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Effect of crop establishments methods, tillage practices and weed management practices in rice on growth indices of crops under rice-chickpea cropping system

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Abstract
A field experiment was carried out during *Kharif-Rabi* season of 2022-23 and 23-24 on experimental farm of CoA, Banda University of Agriculture and Technology, Banda, (U.P.) to study of crop establishment methods, tillage and weed management in rice- chickpea system. The experiment was layout in Split -Split Plot Design (SSPD) with three replications taken two crop establishment DSR (Direct seeded rice) and TPR (Transplanted rice) in main plot, two tillage practices ZT (Zero tillage) and CT (Conventional tillage) in subplot and four weed management practices IWM (Pretilachlor + Safener + 1 HW) in rice /Pendimethalin +1 HW in Chickpea, Pretilachlor + Safener in rice/ Pendimethalin in Chickpea, Bispyribac Sodium in rice / Topramezone in Chickpea and Weedy check in rice and chickpea in sub-sub plot.Results revealed that significantly higher crop growth rate, relative growth rate, absolute growth rate and grain yield was recorded in DSR (Direct seeded rice), ZT (Zero tillage) and IWM (Pretilachlor + Safener + 1HW),which was comparable to weed free during both the years of investigation under rice-chickpea cropping system.

Keywords: CGR, RGR, AGR, Crop establishment, Tillage practices, Herbicides and rice-Chickpea cropping system

1. Introduction
The most significant and widely cultivated food crop in India is rice, which takes up 43.79 mha of land and yields 116.42 mt of production and 26.55 q $ha^{-1}$of productivity. In Uttar Pradesh, 5.75 million hectares comes under rice where productivity is 27.04 q ha^{-1} and production is 15.54 mt. During the rainy season, farmers in the Bundelkhand region also cultivate rice on a greater area. The Banda district in UP Bundelkhand receives between 850 and 900 mm of rain a year, most of it in the monsoon season. Irrigation facility is available in limited number of the district's development blocks, while during the kharif season, rice is cultivated as main crop, followed by wheat during the rabi season. The traditional method of growing rice involves creating puddles in the soil and then transplanting rice seedlings within them. Rice benefits greatly from puddling because it minimizes water loss through percolation, inhibits weed growth, facilitates seedling establishment, and creates anaerobic conditions that improve nutrient availability during crop season. Yet, this method uses a lot of water 3000–5000 L are needed to produce 1 kg of rice as well as labour (Pena *et al.*, 2023) [1] which is getting harder to come by and more expensive.
The cultivation of rice and chickpea in a cropping system presents a unique agricultural scenario that demands careful consideration of crop establishment methods, tillage practices, and weed management strategies. This introduction provides an overview of the significance of these factors and their interactions within the rice-chickpea cropping system, highlighting the need for integrated and sustainable approaches to maximize productivity and resource efficiency. Crop establishment methods play a pivotal role in determining the success of rice and chickpea cultivation. The choice between direct seeding, transplanting, or relay cropping significantly impacts resource utilization, labour requirements, and crop performance. Understanding the

advantages and limitations of each method is crucial for optimizing yields and profitability in the rice-chickpea system (Kumar *et al.*, 2017) [3].

2. Materials and Methods

A field experiment was carried out during *Kharif-Rabi* season of 2022-23 and 23-24 on experimental farm of CoA, Banda University of Agriculture and Technology, Banda. The experimental site situated between Latitudes 24º 53′ and 25º 55′ N and Longitudes 80º 07′ and 81º 34′ E, and having an altitude of 168 m above mean sea level. Climate of Banda is classified as warm and semi-arid. The district of Banda is located in Bundelkhand region of Uttar Pradesh state. Climate of the region is generally semi-arid and is marked by extremes in summer and winter temperatures. Temperatures can reach as high as 48 °C in the summer and as low as 4 °C in the winter. Rate of evaporation varies between 1mm to 23 mm, lowest during winter and highest during summer. Annual average rainfall of Banda district is 860mm in 40 to 44 rainy days, out of which 80 percent rainfall received during July to September. The region experienced erratic rainfall. The experiment was layout in Split -Split Plot Design (SSPD) with three replications taken two crop establishment DSR (Direct seeded rice) and TPR (Transplanted rice)in main plot, twotillage practices ZT (Zero tillage) and CT (Conventional tillage) in subplot and four weed management practices IWM (Pretilachlor + Safener + 1 HW) in rice /Pendimethalin +1 HW in Chickpea, Pretilachlor + Safener in rice/ Pendimethalin in Chickpea, Bispyribac Sodium in rice / Topramezone in Chickpea and Weedy check in rice and chickpea in sub-sub plot. The soil of experimental field was silty clay (Inceptisols) soil, flat well drained and moderately fertile, being low in available organic carbon, phosphorus and high in potassium and sulphur.

2.1 CGR (Crop growth rate) g m^{-2} day^{-1}

The method was suggested by Watson (1956). The CGR explains the dry matter accumulated per unit land area per unit time (g m^{-2} day^{-1}). CGR of a species are usually closely related to interception of solar radiation. CGR calculated by the formula.

$$CGR = \frac{(W2 - W1)}{\rho\,(t2 - t1)}$$

Where,

W_1 and W_2 are whole plant dry weight at time t_1 – t_2 respectively.

P is the ground area on which W_1 and W_2 are recorded.

2.2 RGR (Relative growth rate) g g^{-1} day^{-1}

The term was coined by Williams (1946). Relative Growth Rate (RGR) expresses the total plant dry weight increase in a time interval in relation to the initial weight and expressed as unit dry weight / unit dry weight / unit time (g g^{-1} day^{-1}).

$$RGR = \frac{\log_e W2 - \log_e W1}{t2 - t1}$$

Where,

W_1 and W_2 are whole plant dry weight at t_1 and t_2 respectively.

t_1 and t_2 are time interval in days.

2.3 AGR (Absolute growth rate) g day^{-1}.

Absolute growth rate is the rate of increase of the growth variables dry matter (W) at time (t). The differentiation coefficient with respect to time was used to measure it. The formula provided by Richards (1969) was used to calculate the absolute growth rate of the total dry matter per plant.

$$AGR = \frac{W2 - W1}{t2 - t1}\ g\ day^{-1}$$

Where,

W_1 and W_2 are whole plant dry weight at time t_1 – t_2 respectively

3. Results and Discussion

3.1 Crop growth rate (CGR) g m^{-2} day^{-1}

Keen observation of data (Table 1), reveals that establishment methods, tillage practices and weed management affect CGR notably at all stages of crop during both the years. CGR value decreased with advancement of stage. CGR value during early growth noticed higher with DSR while at later stage it was in TPR. Almost similar value observed under both tillage practices. In case of weed management treatments CGR 11.1, 7.9 and 8.4 recorded at early, mid and late stage, respectively under IWM treatments (Pretilachlor + Safener *fb* 1HW). No any interaction was significant. This might be due to uncontrolled weeds in weedy check plots caused an average reduction in yield to the extent of 65-90% as compared with weed free plots, mainly due to high density and more dry matter accumulation by weeds in weedy check plots. This could be attributed to greater reduction of dry weight of weeds by the combined effect of herbicides and hand weeding at later stage. Similar findings were reported by Kumar *et al* (2012) [5] and Naresh *et al.* (2011) [4].

3.2 Relative growth rate (RGR) g g^{-1} day^{-1}

Keen observation of data (Table 2), reveals that establishment methods, tillage practices and weed management affect RGR markedly at all stages of crop during both the years. RGR value decreased gradually with advancement of stage. RGR value during early growth noticed higher while at later stage it was lesser. Almost similar value of RGR observed under treatments at particular stage. No any interaction effect was noticed significant. This might be due to uncontrolled weeds in weedy check plots caused an average reduction in yield to the extent of 65-90% as compared with weed free plots, mainly due to high density and more dry matter accumulation by weeds in weedy check plots. This could be attributed to greater reduction of dry weight of weeds by the combined effect of herbicides and hand weeding at later stage. Similar findings were reported by Kumar *et al* (2012) [5] and Naresh *et al.* (2011) [4].

3.3 Absolute growth rate (AGR) g day^{-1}

Data pertaining in (Table 3) reveals that establishment methods, tillage practices and weed management affect AGR outstandingly at all stages of crop during both the years. AGR values decreased with advancement of stage. AGR value during early to late growth period observed higher with DSR. On the other hand, in case of tillage higher value observed under zero tillage practices. In case of weed management treatments, AGR 11.06, 7.94 and 7.75 recorded at early, mid and late stages, respectively under IWM treatments (Pretilachlor + Safener *fb* 1HW). No any interaction was significant. Lower value of AGR 9.95, 7.33 and 7.24, perceived with weedy check. This might be due to uncontrolled weeds in weedy check plots caused an average reduction in yield to the extent of 65-90% as compared with weed free plots, mainly due to high density and more dry matter accumulation by weeds in weedy check plots. This could be attributed to greater reduction of dry weight of weeds by the combined effect of herbicides and hand weeding at later stage. Similar findings were reported by Kumar *et al.* (2012) [5] and Naresh *et al.* (2011) [4].

Table 1: Effect of different treatments on crop growth rate (CGR) at various stages of rice crop.

Treatment	CGR (g m^{-2} day^{-1})								
	30-60DAS			60-90DAS			90 DAS-at harvest		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Establishment (Main factor)									
E1: DSR	10.8	10.6	10.7	7.6	7.5	7.5	7.8	7.8	7.8
E2: TPR	10.5	10.4	10.4	7.5	7.5	7.5	8.3	8.2	8.2
S.Em±	0.02	0.02	0.02	0.06	0.06	0.06	0.08	0.08	0.08
C.D.(P=0.05)	0.41	0.39	0.40	1.03	1.03	1.03	1.39	1.39	1.39
Tillage Practices (Sub factor)									
T1: ZT	10.7	10.6	10.7	7.6	7.6	7.6	7.9	7.9	7.9
T2: CT	10.5	10.5	10.5	7.5	7.4	7.5	8.1	8.1	8.1
S.Em±	0.03	0.03	0.03	0.06	0.06	0.06	0.06	0.06	0.06
C.D.(P=0.05)	0.54	0.53	0.53	1.13	1.13	1.13	1.12	1.11	1.12
Weed Management (Sub-sub factor)									
W1: IWM (Pretilachlor + Safener + 1HW)	11.1	11.1	11.1	8.0	7.9	7.9	8.4	8.3	8.4
W2: Pretilachlor + Safener	10.7	10.5	10.6	7.3	7.2	7.2	7.7	7.6	7.7
W3: Bispyribac Sodium	10.7	10.7	10.7	7.6	7.5	7.5	7.8	7.8	7.8
W4: Weedy Check	10.0	9.9	9.9	7.3	7.3	7.3	8.3	8.2	8.3
S.Em±	0.56	0.55	0.55	0.58	0.58	0.58	0.54	0.54	0.54
C.D.(P=0.05)	2.51	2.50	2.51	2.60	2.59	2.59	2.44	2.43	2.44

Table 2: Effect of different treatments on relative growth rate (RGR) at various stages of rice crop

Treatment	RGR (g g^{-1} day^{-1})								
	30-60 DAS			60-90 DAS			90 DAS-at harvest		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Establishment (Main factor)									
E1: DSR	0.08	0.08	0.08	0.02	0.02	0.02	0.01	0.01	0.01
E2: TPR	0.07	0.08	0.07	0.02	0.02	0.02	0.01	0.01	0.01
S.Em±	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C.D.(P=0.05)	NS	NS		NS	NS		NS	NS	
Tillage Practices (Sub factor)									
T1: ZT	0.07	0.08	0.08	0.02	0.02	0.02	0.01	0.01	0.01
T2: CT	0.07	0.08	0.08	0.02	0.02	0.02	0.01	0.01	0.01
S.Em±	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C.D.(P=0.05)	NS	NS		NS	NS		NS	NS	
Weed Management (Sub-sub factor)									
W1: IWM (Pretilachlor + Safener + 1HW)	0.07	0.08	0.08	0.02	0.02	0.02	0.01	0.01	0.01
W2: Pretilachlor + Safener	0.07	0.07	0.07	0.02	0.02	0.02	0.01	0.01	0.01
W3: Bispyribac Sodium	0.07	0.07	0.07	0.02	0.02	0.02	0.01	0.01	0.01
W4: Weedy Check	0.08	0.08	0.08	0.02	0.02	0.02	0.01	0.01	0.01
S.Em±	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C.D.(P=0.05)	NS	NS		NS	NS		NS	NS	

Table 4.24: Effect of different treatments on absolute growth rate (AGR) at various stages of rice crop.

Treatment	AGR (g day^{-1})								
	30-60 DAS			60-90 DAS			90 DAS-at harvest		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Establishment (Main factor)									
E1: DSR	10.76	10.65	10.71	7.57	7.5	7.54	7.48	7.41	7.45
E2: TPR	10.46	10.39	10.43	7.52	7.48	7.50	7.45	7.36	7.41
S.Em±	0.02	0.02	0.02	0.06	0.06	0.06	0.05	0.05	0.05
C.D.(P=0.05)	0.41	0.39	0.4	1.03	1.03	1.03	1.01	1.02	1.02
Tillage Practices (Sub factor)									
T1: ZT	10.68	10.64	10.66	7.63	7.6	7.62	7.55	7.52	7.54
T2: CT	10.54	10.46	10.5	7.47	7.45	7.46	7.41	7.32	7.37
S.Em±	0.03	0.03	0.03	0.06	0.06	0.06	0.05	0.05	0.05
C.D.(P=0.05)	0.54	0.53	0.53	1.13	1.13	1.13	1.12	1.11	1.12
Weed Management (Sub-sub factor)									
W1: IWM (Pretilachlor + Safener + 1HW)	11.06	11.05	11.06	7.97	7.9	7.94	7.78	7.71	7.75
W2: Pretilachlor + Safener	10.66	10.55	10.6	7.29	7.21	7.25	7.21	7.11	7.16
W3: Bispyribac Sodium	10.73	10.72	10.72	7.59	7.5	7.55	7.48	7.4	7.44
W4: Weedy Check	10	9.9	9.95	7.34	7.31	7.33	7.26	7.22	7.24
S.Em±	0.56	0.55	0.55	0.58	0.58	0.58	0.54	0.54	0.54
C.D.(P=0.05)	2.51	2.5	2.51	2.6	2.59	2.60	2.44	2.43	2.44

4. Conclusion

It is concluded that, DSR (Direct seeded rice), ZT (Zero tillage) and IWM (Pretilachlor + Safener + 1HW) for weed management practices was found better for all growth indices (CGR, RGR & AGR) under rice-chickpea cropping system.

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