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Simulation impact on biomass, nutrients and weed intensity dynamics in soil using intercrop model

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Abstract
In *Kharif* season an experiment was conducted at Kuthulia farm of JNKVV, Rewa (M.P.). The soil of experimental field was silty clay loam in texture; the rice (*Oryza sativa* L.) crop was transplanted at planting geometry of 20 cmx 15 cm in which two seedlings per hill was transplanted. The fertilizer dose for rice was 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha under all the cropping systems. The number of tillers/hill of rice was recorded at 25 DAT, 50 DAT and 75 DAT (at harvest) stage of rice and maximum tillers/hill of rice were noted in berseem-rice followed by mustard-green manure-rice, potato-wheat-rice and garlic-rice. The biomass yield 153.96 q/ha was maximum in mustard-green manure-rice followed by 148.27 q/ha in toria-onion-rice and 147.65 q/ha in potato-wheat-rice these cropping system gave more biomass yield by 15.92 percent to 22.85 percent as compared to existing wheat-rice system. The organic carbon increased by 12.5 to 17.85 percent. The intensity of weed varied from 18.45 to 43.01 weeds/m^2 under different cropping systems. The maximum harvest index was 37.36 percent in berseem-rice.

Keywords: Cropping systems, green manure, chemical properties weed intensity and biomass

Introduction
Transplanted rice may face yield reduction upto 39% due to uncontrolled weeds (Raju and Reddy, 1995) [8]. Weeds pose major problem in rice production and not only reduce yield but also hinder quality (Kathiresan, 2001) [1]. The use of herbicides offers selective and economic control of weeds from the beginning and gives the crop an advantage of a good start and competitive superiority.

Cereals play an important part of our food system next to that pulse come in the line to stabilize nutritional base. India is the largest producer and consumer of pulses in the world but the per capita availability of pulses has been declining adversely.

In India, rice is the principal crop during kharif season and it occupies an area of more than 40 m ha. The area under rice is never utilized productively and fully in the subsequent Rabi season; roughly more than 10-12 m ha remains fallow (Subbarao *et al*., 2001) [10].

Black gram is grown not only as a food leguminous plant under various climatic and soil conditions as sole crop or combined with different cereals but also to maintain the soil biochemical fertility through biological N fixation which in turn stabilize the total N (Panwar and Sharma, 2004) [7] and soil organic carbon content thus improve the water holding capacity of soil.

The influence of nutrients applied to the preceding crops in a cropping sequence is constructively affecting the productivity of succeeding crop. Based on the applied source and level of nutrients, the residual outcome would vary along with nature of the crop followed by.

Apart from the residual effect of nutrient management practices, the cultivation methods adopted to rice in rice - fallow pulse cropping sequence also plays an important role in improving residual soil moisture level through better below ground dry matter production and soil available nutrient status significantly by avoiding nutrient losses compared to conventional method of cultivation.

Rice is the important crop of rice-wheat zone of Madhya Pradesh which occupies an area of 16.75 lakh hectares with the average productivity of 1194 kg/ha. In Rewa region of Madhya Pradesh, rice is cultivated in 6.09 lakh hectares with the production of 4.47 lakh tonnes and productivity of 917 Kg/ha which is very low as compared to national and state average productivity (Rao 2012) [9]. Introduction of pulses and oil seed in the system are more beneficial than cereal-cereal sequence (Umarani *et al*., 1992) [10]. In cropping system inclusion of pulse, oilseed and vegetable are more beneficial than cereals after cereals (Kumpawat 2001) [5].

Rice-potato-wheat system utilized the water most efficiently closely followed by medium duration rice-berseem system. The growing of vegetable pea and potato between rice and wheat increased organic carbon by 8.9% and 17.1%, available N by 6.3% and 8.3%, Olsen, s production by 6.3% and 19%, respectively in soil as compared to rice-wheat sequence (Kharub *et al*., 2003) [2].

Materials and Methods

Experimental site: The experiment was laid out at JNKVV farm of Kuthulia, College of agriculture Rewa (M.P.). The selected sitewas representative of the major rice growing area of the region in which transplanted rice was grown in *kharif* followed by wheat, gram, berseem, potato, garlic, toria, mustard, pea and gram + linseed, barley in *rabi*.

Soil: The soil of experimental field was silty clay loam in texture, neutral in reaction (pH 7.25), medium in organic carbon (0.56%) and low in available nitrogen and phosphorus and high in potash (315 kg/ha).

Climate and weather conditions: Rewa is situated in North Eastern part of Madhya Pradesh at 24º 30' North latitude, 81º15' East longitude and 365.7 meters above mean sea level. The average annual rainfall of the tract is 1140 mm. The maximum and minimum temperatures recorded during the crop season were 44.14 ºC and 11.27 ºC in the month of June and December respectively.

Experimental details: The experiment was laid out in a randomized block design (RBD) with four replications. The ten cropping systems (T_1-wheat-rice, T_2-chickpae-rice, T_3-berseem-rice, T_4 –potato-wheat-rice, T_5-garlic-rice, T_6-toria-onion-rice, T_7-barley-green manure-rice, T_8-pea-wheat-rice, T_9-chickpae+linseed-rice, T_{10}-mustard-green manure-rice) were tried. These cropping systems were randomly allocated in each replication. The present experiment was started in the year 2007-08 and same layout has been adopted for current year also. The details of treatments are given below:

Results and Discussion

Biomass Yield: The biomass yield of rice recorded after complete sun drying given in Table 1. The analysis of variance revealed that biomass yield of rice differed significantly under different cropping system. The biomass yield 153.96 q/ha was maximum in mustard-green manure-rice followed by 148.27 q/ha in toria-onion-rice and 147.65 q/ha in potato-wheat-rice these cropping system gave more biomass yield by 15.92 percent to 22.85 percent as compared to existing wheat-rice system. The biomass yield of rice was decreased by 1 percent in chickpea-rice and 3.07 percent in barley-green manure-rice cropping system as compared to wheat-rice system. Similar results were obtained by Kumar and Singh (2010) [4].

Chemical properties: The chemical properties of soil after completion of eight year of different cropping system depicted in Table 2. It is evident from the data the soil pH and electrical conductivity of the soil under different cropping system were not affected as compared to initial status. The organic carbon status has given in Table 2 revealed that organic carbon content increased by 12.5 percent to 17.85 percent under different cropping system. The organic carbon status in soil was increased maximum in berseem-rice, garlic-rice and barley-green manure-rice @ 17.85% over initial status. The available N in soil under the influence of different cropping systems revealed that N status of soil was increased by 3.12 percent to 12.94 percent under different cropping system. The maximum increase of available N was observed in barley-green manure-rice cropping system followed by berseem-rice cropping system. These cropping systems gave higher N status as compared to existing wheat-rice cropping system. Available phosphorous in soil under different cropping system has been given Table 2. indicates that phosphorous status in soil under different cropping system have been increases by 7.19 percent to 13.17 percent. The maximum phosphorous status in soil was increased by 13.17 percent in chickpea-rice followed by 12.19 percent in toria-onion-rice and 11.82 percent in berseem-rice cropping system as compared to initial status. The available potash in soil after completion of 8 years have been given 3 revealed that available potash in soil was decreased by 6.03 percent to 12.69 percent under different cropping system over initial status. The available potash status was decreased maximum in mustard-green manure-rice cropping system followed by chickpea-rice cropping system. As accorded by Mikha *et al.*, (2005) [6].

Weed intensity and density: The weed intensity and density were recorded at 40 DAT which have been given in Table 4 revealed that the intensity of weed under different cropping system varied from 18.45 to 43.01 weeds/m^2 under different cropping systems. The major weeds in rice field were *Jussiaea suffruticosa, Monochoria vaginalis, Fimbristylis dichotoma, Polygonum barbatum* and *Echinochloa colonum. Polygonum barbatum* were most dominating weeds of rice in gram-rice, pea-wheat-rice and mustard-green manure-rice cropping system. *Echinochloa colonum* was major weeds in berseem-rice, garlic-rice and barley-green manure-rice. *Fimbristylis dichotoma* was more dominant in toria-onion-rice and chickpea+linseed-rice cropping system. *Jussiaea suffruticosa* was dominant weeds in wheat-rice and potato-wheat-rice cropping system. Similar work was carried out by Koocheki *et al.*, (2009) [3].

Table 1: Major cropping sequence with varieties and fertilizer dose

Treatments		Fertilizers dose NPK kg/ha
T1	Wheat–Rice	K - 120:60:40 R - 120:60:40
T2	Chick pea – Rice	K - 120:60:40 R - 20:60:20
T3	Berseem (fodder + seed) - Rice	K – 120:60:40 R – 20:60:20
T4	Potato-Wheat – Rice	K – 120:60:40 P – 120:100:100 R – 100:60:40
T5	Garlic – Rice	K – 120:60:40 R - 100:75:50
T6	Toria-Onion – Rice	K - 120:60:40 T – 60:30:20 O -120:60:40
T7	Barley-Green manure – Rice	K - 120:60:40 R - 20:60:20
T8	Pea-Wheat – Rice	K – 120:60:40 P - 20:60:20 W-120:60:40
T9	Chickpea + Linseed – Rice	K – 120:60:40 R - 20:60:20
T10	Mustard – Green manure- Rice	K - 120:60:40 R – 120:60:40

Table 2: Average biomass, grainsand straw yield of rice under various cropping systems.

Treatment	Biomass q/ha	Grain yield q/ha	Straw yield q/ha	Harvest index%
T1 Wheat–Rice	125.32 (0.00%)	45.43(0.00%)	79.82 (0.00%)	36.25
T2 Chick pea - Rice	124.05(-1.01%)	45.59(.35%)	78.46(-1.70%)	36.75
T3 Berseem (fodder+seed) - Rice	141.19(12.66%)	52.76(16.13%)	88.42(10.77%)	37.36
T4 Potato-Wheat - Rice	147.65(17,81%)	52.37(15.27%)	95.28(19.36%)	35.46
T5 Garlic - Rice	145.28(5.92%)	51.11(12.50%)	94.17(17.97%)	35.18
T6 Toria-Onion - Rice	148.27(18.31%)	50.00(10.05%)	98.26(23.10%)	33.72
T7 Barley-Green manure - Rice	121.47(-3.07%)	43.30(-4.68%)	78.16(-2.07%)	35.64
T8Pea-Wheat – Rice	141.50(12.91%)	48.74(7.28%)	92.12(15.40%)	34.44
T9 Chickpea + Linseed - Rice	132.19(5.48%)	44.13(-2.86%)	88.05(10.31%)	33.38
T10 Mustard – Green manure- Rice	153.96(22.85%)	51.90(14.24%)	102.06(27.86%)	33.71
S.Em±	5.18	1.733	3.877	0.729
CD at 5%	15.042	5.029	11.252	2.117

*Figures in parentheses are percent increase or decrease (-) over rice-wheat system

Table 3: Changes in chemical properties of soil after completion of 8 years of different cropping systems

Treatment	Soil pH	Soil EC Mmhos/cm	OC%	Available N kg/ha	Available P_2O_5 kg/ha	Available K_2O kg/ha
T1Wheat–Rice	7.32	0.55	0.63 (12.5%)	236 (5.35%)	8.96 (9.26%)	293 (-6.98%)
T2 Chick pea - Rice	7.19	0.45	0.65 (16.07%)	248 (10.71%)	9.28 (13.17%)	280 (-11.11%)
T3 Berseem (fodder+seed) - Rice	7.25	0.47	0.66 (17.85%)	251 (12.05%)	9.17 (11.82%)	296 (-6.03%)
T4 Potato-Wheat - Rice	7.23	0.48	0.65 (16.07%)	231 (3.12%)	8.91 (8.65%)	294 (-6.66%)
T5 Garlic - Rice	7.24	0.55	0.66 (17.85%)	231 (3.12%)	8.79 (7.19%)	295 (-6.34%)
T6 Toria-Onion - Rice	7.22	0.45	0.64 (14.28%)	241 (7.58%)	9.20 (12.19%)	295 (-6.34%)
T7 Barley-Green manure - Rice	7.37	0.47	0.66 (17.85%)	253 (12.94%)	8.96 (9.26%)	294 (-6.66%)
T8Pea-Wheat – Rice	7.33	0.48	0.65 (16.07%)	239 (6.69%)	9.07 (10.60%)	284 (-9.84%)
T9 Chickpea + Linseed - Rice	7.35	0.47	0.64 (14.28%)	243 (8.48%)	8.87 (8.17%)	287 (-8.88%)
T10 Mustard – Green manure- Rice	7.34	0.48	0.64 (14.28%)	237 (5.80%)	8.86 (8.04%)	275 (-12.69%)
Total initial value	7.25	0.46	0.56	224 kg	8.2 kg	315 kg

*Figures in parentheses are percent increase or decrease initial status.

Table 4: Weed intensity/m^2 under different cropping system at 40DAT.

Treatment	*Jussiaea suffruticosa*	*Monochoria vaginalis*	*Fimbristylis dichotoma*	*Polygonum barbatum*	*Echinochloa colonum*	Total
T1Wheat–Rice	6.15	4.05	2.25	1.70	4.30	18.45
T2 Chick pea - Rice	8.30	4.10	7.00	10.02	1.20	30.62
T3 Berseem (fodder+seed) - Rice	2.25	3.75	4.45	6.55	5.45	22.45
T4 Potato-Wheat - Rice	8.10	5.00	4.65	6.20	2.20	26.15
T5 Garlic - Rice	9.15	7.05	4.08	8.45	11.754	40.48
T6 Toria-Onion - Rice	6.35	4.09	8.25	2.70	6.15	27.54
T7 Barley-Green manure - Rice	5.05	7.16	8.05	6.35	9.20	35.81
T8Pea-Wheat – Rice	9.10	5.11	10.15	16.00	2.65	43.01
T9 Chickpea + Linseed - Rice	4.02	6.04	7.65	3.35	4.70	25.76
T10 Mustard – Green manure- Rice	7.35	5.81	8.33	9.40	3.08	33.97

The organic carbon status in soil was increased in berseem-rice, garlic-rice and barley-green manure-rice @ 17.85% over initial status. The available N in soil under the influence of different cropping systems reveals that N status of soil was increased by 3.12 percent to 12.94 percent under different cropping system

Conclusion

From the findings it was concluded that introduction of pulses, oil seed and vegetables in the system are more beneficial than cereal-cereal sequence. The cropping system mustard-green manure-rice gave maximum straw yield of rice 102.06 q/ha followed by toria-onion-rice 98.26 q/ha and potato-wheat-rice 95.28 q/ha. The biomass yield was most in mustard-green manure-rice followed by in toria-onion-rice and in potato-wheat-rice these cropping system gave more biomass yield by as compared to existing wheat-rice system. The organic carbon increased intensity of weed decresesed and the maximum harvest index was 37.36 percent in berseem-rice.

Conflict of interest: NA.

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