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Growth and yield of wheat crop as influenced by nitrogen levels, previous rainy season legumes and their recycling in the gangetic alluvial soil of West Bengal

A. P. PATRA; P. GHOSH; A. BISWAS; S. S. NAYEK; S. K. GHOSH AND M. SAHA

Department of Agronomy,
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, W.B.

ABSTRACT

An experiment was conducted at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal (India) for three consecutive years the upland of Gangetic alluvial soil (entisol) in split plot design, with rainy season crops greengram, blackgram, soybean, groundnut, ricebean, cowpea and rice with or without incorporation of their straw/stover as mainplot treatments; and three levels of nitrogen (0, 60 and 120 kg N ha^{-1}) on wheat as subplot treatments. Shoot growth of wheat was higher due to residual effect of ricebean fodder, blackgram and groundnut; LAI, LAD and CGR were higher in ricebean and blackgram plot than rice. These parameters were improved due to incorporation of stover or nitrogen levels. Number of effective tillers m^{-2} and grain $spike^{-1}$ of wheat augmented in the plots of ricebean, blackgram, soybean and groundnut over rice, and were improved due to incorporation of their stover or direct effect of N. Grain yield of wheat was the highest due to residual effect of ricebean fodder, followed by blackgram, groundnut and soybean and was augmented due to soil incorporation of stover or increasing levels of nitrogen.

Key Words : Rainy season, legumes, soil incorporation, residual effect

There is an urgent need to increase the production of food crops like wheat, as well as, proteinaceous crops to provide the quantity and quality of the food required by the people. Given the constraints of cultivated land and resources, the emphasis has to be given to suitable cropping systems and better utilization of available resources to increase the production of these crops (De and Singh, 1983; Basri, et.al 1985), and at the same time to improve and maintain the soil health and ecological environment (Ahlawat et al., 1981), which are essential for sustainable agriculture production. This perspective ascertain the scope to undertake an experiment with a view to increase the production of both wheat and pulses by economizing the need of nitrogenous fertilizer for wheat crop through growing of rainy season legumes and recycling their stover, thereby to improve the quantity and quality of food, soil health and ecological environment, and thus sustain agricultural production.

MATERIALS AND METHODS

An investigation was undertaken at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia situated at 23º5'N, 89ºE and 9.75m above MSL during 1998-99 and 1999-2000 in Indo-Gangetic alluvial soil (entisol) under a typical upland condition in West Bengal (India). Different rainy season crops like greengram, blackgram, soybean and groundnut for seed, ricebean for green fodder, cowpea for green pod and rice were grown during rainy season with or without incorporation of their stover/straw along with extra treatment of *kharif* fallow. During winter season wheat was grown in the same plots in split plot design, with three replications, where rainy season crops with or without recycling of their stover/straw were considered as main plot treatments and levels of nitrogen (0, 60 and 120 kg N ha^{-1}) as subplot treatments. The soil of the experimental field was well drained sandy loam with about neutral pH (6.43), low in total nitrogen (0.076%) and available phosphate (17.78 kg P_2O_5 ha^{-1}) and medium available potassium (127.59 kg K_2O ha^{-1}). The maturity (days) and the amount of incorporated stover/straw (t ha^{-1}) of rainy season crops in the soil were 69 and 3.25, 133 and 12.76, 122 and 7.25, 111 and 10.44, 133 and 23.71, 69 and 4.22, and 105 and 10.08 in case of greengram, blackgram, soybean, groundnut, ricebean, cowpea, and rice, respectively. Dry matter accumulation in shoot, Leaf Area Index (LAI), Leaf Area Duration (LAD), Crop Growth Rate (CGR) and Net Assimilation Rate (NAR) of wheat were studied to evaluate the growth, along with the yield components and yield of wheat were also studied.

RESULTS AND DISCUSSION

Effect on shoot growth of wheat

Shoot growth of wheat increased at high rate upto 84 Days after sowing **(**DAS**)**. Out of different of kharif crops, the highest shoot growth of wheat was recorded due to the residual effect of blackgram, followed by ricebean, groundnut and soybean

(Table-1). The lowest shoot growth was recorded from the plot of kharif fallow. Recycling of kharif crops increased the shoot growth (84 DAS) of wheat by 17.4% over no recycling, whereas, due to the direct effect of N shoot growth of wheat increased by 78.0 and 38.0% at 120 and 60 kg N ha^{-1} over control.

Effect on LAI of wheat

The LAI of wheat increased upto 63 DAS and declined thereafter. LAI (at 63 DAS) was the highest due to residual effect of ricebean, followed by blackgram and groundnut. It was the lowest from kharif fallow plot. Recycling of kharif crops increased the LAI (63 DAS) by 34.2% over that of no-recycling, whereas due to the direct effect of nitrogen LAI increased by 128.8% and 58.6% at 120 and 60 kg N ha^{-1} over control.

Effect on LAD of wheat

The LAD of wheat crop increased appreciably due to recycling over that of no recycling of all the preceding kharif crops. The values were much higher in case of ricebean and blackgram under recycling as well as no recycling. Groundnut, soybean and rice were more or less similar in this respect (Fig. 1).

Effect on CGR

The CGR also increased at the later stage which was particularly due to the spike growth. In respect of residual effect of different kharif crops on CGR of wheat, blackgram recorded the highest efficiency, followed by groundnut and ricebean or greengram. Kharif fallow showed the lowest efficiency in this respect. Incorporation of straw or stover of kharif crops increased the CGR of wheat by 12.7 – 18.7% over that of no-incorporation. The CGR of wheat at later stage was enhanced by 39.0 and 24.4% due to the direct effect of N at 120 and 60 kg N ha^{-1} over no N.

Effect on NAR of wheat

The scenario of the residual effect of kharif crops on NAR was different from that on CGR of wheat (Table 1). The NAR of wheat in greengram plot was maximum, followed by kharif fallow, whereas the efficiencies were low in case of ricebean and soybean. The treatments recording low LAI showed their high efficiency in respect of NAR. It was obvious that low LAI caused reduced mutual shading, and thus increased efficiency of leaf, whereas the treatments producing high LAI increased the mutual shading and thus reduced the efficiency of leaf. Due to the same reason recycling of kharif crops and application of N fertilizer (at 60 and 120 kg N ha^{-1}) recorded reduced values of NAR over their respective control.

Effect on yield components of wheat

The highest number of effective tillers per sq m. was recorded due to the residual effect of ricebean, followed by blackgram and groundnut. The differences between them is significant. The lowest number was observed from the kharif fallow plot. The significant increase in the no. of effective tillers of wheat was obtained from recycling over no recycling and with application of N fertilizer (60 or 120 kg N ha^{-1}) over no N. Number of grains per spike of wheat was the highest in the plot of blackgram, followed by ricebean and groundnut, which were statistically at par among themselves, but significantly superior to other kharif croppings. The number of grain per spike of wheat varied due to the effect of recycling or N fertilizers in the way similar to that of number of effective tillers per sq m. Recycling i.e. soil incorporation of stover of previous kharif crops enriched the soil and exhibited beneficial effect on succeeding wheat crop. Test weight of wheat did not vary significantly due to kharif crops or recycling but reduced significantly at 120 kg N ha^{-1} over that of 0 or 60 kg N ha^{-1}. At 120kg N ha^{-1} the number of grain per sq m. was much higher than that of the 0 or 60 kg Nha^{-1} and probably due to this the grain development was negatively influenced.

Effect on grain yield of wheat

Out of different kharif crops showing residual effect on producing grain yield of successive wheat crop, ricebean was found to be most efficient, followed by blackgram, groundnut and soybean. Ricebean was statistically at par with blackgram and groundnut, but significantly superior to other kharif crops. The grain yield of wheat following a legume (ricebean) grown for fodder was much higher than that after the legumes grown for seed production, which was supported by Velayudham and Seth (1987). The other workers similarly reported the high efficiency of blackgram (Kumar et al., 2000), groundnut (Srivastava and Srivastava, 1993) and soybean (Patra, 2001). Blackgram, with low yield potentiality and very low harvest index, had low N demand, and thus showed prominent residual effect on wheat. On the other hand groundnut due to its nodulation throughout the growing period and soybean due to its high nodulation were also efficient in increasing grain yield of succeeding wheat crop. The lowest wheat grain yield was recorded from kharif fallow plot, followed by greengram and cowpea. These two seed/pod yielding legume with shorter growing periods showed less residual effect. Recycling of kharif crops significantly increased grain yield of following wheat crop over that of no recycling. Recycling, being the source of organic matter, improved the physical, chemical and biological properties of soil (Tiwari et al., 1998) and thus enhanced the grain yield of succeeding wheat crop. Wheat yield

increased significantly with successive higher dose of N, which was expected.

Effect on straw yield

Straw yield of wheat was positively influenced due to the residual effect of blackgram, ricebean, groundnut and soybean over that of other kharif crops or fallow. Positive influence on straw yield was also found due to incorporation of stover or straw of kharif crops or direct effect of N application. The reasons behind that was similar to that discussed in respect of grain yield.

Effect on harvest index and grain - straw ratio

Harvest index of wheat did not vary appreciably due to residual effect of different kharif crops. The indices were low in the plots of kharif fallow and blackgram. The harvest index of wheat increased significantly due to recycling over no recycling and reduced significantly with successive higher dose of N. Higher doses of nitrogen increased the vegetative growth, which was also reflected in straw yield, as a result harvest indices were reduced with increasing levels of N. the grain : straw ratio of wheat due to different treatments varied in the way similar to their harvest index (Table 2).

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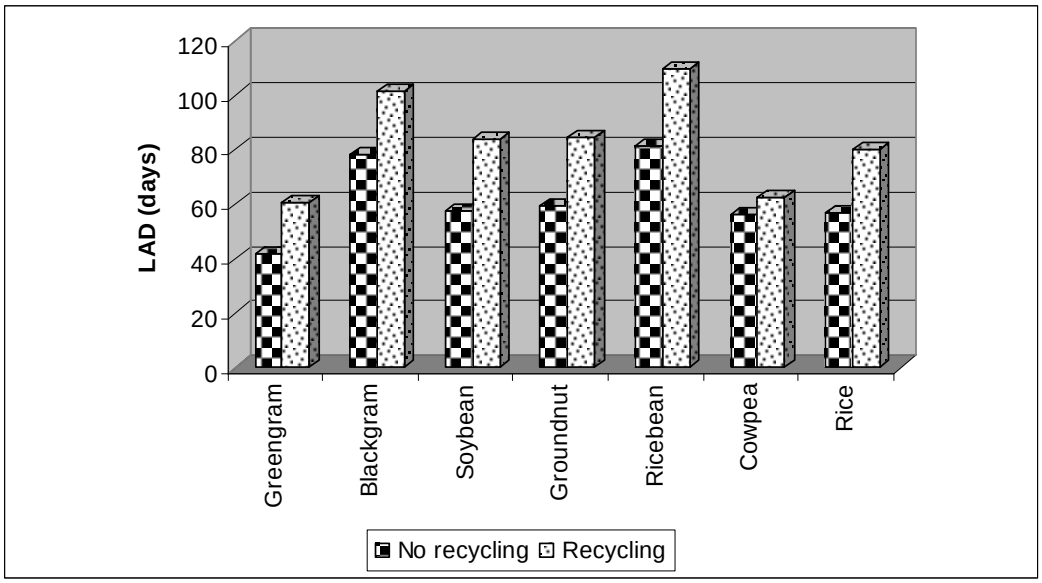

Fig. 1 : Effect of different treatments on LAD of wheat

Table 1 : Effect of different treatments on shoot growth, leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) of wheat (Mean of two years)

Treatment	Shoot (g m^{-2})			LAI			CGR (g m^{-2} day)		NAR (g m^{-2} of leaf day^{-1})	
	42 DAS	63 DAS	84 DAS	42 DAS	63 DAS	84 DAS	42-63 DAS	63 -84DAS	42-63 DAS	63 -84DAS
Kharif Crop										
Greengram	48.8	226.9	550.7	0.71	1.24	0.85	8.62	15.58	9.88	16.53
Blackgram	78.7	356.6	785.5	1.26	2.27	1.42	13.24	20.40	7.61	11.62
Soybean	62.4	339.5	581.4	1.00	1.79	0.98	13.16	11.52	9.58	9.38
Groundnut	50.6	295.0	688.7	0.89	1.95	1.16	11.64	18.75	8.28	12.73
Ricebean	68.5	357.1	734.1	1.12	2.60	1.35	13.87	15.59	8.13	7.71
Cowpea	49.3	270.1	518.7	0.80	1.46	1.05	10.32	12.04	9.41	12.03
Rice	43.6	288.3	574.2	0.69	1.90	1.21	11.70	15.85	10.35	12.71
Fallow	34.3	187.0	469.5	0.57	1.23	0.75	8.70	8.70	10.46	13.39
S.Em(±)	1.22	3.24	6.76							
CD 5%	3.52	9.40	19.59							
Recycling										
No recycling	47.2	273.9	582.6	0.76	1.61	1.01	10.78	14.74	9.80	13.04
Recycling	66.6	335.7	683.9	1.09	2.16	1.26	12.80	16.61	8.27	10.59
S.Em(±)	0.65	1.73	3.61							
CD 5%	1.80	5.02	10.47							
N Levels in Wheat										
N_0	32.6	182.1	448.7	0.59	1.11	0.76	7.09	12.74	9.56	16.03
N_{60}	56.1	300.0	619.4	0.92	1.76	1.11	11.60	15.86	8.68	10.62
N_{120}	78.6	415.8	798.6	1.19	2.54	1.45	16.07	17.71	9.15	9.68s
S.Em(±)	0.88	3.03	4.38							
CD 5%	2.49	8.56	12.39							

Table 2 : Effect of different treatments on yield components, yields, harvest index and grain-straw ratio of wheat (Mean of two years)

Treatments	Yield components			Yield (t ha^{-1})		Harvest index	Grain:Straw
	No. of effective tiller m^{-2}	No. of grain spike^{-1}	1000 grain weight (g)	Grain	Straw		
Kharif crops							
Greengram	217.2	25.3	44.5	3.14	3.83	0.45	0.82
Blackgram	282.9	29.8	44.2	4.74	6.74	0.41	0.71
Soybean	253.8	27.4	45.6	3.98	5.12	0.44	0.77
Groundnut	259.0	28.0	43.5	4.08	5.44	0.43	0.75
Ricebean	314.4	29.7	44.5	4.86	6.17	0.44	0.79
Cowpea	188.1	22.4	46.1	3.16	4.02	0.44	0.79
Rice	233.2	25.5	44.0	3.74	4.70	0.444	0.80
Fallow	166.5	20.0	44.9	2.60	3.90	0.40	0.67
S.Em(±)	7.05	0.71	0.54	0.204	0.129	0.156	0.0434
CD 5%	20.44	2.07	N.S	0.592	0.373	NS	NS
Recycling							
No recycling	229.8	26.0	44.6	3.36	4.58	0.42	0.73
Recycling	269.9	27.7	44.7	4.56	5.71	0.45	0.80
S.Em(±)	3.77	0.38	0.29	0.110	0.069	0.0084	0.0232
CD 5%	10.93	1.11	NS	0.318	0.199	0.0242	0.0674
N levels in wheat							
N_0	184.5	22.4	45.7	2.54	2.96	0.47	0.86
N_{60}	260.1	27.3	44.8	4.06	5.16	0.44	0.79
N_{120}	288.3	29.5	43.5	4.92	7.06	0.41	0.70
S.Em(±)	3.26	0.29	0.33	0.098	0.075	0.0087	0.0244
CD 5%	9.23	0.83	0.93	0.276	0.212	0.0246	0.0690