Original Research Article

Correlation studies of growth, yield and nutrient content of wheat grown under different date of sowing and varieties

ABSTRACT

A field experiment was conducted during *Rabi season (*2015-16) at Instructional Farm, Department of Agronomy, College of Agriculture JAU, Junagadh (India) to evaluate the identification of suitable date of sowing and variety of wheat (*Triticum aestivum L.*) for South Saurashtra (Gujarat). The experiment was laid out in split plot design with four dates of sowing in main plots (05th November, 15th November, 25th November and 05th December) and three varieties in sub plots (GW 322, GW 366 and GW 173) and replicated thrice. The analysis showed positive correlation between grain yield and growth parameters *viz*., plant height at 60 DAS (r=0.932**) and harvest (r=0.940**), dry matter accumulation at harvest (r=0.976**), crop growth rate between 30 to 60 DAS (r=0.996**), root dry weight at 60 DAS (r=0.945**) and harvest (r=0.867*), root length at 60 DAS (r=0.960**) and harvest (r=0.935**). Grain yield showed positive correlation with yield attributes and nutrient content *viz*., effective tillers/plant (r=0.758**), spike length (r=0.937**), grains/spike (r=0.991**), spike weight (r=0.954**), test weight (r=0.995**), water use efficiency (r=0.785**), N content (r=0.884**), P content (r=0.918**) and K content in grain (r=0.873*).

Keywords: Correlation; Date of sowing; Growth; Variety; Wheat; Yield.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the world's leading cereal crop in the term of area harvested. It is the third most-produced cereal after maize and rice in the world. India achieved remarkable progress in wheat production during the last four decades and is the second largest wheat producer in the world. Wheat has highest protein among cereals, which is known as gluten and is important for the bakery purpose. It is a thermo-sensitive cool season crop and long day plant; hence, weather affects its growth, productivity as well as grain quality. Studies indicate that weather during cropping season strongly influences crop growth and it accounts for two third of the variation in productivity, while other factors including soil and nutrient management accounts for only one third of productivity [1]. The predominant influence of weather is operative even before the crop is sown as the moisture availability and the thermal regime of the seed zone determine the date of sowing and the appropriate genotype to be sown. Among the climatic factors, temperature plays a key role in determining sowing time and consequently the duration of different phenophases and thus, the crop productivity of wheat in almost all wheat growing regions starting from germination to maturity [1, 2]. The physiological functions and growth stages are severely affected with temperature which decides the duration of life cycle of wheat plant [3]. Under late sown conditions, the wheat crop forcefully completes its life cycle before stipulated time available to grow the crop. Normally, this temperature occurs in first fortnight of November, but when sowing is delayed, the temperature gets low which does not allow quick germination, early growth and development of crop. Besides, flowering and maturity period of the crop tend to enhance and as a consequence, crop is liable to suffer due to high temperature coupled with high wind velocity at the time of grain formation. This means reduction tendency in all yield contributing characters and finally the yield.

It has been realized that the average yield of wheat of this region, sown during the month of November, (10 to 30th November) is well comparable to the state average [4, 5, 6], but declining trend in wheat yield has been noticed with delayed sowing i.e. in the month of December and January. It is mostly due to shorter growth period available to late sown wheat coupled with high temperature and hot winds during reproductive growth period, which leads to forced maturity and ultimately poor grain yield.

The increase in temperature is expected to affect productivity of wheat as temperature plays the most dominant role in wheat production. High temperature at ripening stage leads to premature ripening [7]. Further, selection of varieties tolerant to heat stress is another major adaptation strategy to reduce the adverse effects of high temperature on wheat crop. Higher reduction in LAI and total dry matter, but no change in maturity and anthesis days was observed at 01st and 15th November sowing as compared to later sowing in both the cultivars. GW 322 was found to give higher yield when sown at 30th November and 10th December as compared to GW 496 [8].

2. MATERIALS AND METHODS

2.1 Experimental location and climatic condition

The experiment was conducted during *Rabi* 2015-16 at Instructional Farm, Department of Agronomy, College of Agriculture JAU, Junagadh (India) to quantify the wheat yield losses and identify the suitable wheat variety for high yield under heat stress for South Saurashtra, Gujarat. The soil of experimental plot was clayey in texture and slightly alkaline in reaction with pH 7.8 and EC of 0.35 dS/m. The soil was medium in available N (241.0 kg/ha) and high in available P_2O_5 (25.5 kg/ha), and available K_2O (259.0 kg/ha). Geographically, Junagadh is situated at 21.50° N latitude and 70.50° E longitude with an altitude of 60 m above the mean sea level under South Saurashtra agro-climatic region of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer, and warm and moderately humid monsoon. The rainy season commences in the first fortnight of June and ends by mid of September with an average rainfall of 1094 mm.

2.2. Design and treatment detail

Experiment consisted of four dates of sowing in main plots viz., 05th November, 15th November, 25th November, and 05th December and three varieties in sub plots i.e. GW 322, GW 366 and GW 173 in split plot design with three replications. N, P and K content in grain was estimated by Kjeldahl method [9], Venedo-molybdous phosphoric acid yellow color method [10] and flame photometric method [11], respectively. Growth parameters, yield attributes and yield were observed using standard method. The protein content was estimated by multiplying N content of seed with a factor 6.25 [12].

2.3 Crop management

The crop was sown in rows 22.5 cm apart using 120 kg/ha seed rate. The recommended dose of N, P and K was 120, 60 and 60 kg/ha. Half N and full dose P and K was applied as basal while remaining half dose of N was given in two equal splits 25 and 45 days after sowing. N was applied through urea and DAP, P through DAP and K through MOP. Weeds were controlled by pre-emergence spray of pendimethalin herbicide 30 EC @ 0.9 kg/ha followed by one hand weeding at 30 DAS.

2.4 Statically analysis

To investigate the relationship among yield with various growths, yield attributes, yield and nutritional content, the correlations matrix were drawn using SPSS. Correlation between various parameters *viz*., growth parameters, yield parameters, yield and nutrient content were determined at probability 1 and 5% using method given by Panse and Sukhatme [13]. Simple linear regression equations for various growth, yield attributes, yield and nutritional characteristics were worked out [13].

3. RESULTS AND DISCUSSION

Results (Table 1) indicate the significant correlation among various growth characters and grain yield. Relationship among growth attributes shows that plant height at 60 DAS had positive correlation with dry matter accumulation at 60 DAS (r=0.811; $P<0.05$), harvest (r=0.918; $P<0.01$); crop growth rate between 30 to 60 DAS (r=0.933; $P<0.01$). While at harvest, plant height was significantly and positively correlated with dry matter accumulation at 60 DAS (r=0.809; $P<0.05$), harvest (r=0.918; $P<0.01$) and crop growth rate between 30 to 60 DAS (r=0.946; $P<0.01$). Root length at 60 DAS and harvest showed positive correlation with root dry weight (r=0.988; $P<0.01$ and r=0.906; $P<0.01$, respectively). Significant and positive correlations were noticed between grain yield and most of the growth characters. The relationship between grain yield and plant height at 60 DAS (r=0.932) and harvest (r=0.940); and dry matter accumulation at harvest (r=0.976) were highly significant ($P<0.01$) and positively correlated with each other. At initial crop growth stage (30 to 60 DAS), the grain yield was highly significant ($P<0.01$) and positively correlated (r=0.996) with crop growth rate (CGR), but non-significant relationship was found at later stage (60 DAS to harvest). Correlation between grain yield and root dry weight at 60 DAS (r=0.945; $P<0.01$), harvest (r=0.867; $P<0.05$), root length at 60 DAS (r=0.960; $P<0.01$) and harvest (r=0.935; $P<0.01$) were found to be significant and positively correlated. This means that increasing value of one parameter causes significant increment in another parameter. Growth characters viz., plant height, dry matter accumulation, root length and weight are responsible for the higher grain yield. Since, plant growth is assessed in terms of rate of dry matter production and partitioning into distinct plant sections, which ultimately reflects on economic yield, because it is a result of multiple physiological and biological processes. In this manner, the grains serve as a source of dry matter production and the vegetative plant parts as a sink for dry matter accumulation. These findings supported the results of Singh and Dwivedi [5], Mishra et al. [14] and Sanghera and Thind [15].

Relationship between grain yield and yield attributes viz., effective tillers/plant (r=0.758; $P<0.05$), spike length (r=0.937; $P<0.01$), grains/spike (r=0.991; $P<0.01$), spike weight (r=0.954; $P<0.01$) and test weight (r=0.995; $P<0.01$) was significantly positive. Spike length showed positive correlated with grains/spike (r=0.965; *P*<0.01). Grains/spike also had positive correlation with spike weight (r=0.969; *P*<0.01). Grain yield was significantly and positively correlated with water use efficiency (r=0.785; *P*<0.05) and nutrient content viz., N (r=0.884; *P*<0.01), P (r=0.918; *P*<0.01) and K content in grain (r=0.873; *P*<0.05). With increasing test weight, the grain yield was also increased due to availability of optimum temperature for growth and development [16, 17]. The favorable temperature as observed with timely sowing had positive effects on tillering capacity of plants; thereby, increasing number of effective tillers/plant ultimately led to increased grain yield. Qasin et al. [18], Tahir et al. [19], Ali et al. [20], Singh et al. [21] and Jat et al. [22] also reported similar findings. In another study, it was reported that grain yield had a positive and significant correlation with yield parameters [23, 24].

4. CONCLUSION

The correlation studies showed that growth characters viz., plant height at 60 DAS and harvest, dry matter accumulation at harvest, crop growth rate between 30 to 60 DAS, root dry weight at 60 DAS and harvest, root length at 60 DAS and harvest significantly and positively influenced the grain yield of wheat. Various yield attributes viz., number of effective tillers/plant, spike length, number of grains/spike, spike weight and test weight also significantly and positively affected the grain yield of wheat sown under different dates of sowing and varieties.

REFERENCES

1 Prajapat BS, Jat RA, Dhansil A, Bairwa DD. Date of sowing and varietal effects on physiological parameters in wheat (*Triticum aestivum* L.). Research Journal of Agricultural Sciences. 2018;9(4):912-915.

2 Tewari SK, Singh M. Yielding ability of wheat at different date of sowing a temperature development performance. Indian Journal of Agronomy. 1993;38(2):204-209.

3 Sahu DD, Chopada MC, Kacha HL. Trends in rainfall and temperature distribution over Saurashtra region extended summaries. National symposium on climate change and rainfed agriculture held at Hyderabad, Feb 18-20, 2010 pp.40-46.

4 Meena JP, Verma RS. Effect of different sowing dates on growth and yield of wheat varieties under humid sub tropical zone of Uttarakhand, India. Environmental Biotechnology Journal. 2015;21(2): 919-922.

5 Singh P, Dwivedi P. Morpho-physiological responses of wheat (*Triticum aestivum* L.) genotypes under late sown condition. Society for Plant Research. 2015;28(1): 16-25.

6 Hassan HA, Rahim A. The Quality characteristics of different wheat varieties grown under varying sowing dates in two locations in the northern state in Sudan. Journal of Agriculture and Research. 2016;6(2): 1-19.

7 Asseng S, Ewert F, Martre P, Rotter RP, Lobell DB. Rising temperatures reduce global wheat production. *Nature Climate Change*. 2014;15:143-147.

8 Patel HP, Lunagaria MM, Karande BI. Impect of projected climate change on wheat and maize in middle Gujarat agroclimatic zone. Journal of Agrometeorology. 2012;2(14):134-137.

9 Subbiah B, Asija GL. Alkaline permanganate method of available nitrogen determination. Current Scienc. 1956;25:259.

10 Olsen R, Watanable PS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circular No. 1954; 939.

11 Jackson ML. Soil chemical analysis. Prentice hall of India Pvt. Ltd., New Delhi. 1974;327-350.

12 Gassi S, Tikoo JL, Banerjee SK. Changes in protein and methionine content in the maturing seeds of legumes. Seed Research.1973;1:104-106.

13 Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council of Agricultural Research, 1985;New Delhi.

14 Mishra V, Misra RD, Singh M, Verma RS. Dry-matter accumulation at pre- and post-anthesis and yield of wheat (Triticum aestivum L.) as affected by temperature stress and genotypes. Indian Journal of Agronomy. 2003;48(4):277-281.

15 Sanghera, A. K. and Thind, S. K. Dry matter accumulation in wheat genotypes as affected by date of sowing mediated heat stress. International Journal of Scientific Research. 2014;8(3):2-6.

16 Dhaka AK, Bangarwa AS, Pannu RK, Malik RK, Garg R. Phenological development, yield and yield attributes of different wheat genotypes as influenced by sowing time and irrigation levels. Agrical. Sci. Digest. 2006;26(3):174-177.

17 Abdullah M, Rehman NA, Ijaz R. Planting time effect on grain and quality characteristics of wheat. Pakistan Journal Agriculture Science. 2007;44(2):200-202.

18 Qasin M. Qamer M. Faridullah A. Sowing dates effect on yield and yield components of different wheat varieties. Journal of Agriculture Research. 2008;46(2):135-140.

19 Tahir M, Ali NMA, Hussain A, Khalid F. Effect of different sowing dates on growth and yield of wheat (Triticum aestivum L.) varieties in district Jhang, Pakistan. Pakisthan Journal life Social Science. 2009;7(1):66-69.

20 Ali MA, Ali M, Sattar M, Ali L. Sowing date effect on yield of different wheat varieties. Journal Agricultural Research. 2010;48(2):157-162.

21 Singh A, Singh D, Kang JS, Aggarwal N. Management practices to mitigate the impact of high temperature on wheat. The IOAB journal. 2011;2(7):11-22.

22 Jat LK, Singh SK, Latare AM, Singh RS, Patel CB. Effect of dates of sowing and fertilizer on growth and yield of wheat (Triticum aestivum L.) in an Inceptisol of Varanasi. Indian Journal of Agronomy. 2013;58(4):168-171.

23 Sadek SE, Ahmed MA, Abd El-Ghaney HM. (2006) Correlation and path coefficient analysis in five parents inbred lines and their six white maize (*Zea mays* L.) single crosses developed and grown in Egypt. Journa App Sci Res,. 2006;2(3):159-167.

24 Kalla V, Kumar R, Basandrai AK. Combining ability analysis and gene action estimates of yield and yield contributing characters in maize (*Zea mays* L.). Crop Res-HISAR. 2001;22(1):102-106.

Table 1. Correlation matrix showing relationship among growth and yield of wheat

	Grain yield	PH at 60 DAS	PH at harvest	DMA at 60 DAS	DMA at harvest	CGR 30 to 60 DAS	CGR 60 to at harvest	RDW at 60 DAS	RDW at harvest	RL at 60 DAS	RL at harvest
Grain yield	1	0.932**	0.940**	0.710	0.976**	0.996**	-0.392	0.945**	0.867*	0.960**	0.935**
PH at 60 DAS		1	0.993**	0.811*	0.918**	0.933**	-0.639	0.912**	0.865*	0.940**	0.993**
PH at harvest			1	0.809*	0.918**	0.946**	-0.644	0.921**	0.874*	0.945**	0.991**
DMA at 60 DAS				1	0.802*	0.690	-0.834*	0.823*	0.484	0.859*	0.787*
DMA at harvest					1	0.957**	-0.471	.967**	0.777*	0.988**	0.907**
CGR 30 to 60 DAS						1	-0.386	0.941**	0.901**	0.948**	0.945**
CGR 60 to at harvest							1	-0.513	-0.292	-0.569	-0.597
RDW at 60 DAS								1	0.828*	0.988**	0.923**
RDW at harvest								.	1	0.794*	0.906**
RL at 60 DAS										1	0.935**
RL at harvest								.			1

Note :- PH at 60 DAS (Plant height at 60 DAS), PH at harvest (Plant height at harvest), DMA at 60 DAS (Dry matter accumulation at 60 DAS), DMA at harvest (Dry matter accumulation at harvest), CGR 30 to 60 DAS (Crop Growth Rate 30 to 60 DAS), CGR 60 to at harvest (Crop Growth Rate 60 to at harvest), RDW at 60 DAS (Root dry weight at 60 DAS), RDW at harvest (Root dry weight at harvest), RL at 60 DAS (Root length at 60 DAS), RL at harvest ((Root length at harvest); *P<0.05; **P<0.01 are the probability levels for significant of Pearson correlations (two tailed).

Table 2. Correlation matrix showing relationship among yield attributes, yield and nutrient content of wheat

	Grain yield	ET/plant	Spike length	Grains/spike	Spike weight	Test weight	WUE	NC in grain	PC in grain	KC in grain
Grain yield	1	0.758*	0.937**	0.991**	0.954**	0.995**	0.758*	0.884**	0.918**	0.873*
ET/plant		1	0.899**	0.810*	0.809*	0.784*	0.354	0.882**	0.919**	0.892**
Spike length			1	0.965**	0.967**	0.945**	0.599	0.950**	0.975**	0.919**
Grains/spike				1	0.969**	0.995**	0.696	0.922**	0.955**	0.910**
Spike weight					1	0.952**	0.736	0.880**	0.920**	0.834*
Test weight						1	0.728	0.893**	0.934**	0.892**
WUE							1	0.389	0.477	0.356
NC in grain								1	0.986**	0.983**
PC in grain									1	0.981**
KC in grain										1

Note :- ET/plant(Effective tillers/plant), WUE (Water Use Efficiency), NC in grain (Nitrogen content in grain), PC in grain (Phosphorus content in grain), KC in grain (potassium content in grain); *P<0.05; **P<0.01 are the probability levels for significant of Pearson correlations (two tailed).