. 5a). This might be due to created better physico-chemical conditions, which enhance the soil microbial activities and P availability. Among the nutrient management practices higher available N (207.56 kg/ha), available P (17.56 kg/ha) and available K (180.02 kg/ha) were recorded with 100 % RDF over control. Increase in available N and P might be due to the direct addition of N through improved microbial activities, which might have converted organically bound N to inorganic forms. Increase in P availability might be due to the fact that organic materials form a cover on sesquioxides and thus reduce the phosphate fixing capacity of the soil and increased phosphorus solubilization for the native soil pool. The benefit of using organic manure was due to release of aliphatic and aromatic hydroxy acids and humates leads to higher availability of nutrients. The results corroborate with the similar findings of (Das and Sinha. 2004; Thakur et al., 2011).

The maximum values of soil pH, EC and B.D were noticed in P_3 (CT- TPR), while lowest value were observed in P_1 (RT- TPR) treatment. Among the different fertility levels, the highest and lowest values of soil pH, EC and bulk density were associated with F_3 (125% RDF) and F_1 (Control) treatment, respectively. The effect of fertilizer application on bulk density was noticed at any stage since bulk density between planting techniques and fertility levels did varied significantly has been also reported by (Naresh et al., 2015; Dubey et al., 2015).

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