academicJournals

Vol. 8(47), pp. 6068-6072, 5 December, 2013
DOI: 10.5897/AJAR12.2146
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Growth and yield potentials of wheat as affected by management practices

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Accepted 21 November, 2013

The experiment was conducted to study growth and yield potentials of wheat as affected by agronomic practices. The experiment consisted of three factors such as (1) two methods of planting viz. conventional and bed planting (2) four wheat varieties namely Protiva, Sourav, Shatabdi and Prodip and (3) four levels of nitrogen viz. 0, 60, 110 and 160 kg N ha^{-1}. A split- split plot design was used for the experiment with three applications. The highest total dry matter, leaf area index and crop growth rate were observed in bed planting method with 160 kg N ha^{-1}. Prodip produced the highest total dry matter up to grain filling stage with the application of 160 kg N ha^{-1}. Leaf area index and crop growth rate were higher at booting and tillering stages respectively. Grain yield was higher in bed planting system than conventional one due to improvement in yield components. Grain yield was increased with increasing levels of nitrogen application. Prodip produced the highest grain yield with 160 Kg N ha^{-1}. The highest grain yield was found with the combination of bed planting method and 160 Kg N ha^{-1} and the lowest was recorded from conventional method at control treatment. The overall results indicate that Prodip showed better performance in bed planting system with 160 Kg N ha^{-1}.

Key words: Wheat, growth, management practices, nitrogen and yield.

INTRODUCTION

Bangladesh is a densely populated country and total land area under crop production has been decreasing day by day to accommodate the rapidly increasing population. As a result the total production of cereal grain is decreasing and the country is suffering from low productivity of this cereals. Though wheat is an important cereal crop in Bangladesh, its average yield is low compared to other wheat growing countries of the world. In Bangladesh, wheat is one of the most important food grain crops. It has become established as the second major cereal crop of the country, the second staple food crop next to rice having an annual production of 9.58 lakh tones and total area of 4.39 lakh ha (AIS, 2010). The food production of the country is not increasing to keep pace with the population growth. Planting method is one of the important factor which affects wheat yield. However, raised bed is widely used in developed countries as an improved system of productivity. Bed planting helps to control soil erosion, reduce soil compaction and bettering soil physical structure over time. Additionally, once the beds are established there are new opportunities to reduce crop turn-around time by re-using the same bed without tillage. Plants require several nutrient elements for their normal growth and development. Among different nutrient elements nitrogen is the most important plant nutrient needed to obtain high wheat yield as well as other crops. Nitrogen has beneficial effects in increasing wheat yield (Sobh et al., 2000). The farmers of Bangladesh do not pay enough attention to the use of an optimum N level. While majority of the farmers are

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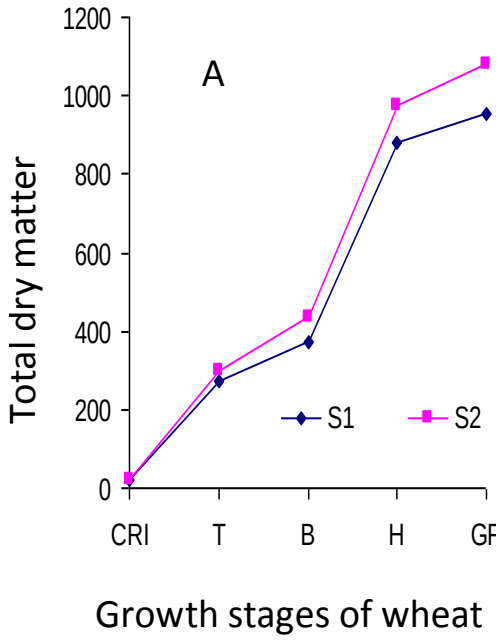

Figure 1A. Effect of sowing method on total dry matter and leaf area index.

generally not aware and not willing to use fertilizers, there is an urgent need to educate them on its optimal application and efficient use to derive maximum benefit. Optimal fertilization is a prerequisite for obtaining higher yield. The aim of the study is to determine growth and yield potential of wheat as affected by agronomic practices.

MATERIALS AND METHODS

The research work was carried out at Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, to study growth and yield potential of wheat as affected by management practices. The experiment consisted of three factors: (1) two methods of planting viz. conventional planting (S_1) and bed planting (S_2); (2) four wheat varieties namely Prodip (V_1), Shatabdi S_2), Sourav (S_3) and Protiva (V_4) and (3) four levels of nitrogen viz. 0 (N_1), 60 (N_2), 110 (N_3) and 160 (N_4) kg N ha^{-1} .The experiment was laid out in a split-split plot design with three replications. The plot size was 3 m × 4 m. Triple super phosphate (TSP), muriate of potash (MP) and gypsum were applied to the plots at the rate of 180, 50, 120 kg ha^{-1} respectively, during final land preparation. Nitrogenous fertilizer was applied as per treatment in two installments; two-third at the time of final land preparation and one-third at 27 days after sowing. All the applied fertilizers were thoroughly mixed with the soil. Seeds were sown in 25 cm rows apart, opened by specially made iron hand tine. After sowing, the seeds were covered with soil and slightly pressed by hands.

Intercultural operation was done when necessary. Plant samples were collected from each plot using 6 rows for collecting data on growth parameters. Growth study was started from crown root initiation stage (CRI) and continued up to grain filling stage. Five plants per plot were carefully uprooted randomly at each growth stage. Leaf , stem and spike (when appeared) were separated from each plant sample. The samples were packed separately in labeled brown paper bags. Then the samples were oven dried for 72 h at 70-80°C and weights were taken separately with an electrical balance. From the dry weight of different plant parts and leaf area data, leaf area index, crop growth rate and relative growth rate were calculated by classical techniques of growth analysis. After harvesting, crop of each plot was dried separately for 4 days. After that, threshing, cleaning and drying of grains were done plot-wise. Then the yields of grain and straw of each plot were recorded and the yields were then converted to hectare basis. The data recorded were compiled and tabulated for statistical analysis. The data were analyzed statistically using the analysis of variance (ANOVA) technique and the mean differences among the treatments were adjudged by new Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) with the help of MSTAT software.

RESULTS AND DISCUSSION

Total dry matter (TDM)

The increase of total dry matter was slow at the early stages of plant growth but increased rapidly with the advancement of plant age in all the varieties. The cause of rapid increase of TDM at later stages was possibly due to emergence of considerable number of new tillers $plant^{-1}$ and fertile spike $plant^{-1}$ (Balyan, 1992). Significantly higher TDM production was noticed in bed planting system compared to conventional one (Figure1A), due to proper utilization of CO_2 and solar radiation as the plants were spaced-planted in bed planting system. Similar results were obtained by Ahmed et al. (2005) in wheat showing that variety had significantly different effect on dry matter production. Prodip produced the highest dry matter at later stages of plant growth (Table 1). This was due to genetical differences as Prodip accumulated maximum dry matter than rest of the varieties. Total dry matter was higher at the highest level of nitrogen application. Significantly the highest TDM was obtained up to grain filling stage at 160 Kg N ha^{-1} (Table 1). This might be due to the contribution of nitrogen in dry matter production. Similar trend of the effect of nitrogen was also observed in wheat by Alam et al. (2005).

Leaf area index (LAI)

Green leaf area is the source of food production of green plants and significant variation was observed in respect to leaf area index among the varieties. The maximum value for LAI was observed for variety Prodip at booting stage (Table 1). This is due to varietal potentiality as Prodip produced the highest LAI across the varieties. Significantly, the highest LAI was found at the highest level of nitrogen

Table 1. Effect of variety and N levels on TDM (g m^{-2}) and LAI at different growth stages of wheat.

Variety	TDM (g m^{-2})					LAI				
	CRI	T	B	H	GF	CRI	T	B	H	GF
V_1	16.88^{b}	284.50^{a}	394.50^{b}	878.61^{c}	1008.48^{d}	0.249^{d}	0.815^{b}	2.238^{b}	1.856^{c}	1.598^{d}
V_2	20.61^{a}	260.91^{b}	382.32^{b}	832.52^{d}	968.51^{c}	0.258^{c}	0.738^{c}	2.056^{c}	2.268^{b}	1.885^{b}
V_3	20.85^{a}	263.30^{b}	385.10^{a}	982.58^{b}	1028.56^{b}	0.267^{b}	0.779^{b}	2.198^{b}	2.041^{c}	1.671^{c}
V_4	19.98^{a}	295.35^{a}	448.75^{a}	1091.51^{a}	1192.41^{a}	0.331^{a}	1.068^{a}	3.102^{a}	2.381^{a}	2.382^{a}
N Levels										
N_0	16.40^{d}	167.90^{d}	328.80^{d}	695.80^{d}	784.43^{d}	0.206^{d}	0.615^{d}	1.715^{d}	1.334^{d}	1.141^{d}
N_1	18.84^{c}	265.45^{c}	354.85^{c}	853.45^{c}	889.29^{c}	0.245^{c}	0.764^{c}	2.251^{c}	1.935^{c}	1.675^{c}
N_2	20.50^{b}	314.40^{b}	426.90^{b}	1009.95^{b}	1089.80^{b}	0.291^{b}	0.872^{b}	2.539^{b}	2.435^{b}	2.170^{b}
N_3	22.74^{a}	357.75^{a}	529.98^{a}	1227.50^{a}	1424.64^{a}	0.336^{a}	1.105^{a}	2.995^{a}	2.995^{a}	2.805^{a}
LS	0.01	0.01	0.01	0.05	0.05	0.01	0.01	0.05	0.01	0.01
CV %	5.52	6.75	4.85	4.01	2.81	4.02	3.52	2.75	4.12	3.17

In a column, figures having similar letter(s) or without letter(s) do not differ significantly as per DMRT. C= crown root initiation T=tillering B=Butting H= Heading GF=Grain filling TDM=Total dry matter LAI= Leaf area index.

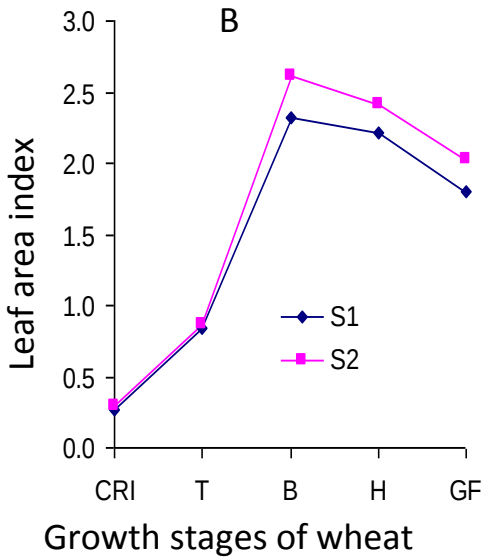

Figure 1B. Effect of sowing method on total dry matter at different growth stages of wheat.

application (160 Kg N ha^{-1}) (Table 1). This might be due to favorable synthesis of growth favouring constituents in plant system due to better supply of nitrogen, which led to the increased number of leaves per unit area resulting in enlargement in leaf area. There was a general trend of declining LAI as the age of the plant advanced. LAI was higher at booting stage and then declined up to grain filling stage. This was because it was the transition period from vegetative to reproductive phase. Bed planting system showed the highest value in respect of LAI at booting stage followed by conventional planting (Figure 1B)

Crop growth rate (CGR)

Prodip produced the highest CGR values in all the harvest (Table 2). Crop growth rate increased slowly at early stages of growth and reached the peak at booting to heading stage, thereafter, it declined. This was due to the maximum production of dry matter at early stages of plant growth. Crop growth rate represents the net result of photosynthesis, respiration and canopy area interception. The highest crop growth rate was noted at 160 Kg N ha^{-1} (Table 2). There was an increasing trend of crop growth rate in bed planting system (Figure 2A).

Relative growth rate (RGR)

Higher relative growth rate was noticed at early stages of growth in all the varieties (Table 2). These results are in agreement with the findings of Rahman (2004) in wheat. The reasons for higher relative growth rate values at early stages of growth is possibly due to the juvenility of the plants and less effects on accumulation of dry

Table 2. Effect of variety and N levels on CGR (g m^{-2} day^{-1}) and RGR (g g^{-1} day^{-1}) and yield of wheat.

Variety	CGR($gm^{-2}day^{-1}$)				RGR($gg^{-1}day^{-1}$)				Yieldtha^{-1}
	CRI-T	T-B	B-H	H-GF	CRI-T	T-B	B-H	H-GF	
V_1	14.915^{b}	7.021^{b}	33.400^{c}	11.712^{a}	0.149^{ab}	0.019^{b}	0.053^{c}	0.009^{a}	2.49^{d}
V_2	13.892^{c}	6.675^{c}	32.890^{c}	8.551^{c}	0.139^{b}	0.022^{b}	0.051^{c}	0.010^{a}	2.86^{c}
V_3	14.013^{c}	6.512^{c}	42.160^{b}	9.051^{b}	0.138^{b}	0.021^{b}	0.074^{a}	0.003^{b}	3.01^{b}
V_4	17.050^{a}	9.039^{a}	44.981^{a}	9.201^{b}	0.159^{a}	0.023^{a}	0.066^{b}	0.005^{b}	3.14^{a}
N Levels									
N0	8.001^{d}	5.495^{d}	29.150^{d}	4.985^{d}	0.120^{b}	0.033^{a}	0.067^{a}	0.009^{a}	1.78^{d}
N1	14.211^{c}	6.705^{c}	34.021^{c}	7.201^{c}	0.148^{ab}	0.018^{ab}	0.064^{a}	0.004^{c}	2.76^{c}
N2	17.057^{b}	7.451^{b}	40.685^{b}	11.021^{b}	0.159^{a}	0.016^{b}	0.058^{a}	0.005^{b}	3.34^{b}
N3	21.156^{a}	8.959^{a}	49.851^{a}	14.981^{a}	0.171^{a}	0.019^{ab}	0.055^{a}	0.009^{a}	3.61^{a}
LS	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01
CV%	4.76	5.91	6.81	5.51	3.04	5.82	3.95	7.20	9.05

In a column, figures having similar letter(s) or without letter(s) do not differ significantly as per DMRT; CGR=Crop growth rate RGR=Relative growth rate

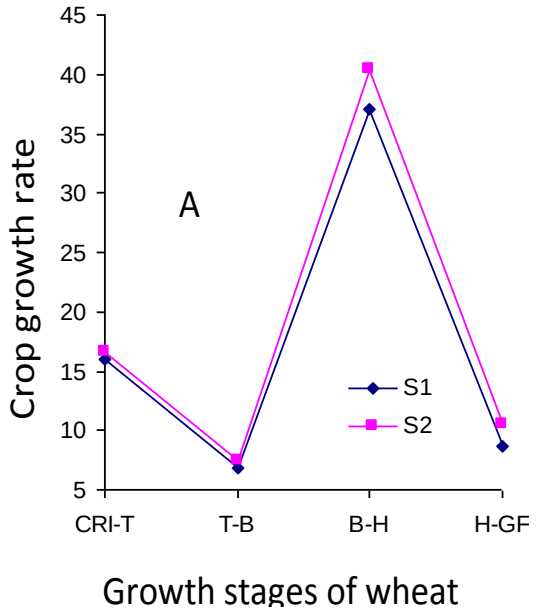

Figure 2A**.** Effect of sowing method on crop growth rate and relative growth rate.

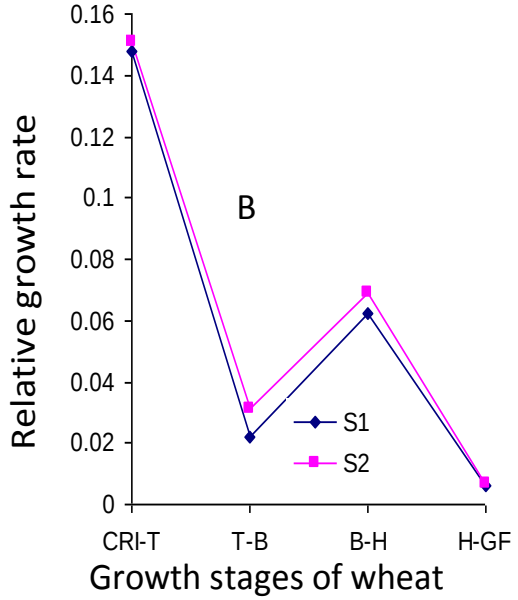

Figure 2B**.** Effect of sowing method on crop growth rate at different growth stages of wheat.

matter. Relative growth rate values decreased juvenility of the plants and less effects on accumulation of dry matter. Relative growth rate values decreased steadily with the advancement of plant age due to less dry matter accumulation. Prodip gave the highest relative growth rate values followed by Proitva (Table 2). There was a significant effect of sowing method on relative growth rate. The maximum relative growth rate values was recorded from bed planting system at crown root to tillering stage and the minimum was obtained from conventional one (Figure 2B).

Grain yield

Yield potential is defined as the yield of an adapted genotype grown under optimal managements. The yield of a crop can be expressed as the product of two components that is, Kernel number and Kernel weight. Prodip produced maximum grain yield (Table 2). The maximum grain yield in Prodip mainly resulted from the maximum expression of important yield attributes. Significantly, the highest grain yield was observed at 160 Kg N ha^{-1} (Table 2). This might be due to the highest nitrogen response to the crops and its

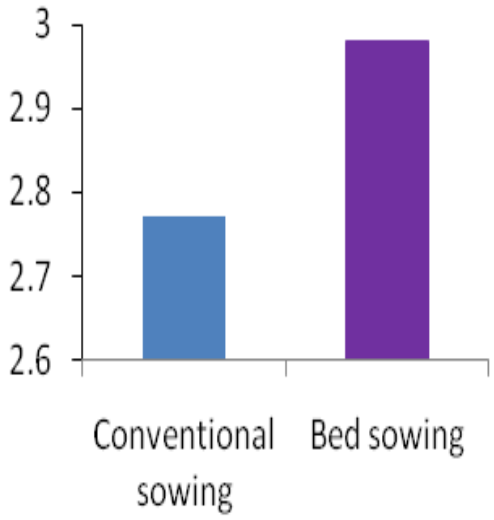

Figure 3. Effect of sowing method on yield of wheat.

efficient use by the plants, significantly resulting in the maximum number of tillers plant^{-1}, highest 1000-grain weight and higher number of grains spike^{-1}. The lowest yield was obtained from control treatment due to poor tiller number, lowest fertile spikelet's spike^{-1}, lowest 1000-grain weight and minimum number of grains spike^{-1}. Hossain et al. *(*2005) reported that grain yield was significantly increased with increasing level of nitrogen fertilizer. Significantly, the highest grain yield was noticed in the bed planting system (Figure 3). This is due to the maximum number of tillers plant^{-1}, highest number of grains spike^{-1} and higher 1000-grain weight. These results are in agreement with the findings of Hossain et al. (2005).

Conclusion

From the overall discussion it can be deduced that bed planting is better than conventional planting for producing higher yield of wheat. Better performance was noticed at increasing N rates among all the varieties. The highest values of TDM, LAI, CGR, RGR and yield were observed at 160 kg N ha^{-1}. Among the varieties, Prodip is the best one for bed planting system in maximizing productivity.

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