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INFLUENCES OF DIFFERENT VARIETIES PLANTED UNDER VARIOUS SEED RATES ON PHYSIOLOGICAL TRAITS OF WHEAT

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ABSTRACT

The influences of different wheat varieties (Sarsabz, Kiran-95, TD-1) and seed rates (100, 125 and 150 kg ha^{-1}) on physiological traits were investigated at Sindh Agriculture University, Tandojam Pakistan. It was observed that the leaf area, net assimilation rate and crop growth rate were significantly higher in Kiran-95 than that of Sarsabz and TD-1. While chlorophyll *a, b* and chlorophyll total appeared better in TD-1 than that of Kiran-95 and Sarsabz. The results despite the maximum leaf area and chlorophyll *a* appeared high at seed rate of 125 kg ha^{-1} than that of 100 and 150 kg ha^{-1}, however, the differences among them were statistically non significant (P> 0.05). The maximum leaf area, net assimilation rate and crop growth rate at seed rate of 125 kg ha^{-1} were in Kiran-95, and the maximum chlorophyll a under seed rate of 125 kg ha^{-1}, chlorophyll b, and total under seed rate of 100 kg ha^{-1} werein TD-1 variety. Based on the findings it is concluded that Kiran-95 under seed rate of 125 kg ha^{-1}, performed better followed by TD-1 and Sarsabz.

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INTRODUCTION

Wheat *(Triticum aestivum* L.) is one of the most important crops among all cereals used as a food grain in the world. It ranks first in the world cereal production and is a staple food of about one third of the world's population (Iqtidar *et al.*, 2010). It is rarely planted as a forage crop for livestock, only the straw (Bhusa) is used as a ruminant fodder component or material for roofing thatch (Kingfisher, 2004). In Pakistan, wheat has an exceptional position in the diet of people, due to mild and acceptable flavour, and unique abilities of protein, starch, fat with certain vitamins and minerals (Soomro and Oad, 2002). It occupies a central position in agricultural policies of the government and contributes 10.1 percent to value added in agriculture and 2.2 percent to gross domestic production (GDP). During the year 2012-13 its plantation scattered at an area of 8693 thousand hectares and yielded 24.2 million tones with an average of 2787 kg ha^{-1} (GOP, 2012). Pakistan is although, among top wheat producing countries of the world (Khan *et al.,* 2002).The average yield of wheat varieties grown in the country is much lower than their potential yield (Arain *et al.,* 2005). The low yield is attributed to many factors viz. sowing patterns, seed rate and varietal potentiality. The selection of suitable sowing rate and seed placement at proper depth helps to speed seed germination and more homogenous plant stand; while high yield potential varieties could play their position in maximum production (Reza *et al.*, 2006; and Qasim *et al.,* 2008). Khan *et al.* (2002) reported that optimum seed rate and suitable cultivars may have an important role in achieving its potential yield. It is of interest to note that many components viz. optimum seed rate, plant density, climatic conditions, soil types, sowing time, sowing method and varieties been direct influence on the production of wheat (Arain *et al.,* 2001). For instance, if optimal seeding rates exceed, the reduction in yield often occur (Beuerlein and Lafever, 1989; Harrison and Beuerlein, 1989). The higher seed rates significantly increased the number of spikes m^2 but significantly decrease the number of grains $spike^{-1}$ (Sial *et al.,* 2000; Arain *et al.,* 2002). It is well known that growth is a vital function of plants and indicates the gradual increase in number and size of cells; the system of growth and development are considered to begin with

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germination, followed by large complex series of agronomical, morphological and physiological events (Ting, 1982). The increase in plant mass due to assimilation i.e. production rate expresses the increase in dry matter per unit time during growth which is determined by periodic harvesting (Akmal *et al.,* 2000). Several studies on wheat have been carried out by many researchers on the influence of seeding rates on the physiological and agronomic traits of wheat, which is supposed an important management factor for improved grain yields; and exceeding or lower than optimal seeding rates influence the yield adversely (Tawaha and Turk, 2001; Hanna *et al.,* 2008; Zewdu 2008; Thomason *et al.,* 2009). Hameed *et al.* (2003) noted that seed rates above the optimum level impose nutrients, light, moisture stresses and hence adversely affect crop yield while seed rate below optimum level usually has lower yields. It is also reported that grain yield in wheat is dependent on assimilates produced by current photosynthesis in the postanthesis period, post-anthesis carbohydrates stored temporarily in vegetative organs before being re-translocated to the grain and assimilates translocated from stored carbohydrates in the vegetative plant parts produced during the pre-anthesis period (Regan *et al.,* 1993). However, such kind of attributes varies from one variety to another due their genetic makeup; it also varies from one agro-ecozone to another. Keeping these factors present study was conducted on the influences of different varieties planted under various seed rates on physiological traits of wheat.

MATERIALS AND METHODS

Plant material

Three promising wheat varieties viz; Sarsabz, Kiran-95 and TD-1 were selected and grown with three different seed rates of 100, 125 and 150 kg ha^{-1}.

Details of experiments

The field experiments were conducted during 2007-08, 2008-09 and 2009-10 at Malir Farm, Sindh Agriculture University, Tando Jam, Pakistan located at 25° 25'60'N 68o31' 60E. The experiments were conducted in randomized complete block design (factorial arrangement) with three replications. The plot size was1.2 x 2 m = 2.4 m^2 with three promising wheat varieties under three seed rates. The sowing was done with single coulter hand drill between 5th to 12th November in Rabi season during consecutive years. The basal dose of NPK fertilizers at the rate of 140-60-30 kg ha^{-1} were applied in the form of urea, Di-ammonium phosphate and sulphate of potash, respectively. All PK and half N were applied at sowing time; while remaining N was equally divided into two splits, applied at 1st and 3rd irrigation. The first irrigation was applied 25-30 days after planting and subsequent irrigations were applied as soil and crop requirement. Weed management practices were carried manually to control weeds. The soil analysis of experimental areas showed that soil was clay loam in texture, non saline, (pH= 7.2- 7.6), low in organic matter (0.88-0.96%), total nitrogen (0.49-0.57%), available phosphorus (0.86-165 mg kg^{-1}) and exchangeable potassium (248-278 mg kg^{-1}). The experiments were harvested during March, 30th to April 15th during 2007-08, 2008-09 and 2009-2010.

Analysis of physiological traits

Ten plants were selected randomly from each treatment for the analysis of physiological trait explained as under:

Leaf area (cm^2)

The flag leaf area was determined through length and breadth method measured by leaf area machine (Model-LI-3100c area meter) (Joshua and Thomas, 2011).

Chlorophyll (a, b & total)

The chlorophyll a and b were determined at 646 and 663 nm, respectively. Chlorophyll a (Ca) and chlorophyll b (Cb) were determined according to the method as reported by Kiong *et al.* (2008).

Chlorophyll a, Ca = 12.25 (OD663) – 2.79 (OD646)
Chlorophyll b, Cb = 21.50 (OD646) – 5.10 (OD663)
Chlorophyll total = (a+b) 7.15 (OD663) + 18.71 (OD646)
Chlorophyll unit: mg gm^{-1} Fresh weight; Acetone 80% 10/0.1 x 100 = 0.1 analyzed through spectrometer (Model-Hitachi 150-20) (Anatoly *et al*., 2003).

Crop growth rate

Crop growth rate was determined according to following formula as reported by Hunt (1978).

$$CGR = (W_2 - W_1) / (t_2 - t_1)$$

Where;

W_1 = Initial weight;
W_2 = Final weight;
T_1 = Initial time;
T_2 Final time

Net assimilation rate

The net assimilation rate was estimated as suggested by Hunt (1978).

$$LAD = \frac{[LAI_1 + LAI_2] \times (t_1 - t_2)]}{2}$$

Statistical analysis

The experimental data were recorded and statistically analyzed through Statistix 8.1 computer software (Analytical Software, 2005), the means were separated using least significant difference (LSD) test. All differences described in the text were significant at the 5% level of probability.

RESULTS AND DISCUSSION

Influence of different varieties on various physiological traits of wheat

The results regarding the physiological traits of three wheat varieties are depicted in Table 1. It was observed that the leaf area (42.45cm^2), net assimilation rate (3.26 mg g^{-1} day^{-1}) and crop growth rate (13.16 mg g^{-1} day^{-1}) were significantly higher in Kiran-95 than that of Sarsabz (10.90mg g^{-1} day^{-1}) and TD-1 (11.98mg g^{-1} day^{-1}). While chlorophyll a (0.80 mg g^{-1} F.Wt.), b (1.34 mg g^{-1} F.Wt.) and chlorophyll total (2.15 mg g^{-1} F.Wt.) appeared better in TD-1 than that of Kiran-95 and Sarsabz. However, net assimilation rate (3.25 mg g^{-1} day^{-1}) of TD-1 was

Table 1.Influence of different varieties on various physiological traits of wheat

Plant traits	Wheat varieties			SE ±	LSD(5 %)
	Sarsabz	Kiran-95	TD-1		
Leaf area (cm^2)	38.83 c	42.45 a	40.24 b	0.2817	0.5653
Chlorophyll a (mg g^{-1} F.Wt.)	0.651 c	0.766 b	0.804 a	0.0062	0.0124
Chlorophyll b (mg g^{-1} F.Wt.)	1.018 c	1.268 b	1.344 a	0.0238	0.0477
Chlorophyll total (mg g^{-1} F.Wt.)	1.669 c	2.035 b	2.148 a	0.0249	0.0500
Net assimilation rate (mg g^{-1} day^{-1})	3.08 b	3.26 a	3.25 a	0.0192	0.0385
Crop growth rate (mg g^{-1} day^{-1})	10.90 c	13.16 a	11.98 b	0.0833	0.1672

In each row, means followed by common letter are not significantly different at 5% probability level.

Table 2. Influence of different seed rates on various physiological traits of wheat

Plant traits	Seed rates (kg ha^{-1})			SE ±	LSD(5 %)
	100	125	150		
Leaf area (cm^2)	40.52 a	40.64 a	40.36 a	0.2817	
Chlorophyll a (mg g^{-1} F.Wt.)	0.737 a	0.744 a	0.741 a	0.1680	-
Chlorophyll b (mg g^{-1} F.Wt.)	1.191 a	1.207 a	1.231 a	0.0238	-
Chlorophyll total (mg g^{-1} F.Wt.)	1.928 a	1.951 a	1.973 a	0.0249	-
Net assimilation rate (mg g^{-1} day^{-1})	3.17 b	3.23 a	3.18 b	0.0192	0.0385
Crop growth rate (mg g^{-1} day^{-1})	11.90 b	12.09 a	12.05 ab	0.0833	0.1672

In each row, means followed by common letter are not significantly different at 5% probability level.

Table 3. Interactive influence of different varieties x seed rates on various physiological traits of wheat

Varieties	Seed rates (kg ha^{-1})	Leaf area (cm^2)	Chlorophyll (a) (mg g^{-1} F.Wt.)	Chlorophyll (b) (mg g^{-1} F.Wt.)	Chlorophyll (total) (mg g^{-1} F.Wt.)	Net assimilation rate (mg g^{-1} day^{-1})	Crop growth rate (mg g^{-1} day^{-1})
	100	38.05 f	0.645 c	0.990 d	1.635 e	3.03 e	10.70 e
Sarsabz	125	39.58 de	0.651 c	1.010 d	1.661 e	3.09 de	10.92 de
	150	38.86 ef	0.657 c	1.054 d	1.711 e	3.11 d	11.07 d
	100	42.83 a	0.764 b	1.212 c	1.976 d	3.24 bc	13.02 b
Kiran-95	125	42.84 a	0.772 b	1.276 bc	2.048 cd	3.32 a	13.32 a
	150	41.69 b	0.763 b	1.316 ab	2.080 bc	3.22 c	13.13 ab
	100	40.69 c	0.801 a	1.371 a	2.173 a	3.25 a-c	11.97 c
TD-1	125	40.23 cd	0.808 a	1.336 ab	2.144 ab	3.29 ab	12.04 c
	150	39.81 c-e	0.803 a	1.324 ab	2.127 a-c	3.21 c	11.94 c
SE ±		0.4879	0.0107	0.0412	0.0432	0.0332	0.1443
LSD (5%)		0.9791	-	-	-	-	-

In each column, means followed by common letter are not significantly different at 5% probability level.

significantly different from that of Sarsabz but statistically not varied (P>0.05) from that of Kiran-95 (3.26 mg g^{-1} day^{-1}). The result showed the maximum leaf area, net assimilation rate and crop growth rate in Kiran-95. However, chlorophyll a, b, chlorophyll total and net assimilation rate appeared better in TD-1. Fumis *et al.* (1997) also found significant differences among different wheat cultivar in this regard. This might be due to crop growth rate was obtained from dry matter, Kiran-95 produced more number of plants. The results confirmed by Sial *et al,* (2005) that different wheat cultivar due to genetic capability of a variety. Net assimilation rate is influenced by temperature, light, carbon dioxide, water, leaf age, mineral nutrients, chlorophyll content and genotype (Iqtidar *et al.*, 2010).

Influence of different seed rates on various physiological traits of wheat

Influence of seed rates on physiological traits are presented in Table 2. The results indicate that despite the maximum leaf area (40.64 cm) and chlorophyll a (0.744 mg g^{-1} F.Wt.) appeared high at seed rate of 125 kg ha^{-1} than that of seed rate 100 kg ha^{-1} (40.52cm and 0.737mg g^{-1} F.Wt., respectively) and 150 kg ha^{-1} (40.36cm and 0.741mg g^{-1} F.Wt, respectively), the differences among them were statistically non significant (P>0.05). Further chlorophyll b and chlorophyll total (1.231 and 1.973mg g^{-1} F.Wt., respectively) seems to be high at a seed rate of 150 kg ha^{-1} compared to that seed rate of 125 kg ha^{-1} (1.207and 1.951 mg g^{-1} F.Wt. respectively) and 100 kg ha^{-1} (1.191 and 1.928mg g^{-1} F.Wt., respectively), the differences among them found to be non significant (P>0.05). These results agree with Mazurek *et al.* (1984) who reported that better performance due to vigorous crop growth and also agreed with (Lemerle *et al.,* 1996; Pester *et al.,* 1999; Lemerle *et al.,* 2001). Ali *et al.* (2010) found that leaf area and canopy establishment, large leaf area development, high tillering capacity and greater plant height. Similar results were reported by Ashraf *et al.* (1994).

Interactive influence of different varieties x seed rates on various physiological traits of wheat

Results presented in Table 3 reveal the interactive effect of varieties x seed rate on various physiological traits of wheat. It was found that interactive effect of varieties x seed rate was significant over majority of physiological traits of wheat. The maximum leaf area (42.84 cm^2), net assimilation rate (3.22 mg g^{-1} day^{-1}) and crop growth rate (13.32 mg g^{-1} day^{-1}) at seed rate of 125 kg ha^{-1} were in Kiran-95 and the maximum chlorophyll a (0.808 mg g^{-1} F.Wt.) under seed rate of 125 kg ha^{-1}, chlorophyll b, and total (1.371, 2.173 mg g^{-1} F.Wt.) under seed rate of 100 kg ha^{-1} were in TD-1 variety. The minimum leaf area (38.05 cm^2), chlorophyll a, b, and chlorophyll total (0.645, 0.990, 1.635 mg g^{-1} F.Wt.), net assimilation rate (3.03 mg g^{-1} day^{-1}) and crop growth rate (10.70 gm^{-2} day^{-1}) were observed under seed rate of 100 kg ha^{-1} in Sarsabz. Our results

are agreed with Otteson *et al.* (2007). Similarly, it is also reported that growth parameters such as leaf area, crop growth rate and net assimilation rate are very important to assess the growth (Khan *et al.,* 2005). Similar, results were also obtained here. In general, the present results revealed that all physiological traits are considerably influenced by varieties at the 5% probability level. Among the three wheat varieties, Kiran-95 had markedly better performance in leaf area, net assimilation rate and crop growth rate. TD-1 was considerably superior in chlorophyll a, b and chlorophyll total, and net assimilation rate.

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