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**Original Research Article**

# Effect of Different Cropping Systems on Growth and Yield of Rice Crop (*Kharif* Season)

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sunlight, soil moisture, growing, crop protection, yield, market prices

**A B S T R A C T**

A field experiment entitled "Studies on diversification and intensification of traditional rice-wheat cropping system under irrigated condition" was studied in an ongoing trial of AICRP at Bihar Agricultural University (BAU), Sabour during 2017-18 and 2018-19. The experiment was laid out in Randomized Block Design with three replications. Total nine cropping sequences were taken to constitute treatments for different intensification of rice-based cropping system *viz.* Rice –wheat – fallow, rice – wheat (ZT) – mungbean (ZT), rice - maize + vegetable pea (ZT) – sorghum + cowpea (F), rice - potato + radish – mungbean (G+R), rice - cabbage + coriander leaf - sesamum, rice – fababean (ZT)- okra, rice - berseem - maize + cowpea (F), rice - mustard – mungbean (G+R) and rice –chickpea + linseed (ZT) – maize (green cob & F). Cultivation practices were followed as per recommendation of different crops. There was non-significant results found in case of growth and yield attributing characters of rice as *Kharif* season crop.

## Introduction

Conventional cropping system involves continuous growing of same kind of crops with the use of higher inputs like- synthetic fertilizers, chemicals for crop protection, more tillage etc. Absolutely it provides enough food for current population but at the cost of unsustainability and declining profitability (Saharawat *et al.*, 2012). However, crop diversification is basically, shift of a crop or cropping system to another crop or cropping system for the best possible utilization of resources by changing and modifying the trend, degree and time options of crop or cropping activities. It is a shift from less profitable crop or cropping system to more profitable and sustainable crop or cropping system. While, crop intensification is addition of one or more crop in our existing/traditional cropping system for better utilization of natural resources *viz*. sunlight, soil moisture, available nutrients in soil and available resources.

Crop diversification and intensification reduce risks associated with yield, market prices, degradation of natural resources and environment in one hand and help in attaining the national goals like self-reliance in critical crop products, earning foreign exchange and employment generation on the other one.

Rice-wheat cropping system (RWCS) is the world's largest agricultural production system of which 85% of the area falls in Indo-Gangetic Plains (Ladha *et al.,* 2003).In India, alone this system is being practiced in around 10.4 Mha area (Singh and Sharma, 2001). It covers large area from Punjab in the Northwest to West Bengal in East (Singh *et al*., 2005) contributing as much as 40% to the total rice and wheat production.

In Indian agriculture, rice based cropping system is predominant and very effective for achieving the objectives of food security through crop diversification and intensification. Crop diversification is an effective strategy for achieving the objectives of nutritional & food security, income growth, employment generation, best use of available, resources, sustainable agriculture and environmental improvement (Hedge *et al.,* 2003). Gangwar *et al.,* (2004) also reported an increment of system productivity from 9.1 to 21.5 t $ha^{-1}$ $year^{-1}$ in traditional RWCS through diversification with high-value crops. A need is felt to diversify and intensify it with remunerative and efficient crops viz. pulses, oilseeds and vegetable crops. Crop diversification and intensification with intervention of legumes, spices, vegetables, high-value crops, employment-generating crops and value-addition are becoming popular among the small holders to increase their profitability. But in this research I was tried to study the impact of cropping systems on growth and yields of rice crop.

## Materials and Methods

### Experimental site

A field experiment entitled "Studies on diversification and intensification of traditional rice-wheat cropping system under irrigated condition" was studied in an ongoing trial of AICRP at farm of BAU, Sabour during 2017-18 and 2018-19. BAU, The average annual rainfall of the locality is around 1250 mm of which 75-80 per cent is received during monsoon months (June to October). Soil of the experimental field was loam in texture, soil is slightly saline in reaction (pH 7.61), low organic carbon (0.45%), with low available N, medium $P_2O_5$ and $K_2O$ (237, 24.46 and 226.02 kg $ha^{-1}$, respectively).

The details of meteorological observations recorded for both the years as weekly temperature (maximum + minimum), relative humidity (maximum + minimum)and rainfall from 01 July, 2017 to 30 June, 2018 (52 weeks) and 01 July, 2018 to 29 June, 2019 (52 weeks) were collected from agro meteorological observatory, Bihar Agricultural College, Sabour, Bhagalpur and have been presented in Fig. 1.

### Experimental treatment

The experiment was laid out in Randomized Block Design with three replications. Total nine cropping sequences were taken to constitute treatments for different intensification of rice-based cropping system *viz.* Rice –wheat – fallow, rice – wheat (ZT) – mungbean (ZT), rice - maize + vegetable pea (ZT) – sorghum + cowpea (F), rice - potato + radish – mungbean (G+R), rice - cabbage + coriander leaf - sesamum, rice – fababean (ZT)- okra, rice - berseem - maize + cowpea (F), rice - mustard – mungbean (G+R) and rice –chickpea + linseed (ZT) – maize (green cob & F). With a view to avoid mixing of soil, individual plot was thoroughly prepared in each season. Cultivation practices were followed as per recommendation of different crops. All the parameters are examine for two consecutive days by standard scientific methods and the data collected were presented below.

## Results and Discussion

### Effect of different cropping systems on growth attributes of rice crop

It is obvious from the data presented below that the different rice based crop sequences does not influence significantly to the growth attributes (plant height, number of tillers, LAI, dry matter accumulation, CGR, RGR and NAR), yield attributes (number of effective tillers per meter$^2$, number of grains per panicle, 1000 grain weight, length of panicle and weight of grains per panicle) and yields (grain, straw and biological yield) of rice crop. Plant height increased as age of rice plant progressed up to maturity. However, significant difference among the different sequences was not seen (Table 1). Numerically higher plant height was recorded in treatment ($T_4$) rice - potato + radish – mungbean (G + R) i.e. 141.75 cm. This sequence recorded taller plants at all the stages during experimentation. Leaf area index (LAI) increased consecutively as the growth progressed up to 90 DAT and thereafter, it declined due to reduction in number of tillers and drying of leaves. Increment in LAI was more during 30 to 60 DAT compared to 60 to 90 DAT. Differences in LAI at different days' interval of rice were non-significant during both the years, however, leaf area index was noted maximum under treatment ($T_4$) rice - potato + radish – mungbean (G + R) that is 5.21. In this experiment inclusion of summer legume crops and incorporation of residues in soil improved the available nitrogen and organic carbon of soil to some extents that benefited the rice crop but not to the mark of significant. The reason behind the non-significant result might be due to same variety of rice in each system, same does of fertilizer application and initial stage of experiment. It is verified by the different scientist (Singh and Sharma, 2001 and Bastia *et al.,* 2008) that the inclusion of leguminous crop in system enhance the performance of rice crop but in this research it was not seen because legume require longer time to give significant result and I was studies in 3$^{rd}$ and 4$^{th}$ year of long term trial. So, it may possible to rice crop show significant result after some years of experiment.

As the growth of rice progressed dry matter was also increased progressively and the maximum value was observed at harvesting stage. Adoption of different cropping systems does not affect dry matter production significantly but the maximum dry matter accumulation at different growth stages was recorded in treatment ($T_7$) rice - berseem – maize + cowpea (F) and ($T_4$) rice - potato + radish – mungbean (G + R). This might be due to leguminous crop in systems that able to fix the atmospheric nitrogen into the soil and also improve the soil health (Bastia *et al.,* 2008 and Singh and Tuteja, 2000). The sum total of overall growth of plant like- increase in plant height, number of tillers m$^{-2}$ and LAI (might produce higher green area and resulted, higher photosynthetic efficiency) of plant in turn resulted a higher dry matter production. Number of tillers m$^{-2}$ increased up to 60 days of transplanting and declined thereafter. After 60 DAT, ageing and senescence of plant is responsible for drying and dying of tillers that ultimately decreases the tillers. The different cropping sequence failed to influence the no. of tillers m$^{-2}$during both the years. Among different sequences higher number of tillers were observed in treatment ($T_4$) rice - potato + radish – mungbean (G + R) (250). Beneficial effect of legumes in cropping system has been reported by Thakur *et al.,* 2009 as well as positive balance of phosphorous at even lower level of fertilizer application (Srivastava and Srivastava, 1993) which favoured better growth and development of plants.

**Table.1** Effect of cropping systems on growth and yield attributing characters of rice in *kharif* season (pooled over two years)

| Cropping systems | | | | Effect on rice crop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tr. No.** | ***Kharif*** | ***Rabi*** | ***Zaid*** | **Plant height (cm)** | **LAI** | **Dry Matter (g $m^{-2}$)** | **No of effective tillers ($m^{-2}$)** | **No. of grains $panicle^{-1}$** | **1000 grain weight (g)** | **Length of panicle (cm)** | **Weight of grains $panicle^{-1}$ (g)** | **Biological yield (t $ha^{-1}$)** | **Harvest Index** |
| $T_1$ | Rice | Wheat | - | 139.67 | 4.87 | 1512.04 | 230.21 | 159.17 | 20.70 | 26.83 | 3.25 | 15.12 | 0.41 |
| $T_2$ | Rice | Wheat (ZT) | Mungbean (ZT) | 140.16 | 4.99 | 1525.04 | 243.68 | 158.20 | 21.25 | 29.37 | 3.44 | 15.25 | 0.42 |
| $T_3$ | Rice | Maize + Veg. pea (ZT) | Sorghum+ Cowpea (F) | 139.10 | 4.98 | 1480.92 | 234.09 | 161.00 | 20.97 | 28.67 | 3.37 | 14.81 | 0.42 |
| $T_4$ | Rice | Potato + Radish | Mungbean (G + R) | 141.75 | 5.21 | 1554.52 | 250.03 | 162.17 | 21.57 | 30.25 | 3.50 | 15.55 | 0.40 |
| $T_5$ | Rice | Cabbage+ Coriander Leaf | Sesamum | 138.47 | 4.89 | 1546.28 | 232.56 | 157.67 | 20.87 | 27.82 | 3.29 | 15.46 | 0.42 |
| $T_6$ | Rice | Fababean (ZT) | Okra | 140.45 | 5.15 | 1550.20 | 249.37 | 159.37 | 21.30 | 29.77 | 3.38 | 15.50 | 0.40 |
| $T_7$ | Rice | Berseem | Maize + Cowpea(F) | 141.12 | 5.15 | 1565.52 | 249.04 | 161.00 | 21.63 | 30.00 | 3.42 | 15.65 | 0.40 |
| $T_8$ | Rice | Mustard | Mungbean (ZT) (G + R) | 137.31 | 4.85 | 1496.48 | 233.43 | 159.33 | 20.25 | 27.12 | 3.22 | 14.95 | 0.41 |
| $T_9$ | Rice | Chickpea+ Linseed (ZT) | Maize (Green Cob & F) | 139.10 | 4.93 | 1505.09 | 230.86 | 159.67 | 20.37 | 28.33 | 3.32 | 15.10 | 0.41 |
| | | **SEm±** | | 2.13 | 0.11 | 26.91 | 5.94 | 4.22 | 0.32 | 0.68 | 0.10 | 0.27 | 0.01 |
| | | **CD (P = 0.05)** | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Fig.1** Weekly weather condition prevailing at Research Form during both year of experimentation

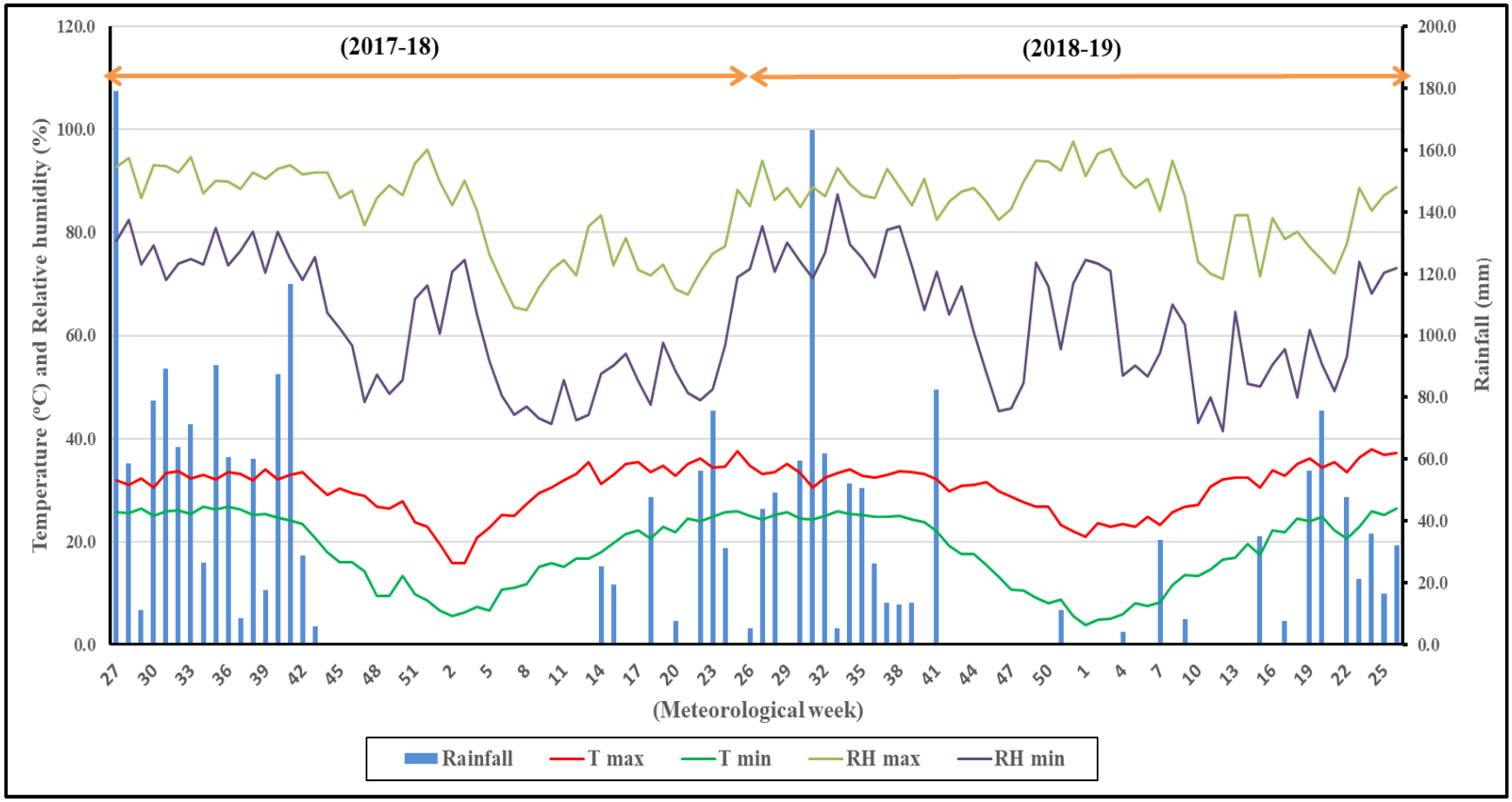


**Fig.2** Effect of cropping systems on dry matter accumulation of rice in *kharif* season (pooled over two years)

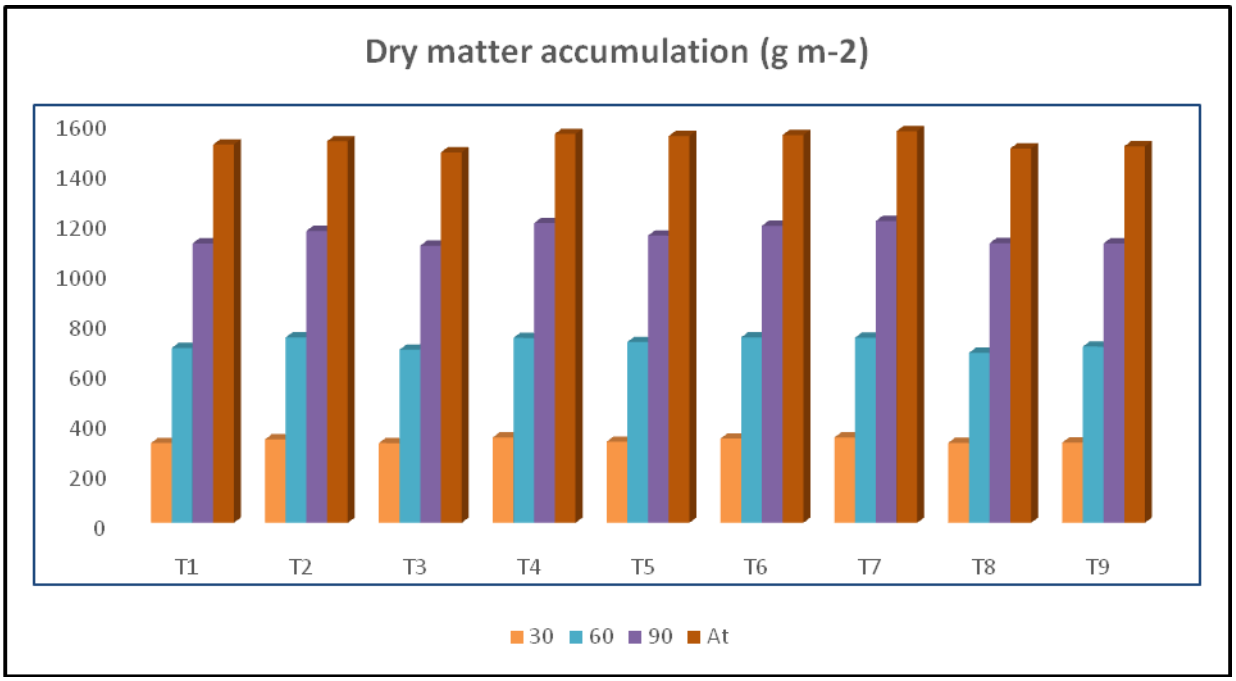



**Fig.3** Effect of cropping systems on crop growth rate (g $m^{-2}$ $day^{-1}$) of rice in *kharif* season (pooled over two years)

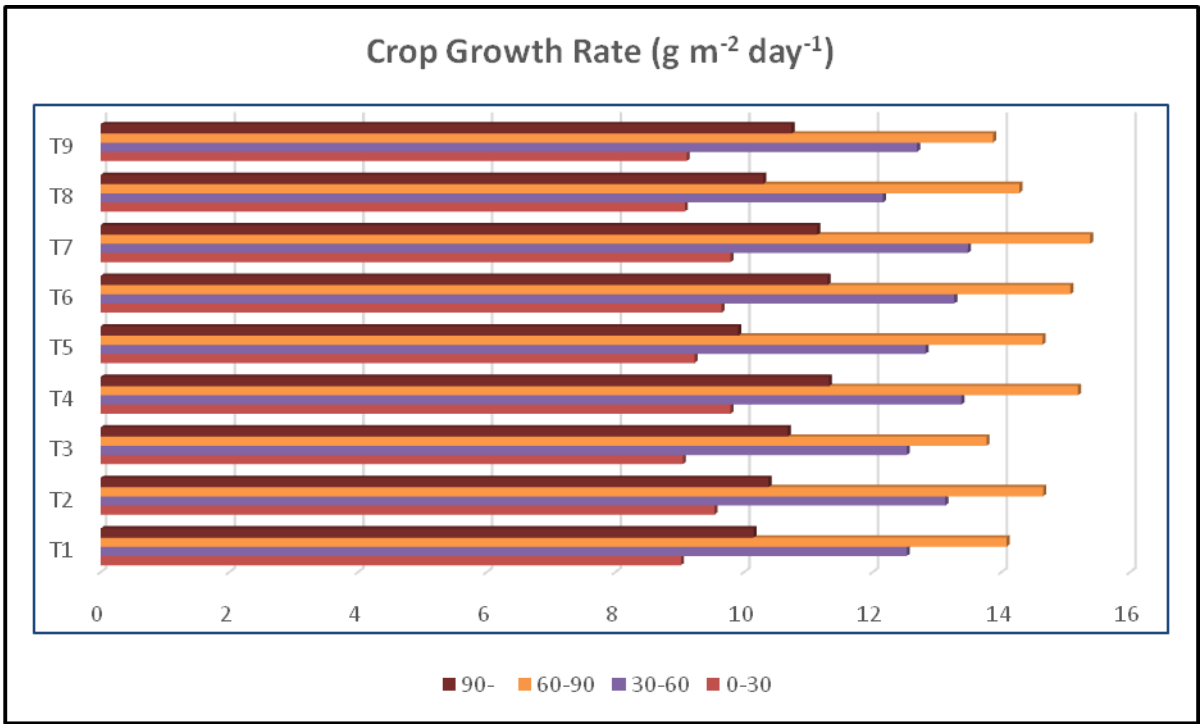


**Fig.4** Effect of cropping systems on relative growth rate (g $g^{-1}$ $day^{-1}$) of rice in *kharif* season (pooled over two years)

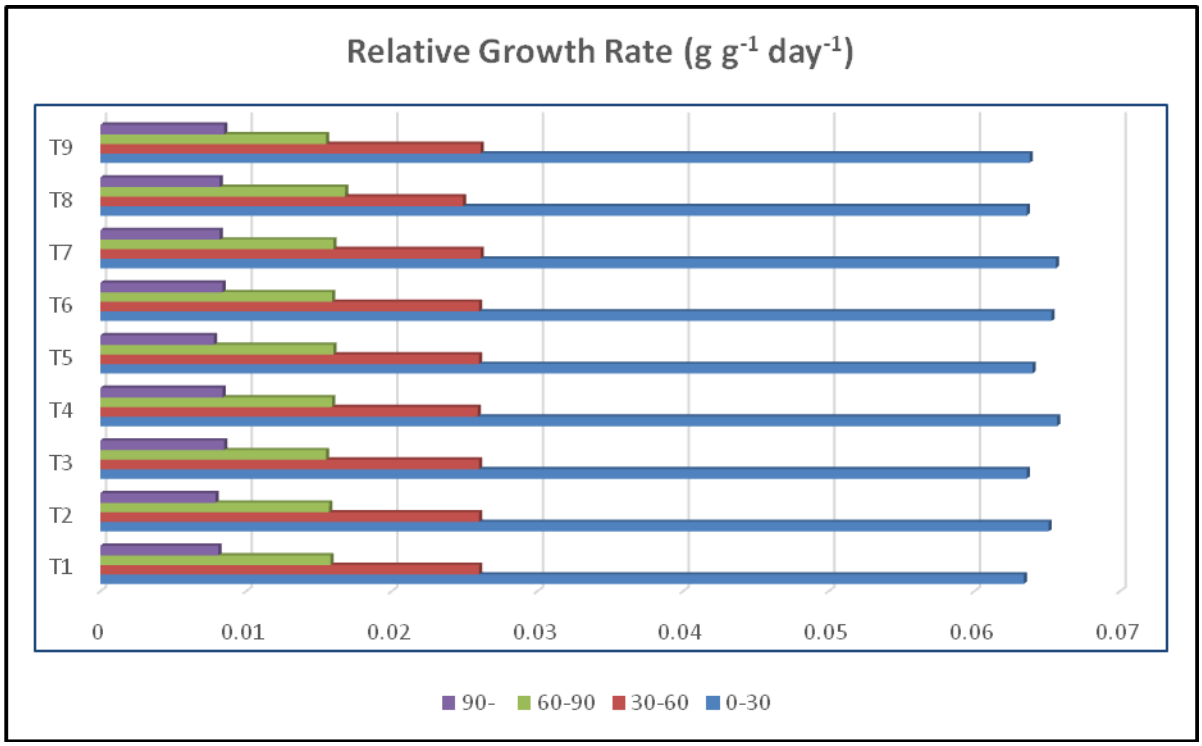



**Fig.5** Effect of cropping systems on net assimilation rate (g $m^{-2}$ $day^{-1}$) of rice in *kharif* season (pooled over two years)

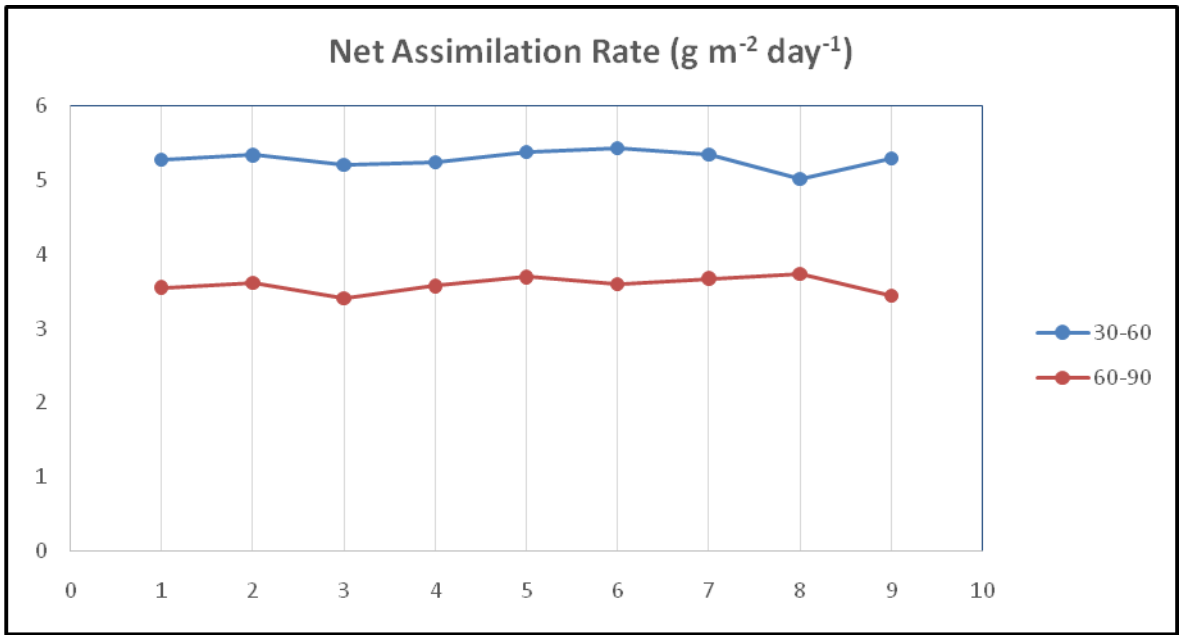
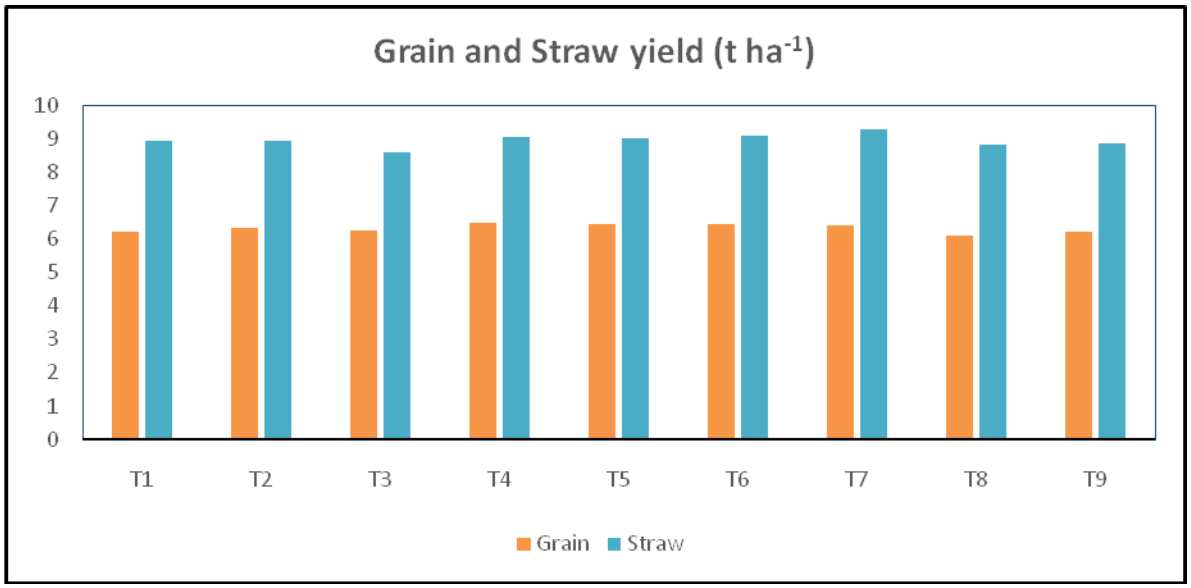


**Fig.6** Effect of cropping systems on grain and straw yield of rice in *kharif* season (pooled over two years)




Crop growth rate, relative growth rate and net assimilation rate of rice was also found non-significant. This might be due to same dose of fertilizers and same variety of rice. These above factors are totally depending on dry matter accumulation and leaf area index and in this research all these parameters were also recorded non-significant. Growth and development of rice under different cropping systems was almost same even inclusion of legumes in cropping systems and this may be because of initial year of experiment but may be this give significant results in upcoming years.

## Effect of different cropping systems on yield attributing characters and yield of rice crop in *kharif* season

All of the yield attributes viz., number of grains per panicle, 1000 grain weight, length of panicle and weight of grains per panicle of rice (Table 1) differ non-significantly under different rice based crop sequences due to same cultivar of rice and same dose of fertilizers was used in experiment. Inclusion of legumes in system improved the physical properties as well as nutrient status of soil but in this research it not found markedly might be due to initial years of experiment and may give better result in upcoming years. Growing of tuber crop like- potato improve the physical property of soil and higher nutrient application also helped to rice crop for producing higher yield by better availability of nutrients.

Final grain yield of crop is the resultant of yield attributes. The beneficial effect of preceding leguminous crops of *rabi* and *zaid* season resulted in slightly higher yield attributing characters of rice (Fig. 6) but not up to the mark of significant. The maximum grain yield (6.49 t $ha^{-1}$) was recorded under treatment ($T_4$) rice - potato + radish – mungbean (G + R) while, maximum straw yield (9.27 t $ha^{-1}$) was recorded in ($T_7$) rice - berseem – maize + cowpea (F) system. Harvest index of rice crop was also found non-significant but the maximum HI (0.42) was recorded in ($T_2$) rice – wheat (ZT) – mungbean (ZT), ($T_3$) rice – maize + vegetable pea (ZT) – sorghum + cowpea (F) and ($T_5$) rice – cabbage + coriander leaf –

sesamum system. This showed that the leguminous crop of different sequences could not enhanced the productivity of succeeding crop due to legume effect at initial stage of experiment but may able to show the significant results after some time.

On the basis of present investigation and above results it may conclude that the adoption of different cropping systems does not affected significantly to the performance of rice crop. We cannot able to conclude that the different cropping systems were not able to affect the growth and yield of rice crop in *Kharif* season, it may take some time to get final results and therefore we have to continue this research for some more years.

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