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Investigation of growth, yield and economics as affected by FYM and some foliar treatments under late sown wheat

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Abstract
An experiment laid out in split plot design replicated four times consisted of 12 treatments, having two FYM levels i.e., FYM (10 t/ha), no FYM and six foliar nutrition (0.1% calcium chloride, 0.5% zinc sulphate, 2.0% potassium chloride, 20g/ha ethylene synthesis inhibiter 1- methyl cyclo propane (1-MCP) and water spray at post anthesis stage) along with control as no foliar spray. Soil Appication of 10 t FYM /ha resulted numerically higher value of soil moisture content at different growth stages, emergence count, dry matter, LAI, yield attributes and ultimately grain yield. Physiological response of wheat in terms of chlorophyll content (SPAD value), photosystem II efficiency (Fv/Fm), canopy temperature, leaf temperature and transpiration rate were also numerically superior with FYM application over no FYM application. However values of aforesaid parameters except canopy temperature at 90 and 110 days after sowing were statistically at par. All foliar spray treatments were numerically superior over no foliar spray. However foliar spray of Zinc sulphate (0.5%) at post anthesis resulted highest yield attributes and grain yield and significantly superior to no spray. Among all treatments, FYM+ZnSO4 gave highest cost of cultivation, gross return and net return. There was not significant interaction between FYM and foliar treatments with respect to all the aforesaid parameters.

Keywords: Growth, foliar nutrition, FYM, heat stress, late sown wheat, yield

Introduction

India produced 97.4 MT of wheat during 2016-17 with a productivity of 3.2t/ha (Directorate of economics and statistics, Ministry of Agriculture and Farmers' Welfare India, 2016-17). The country further requires 100 MT of wheat by the year 2030 (www.iiwbr.org) to fulfill the demands of the growing population which poses a major challenge in the background of prevailing changed climatic scenario. Although we are right on tract in terms of wheat production however, wheat productivity in India is less than its potential mainly due to several factors including socio economic and management factor as well as crops' exposure to various biotic and abiotic stresses. Amongst the abiotic stresses, mainly strong light, elevated temperature, soil salinity, and drought may adversely affect plant growth and performance (Dalmia and Sawney, 2004) [8].

Higher temperature during the grain filling, also called as terminal heat stress is one of the major constraints in decreasing productivity of wheat in tropical countries including India (Rane and Nagarajan, 2004) [25]. Late sowing owing to compulsions of crop rotations is one of major reason of wheat's exposure to terminal heat stress.

To meet the food demand of ever growing population, there is need to reduce yield losses due to temperature stress. Apart from selection of heat tolerant genotypes, irrigation, inorganic fertilizer management, organic fertilizers like FYM, straw mulching and manipulation of sowing date can be employed to tackle terminal heat stress problem (Badaruddin *et al*. 1998) [4].

According to Wahid *et al*., (2007) plant water status is most important variable under changing ambient condition and plant is able to maintain stable tissue water status when water is ample. FYM, apart from source of micro and macro nutrient is also known to increase soil moisture storage (Wang *et al*. 2016; Eldardiry *et al*., 2013) [32, 10]. FYM had greatest yield response over approximately equivalent NPK as former provided growth factors in addition to nutrient content (Badaruddin *et al*. 1999) [3]. They further suggested that heat-tolerant genotype was generally more responsive to additional inputs.

Work on foliar application calcium due to its protection of photosynthetic system (Zhao and Tan, 2005) [37, 38], zinc for its role in imparting thermo-tolerance to photosynthetic apparatus (Graham and Donald, 2001) [13] and enhancing activity of superoxidase dismutase (Singh *et al*., 2011) has been published.

Potassium plays an important role in carbohydrate formation, maintaining water balance in leaves and regulates stomata closing, which have a direct effect on stress resistance of the plant and its water use efficiency, resulted in producing maximum yield attributes ultimately maximum grain yield (Meshah *et al*., 2009) [19]. Foliar spray of 1- MCP (1-Methylcyclopropene a growth regulator) was found to increase kernel weight and number in wheat crop. This may be due to the suppression of the action of stress induced ethylene (Malefyt *et al*., 2010).

It was postulated in present investigation that apart from recommended NPK, extra inputs in terms of FYM and foliar sprays might give better growth physiology, yield attributes and yield under late sown condition where normally crop experiences terminal heat stress.

An experiment at Pantnagar University was conducted in split plot design in 4 replications with FYM (10t/ha) and No FYM in main plots and six foliar application i.e., 0.1% $CaCl_2$, 0.5% $ZnSO_4$, 2% KCl, 20g/ha 1-Methyl Cyclo Propane (MCP)water spray post, No spray (control) in subplots. Each foliar spray were applied at post anthesis (one week after anthesis) stage. Soil of experimental plot was silty clay loam in texture, medium in organic carbon, low in available nitrogen and medium in available phosphorus, potassium, zinc and calcium??? Near neutral in reaction. The mean maximum temperature during the *rabi* season of 2012-13 ranged from 10.8 °C to 36.6 °C whereas the mean relative minimum temperature ranged from 2.5 °C to 19.5 °C. Seed rate for sowing was 125 kg/ha with spacing 20 cm. The crop was fertilized at the rate of 120 kg Nitrogen, 60 kg P_2O_5 and 40 kg K_2O. Fertilizer was applied in 3 splits. In first basal dose, 1/3rd Nitrogen and full of P_2O_5 and K_2O were applied at the time of sowing and out of remaining 1/3rd after first irrigation and remaining 1/3rd dose of nitrogen given after 2nd irrigation. Foliar application of $CaCl_2$, KCl, $ZnSO_4$ and 1-MCP was done at post anthesis stage (2 days after anthesis) by preparing solution of respective concentrations. Spray was done by the use of knapsack sprayer. In case of 1-MCP, since the product had 1.04% a.i., for application rate of 20g/ha 2.40 g product (for 12.5 m^2 in one replication) was dissolved in water (with same spray volume *i.e*. 250 l/ha as in other treatments) and applied at post anthesis stage.

Wheat variety UP2565 was sown on 3 January during *rabi* season of 2013 at Crop research center of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, India.

Data related to soil moisture content, growth, development, physiological response and grain yield were recorded and statistically analyzed by using STPR-1 software developed by Department of Mathematics and Statistics of College of Basic Sciences and Humanities, Pantnagar.

Soil moisture content

FYM treated plots had significantly higher soil moisture (0-15 cm) content as compared to no FYM plots at 60 and 90 days after sowing. Khan *et al*., 2010 [17]; Dejene *et al*., 2012 [18] also reported that Application of farm yard manure (FYM) have been reported to improve soil physical and chemical conditions, reduce permeability, and help conserve soil moisture. Study revealed that effect of foliar nutrients was found non-significant with respect to moisture content in soil at all growth stages.

Growth and physiological

During 60 and 90 days after sowing, dry matter was statistically at par but at harvest it was significantly higher in FYM treated plot as compared to no FYM. All foliar sprays remained at par in terms of dry matter at different stages. LAI progressively decreased from 60 to 90 DAS. Application of FYM had significantly higher LAI at 60 DAS as compared to no FYM plot. However, both treatments i.e., FYM and no FYM were statistically at par at 90 DAS. Application of 0.5% ZnSO4 at post anthesis stage had significantly higher leaf area index over control only. However, all the foliar treatments were statistically similar. Foliar spray of calcium chloride, zinc sulphate, and 1-methyl cyclo propane (1- MCP) at post anthesis stage significantly influenced leaf area index

SPAD reading of FYM treated plots was significantly higher at 90 DAS when compared to without FYM plots. In earlier growth stages FYM application showed numerically higher but at par SPAD value when compared to no FYM. The higher SPAD reading in FYM treatment might be due to FYM applied plots had better moisture content and nutrient availability (Singh *et al.* 2006) [28]. Foliar treatments were unable to affect the physiological parameters significantly. Canopy (90 days) and leaf temperature (90 and 110 days stage) were statistically lower at 90 days stage compared to control.

At harvest stage when plant was exposed to heat stress, due to better nutrient and moisture regime probably FYM performed better. Similar finding was reported by Eifediyi *et al.* (2010) [11]. Zinc sulphate might have improved thermo-tolerance to the photosynthetic apparatus (significantly higher Fv/Fm value, Table 1) of wheat throughout the life cycle of the crop since LAI of the crop were improved by the application. Zinc application has been reported to increase thermo-tolerance of the photosynthetic apparatus of wheat (Graham and McDonald, 2001) [13]. The analysis of LAI revealed that significant differences between treatments with each of the zinc applications leading to an incremental increase in LAI (Eifediyi *et al.* 2010) [11]. It was also observed in our experiment that sprays of 20g/ha 1-MCP at post anthesis improved LAI significantly.

Table 1: Effect of FYM and foliar treatments on soil moisture content (SMC), dry matter, LAI, SPAD value, Fv/Fm, canopy temperature (CT) and leaf temperature (LT)

Treatments	SMC (0-15 cm)		Dry matter			LAI		Physiological Parameters				
	60 DAS	90 DAS	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	SPAD Value (90DAS)	Fv/Fm (90 DAS)	CT (90 DAS)	LT	
											90 DAS	110 DAS
Main plot												
FYM	14.7	11.6	236	550	857	4.46	3.27	41.3	0.71	18.8	23.6	33.5
NO FYM	12.0	9.8	225	530	831	4.20	3.11	39.5	0.70	19.4	24.5	33.7
S. Em.±	0.6	0.3	4.1	5.1	4.5	0.04	0.18	0.2	0.006	0.08	0.12	0.05
C.D. (p=0.05)	2.6	1.2	NS	NS	20.2	0.18	NS	1.1	NS	0.36	0.52	NS
Sub Plot												
$CaCl_2$	13.3	10.6	228	543	846	4.31	3.28	41.1	0.72	19.0	23.9	34.6
$ZnSO_4$	13.0	10.3	232	541	857	4.47	3.39	43.3	0.73	18.0	23.0	33.6

KCl	13.7	11.4	231	540	853	4.48	3.34	40.4	0.72	18.6	23.4	32.9
MCP	13.7	10.2	231	541	843	4.17	3.32	40.6	0.71	19.1	24.1	33.4
Water spray	13.4	11.3	231	539	835	4.27	3.02	38.8	0.70	19.6	24.8	33.1
No spray	13.1	10.3	232	537	832	4.27	2.78	38.1	0.67	19.6	25.0	34.3
S. Em±	0.7	0.6	4.4	9.4	11.3	0.13	0.14	0.8	0.007	0.28	0.27	0.41
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	0.40	2.3	0.019	0.82	1.06	1.17

Yield attributes and grain yield

All the yield attributing characters viz., spike/m^2, grains/spike, 1000 grain weight, spike length numerically higher values in FYM treated plots compared to no FYM. However, among all aforesaid parameters only length of spike was significantly differed in FYM treated plot compared to no FYM. The similar findings were also reported by Abbas *et al. (*2012).

0.5% ZnSO4 applied at post anthesis had the highest values of aforesaid parameters except spike length which was at par with $CaCl_2$ (0.1%), KCl (2.0%), and 1-MCP, and was significantly higher than control, water spray treated plots. The same finding was also done by Khan *et al.* (2008) [16]. The reason behind this might be that within plants zinc seems to affect the capacity for water uptake and transport and to reduce the adverse effects of short periods of heat stress Barcelo and Poschenreider 1990. Regulation of the biochemical reactions in the photosynthetic metabolism is driven by zinc as this metal integrates the structure of Rubisco (Brown *et al.*1993) [7]. Among the foliar treatments, spray of potassium showed significantly high value of spike length over water spray and control, the reason behind this may be that potassium is responsible for the maintenance of membrane integrity and stability under stress. Cell membrane stability was significantly declined under drought stress, thus potassium might have enhanced cell elongation (Bajji *et al.* 2002) [5].Transient water unavailability might expose crop to heat stress in the warm environment, thus might be in present study for small episode of water stress was offset by KCl and crop performed well under heat stress during grain filling.

At post anthesis stage foliar treatments as compared to control (no spray) resulted better effect on grain yield like yield attributes as at that time actual heat stress is experienced by the crop under late sown condition. Application of 0.5% zinc sulphate at post anthesis stage had numerically highest grain yield. There are evidences that zinc is involved in reduction of oxidative stress by inducing expression of genes encoding ant oxidative defence enzymes, such as H_2O_2 scavenging ascorbate peroxidase and glutathione reductase (Tsonko *et al.* 2012) [30]. Table 2 clear that plots treated with ZnSO4 (0.5%) have significantly higher levels of Chlorophyll content and Fv/Fm reading which reflects that plants treated with ZnSO4 (0.5%) have better PS II apparatus and able to produce more photosynthates thus yield is maximum in ZnSO4 spray treatment.

There was not significant interaction between FYM and foliar treatments with respect to all the aforesaid parameters.

Table 2: Effect of FYM and foliar treatments on yield attributes and yield

Treatments	Yield attributing characters				Yield (t/ha)
	Spikes/m^2	Spike length (cm)	Grains/ spike	1000 grains weight (g)	
Main plot					
FYM	266	11.0	36	39.1	4.4
NO FYM	257	10.7	35	38.3	4.2
S. Em.±	9.5	0.05	0.40	0.6	0.09
C.D. (p=0.05)	NS	0.16	NS	NS	NS
Sub Plot					
CaCl2	265	11.0	36	39.3	4.3
ZnSO4	278	11.1	38	40.3	4.5
KCl	268	11.3	36	38.9	4.4
MCP	268	11.2	36	38.7	4.3
Water spray	248	10.7	35	38.3	4.2
No spray	241	10.2	32	36.9	4.1
S. Em±	10	0.09	0.6	0.6	0.1
C.D.(P=0.05)	29	0.26	1.8	2.3	0.3

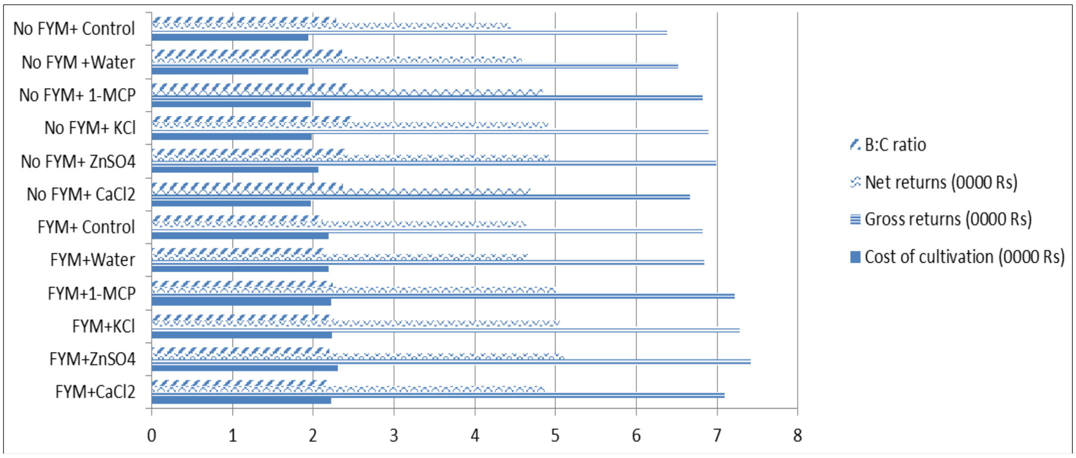

Fig 1: Economics of tretments in terms of cost of cultivation, gross and net returns and benefit: cost ratio

Crop economics

Cost of cultivation was higher in plots treated with FYM compared to no FYM. Among all treatments FYM+ ZnSO4 gave numerically highest cost of cultivation (Rs. 23111.00) when compare to FYM+ Control field (Rs.21861.00), No FYM +ZnSO4 (Rs. 20611.00) and No FYM +Control (Rs. 19361.00). However apart from highest cost of cultivation, highest gross and net returns (Rs 74159 /ha and Rs 51048 /ha respectively) was recorded with application of FYM +ZnSO4 as compared to FYM + control plots (Rs.68236 /ha and Rs 46375 /ha respectively), No FYM +ZnSO4 (Rs. 69902 /ha and Rs. 49291 /ha respectively) and No FYM +Control (Rs. 63851 /ha and Rs. 44490 /ha respectively). All those plots where FYM was applied had lower benefit cost ratio compared to where FYM was not applied. Highest benefit cost ratio was observed in plots treated with KCl followed by 1-MCP and ZnSO4 (all without FYM). Cost incurred in FYM did not produce corresponding gross returns thus resulting in reduced benefit cost ratio. Less value of KCl was the reason of higher B: C ratio in that treatment.

It can be concluded that during first year of application of FYM, non-significant effect was observed on grain yield compared to no FYM, although, FYM improved growth, physiological response, yield attributes and yield of late sown wheat. Foliar sprays of Zinc sulphate (0.5%) at post anthesis stage was statistically superior to control (no spray) in terms of grain yield. FYM with 0.5% $ZnSO_4$ obtained maximum highest returns.

References

1. Abbas G, Khattak JZK, Mir A, Ishaque M, Hussain M, Wahedi HM *et al.* Effect of organic manures with recommended dose of NPK on the performance of wheat (*Triticum aestivum* L.). The Journal of Animal & Plant Sciences. 2012; 22(3):683-687.
2. Aslam W, Muhammad A, Shaukat AS, Farooq A, Zahed M, Umer R *et al.* Effects of exogenously applied Zn on the growth, yield, chlorophyll contents and nutrient accumulation in wheat line L-5066 International Journal of Chemical and Biochemical Sciences. 2014; 5:11-15.
3. Badaruddin M, Reynolds MP, Ageeb OAA. Wheat Management in Warm Environments. Agronomy Journal. 1999; 91:975-983.
4. Badaruddin M, Reynolds MP, Ageeb O. Sustaining wheat yields with crop management in heat stressed environments, effect of organic and inorganic fertilizers, Mulching, and Irrigation Frequency. Wheat Special Mexico, DF: CIMMYT. 1998; 47:14-15.
5. Bajji M, Kinet JM, Lutts S. The use of the electrolyte leakage method for assessing cell membrane stability as a water stress tolerance test in durum wheat. Plant Growth Regulation. 2002; 36:61-70.
6. Barcelo J, Poschenrieder C. Plant water relations as affected by heavy metal stress: a review. J Plant Nutr. 1990; 13:1-37.
7. Brown PHI Cakmak, Zhang Q. Form and function of zinc in plants. Chap. 7, In A.D. Robson (Ed) Zinc in Soils and Plants, Kluwer Academic Publishers, Dordrecht, 1993, 90-106.
8. Dalmia A, Sawney V. Antioxidant defence mechanism under drought stress in wheat seedling. Annual Review of Physiology and Molecular Biology of Physiology. 2004; 10:109-114.
9. Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, GOI, 3rd_Adv_Estimates 2016-17.
10. Eldardiry E, Hellal F, Mansour H, Hady MAE. Assessment cultivated period and farm yard manure addition on some soil properties, nutrient content and wheat yield under sprinkler irrigation system Agricultural Sciences. 2013; 4(1):14-22.
11. Eifediyi EK, Remison S, Okaka VB. Effect of FYM on dry weight of Cucumber varieties. Dept. of Crop Science, Ambrose Alli University Press. MB. 14, Ekpoma, Nigeria. Graham A W 2004. Effects of zinc nutrition and high temperature on the growth, yield and grain quality of wheat (*Triticum aestivum* L.), 2010. http://hdl.handle.net/2440/37982. Accessed on 12.07.2018
12. Graham AW. Effects of zinc nutrition and high temperature on the growth, yield and grain quality of wheat (*Triticum aestivum* L.), 2004. http://hdl.handle.net/2440/37982. Accessed on 12.07.2018
13. Graham AW, Mc Donalds GK. Effects of Zinc on photosynthesis and yield of wheat under heat stress. In: Proceeding of 10th Australian Agronomy conference Hobart, Australian society of Agronomy, Hobart, Tasmania, Australia, 2001. Available at: http:/www.regional.org.au/asa/2001/2/c/ graham.html,
14. Kawakami ME, Oosterhuis MD, Sinder LJ. Effect of 1-MCP on ethylene synthesis and development of cotton flowers under normal and high temperature. Summaries of Arkansas cotton research. AAES Research Series 562, 2007.
15. Khaliq P, Malik A, Gill A. Effect of cropping system, tillage practices and fertilizer treatments on wheat stand establishment under rainfed conditions. Pakistan Journal of Agric Research. 2009; 22:1-2.
16. Khan MA, Fuller MP, Baloch FS. Cereal Research Communications. 2008; 36:571-582.
17. Khan NI, Malik AU, Umer F, Bodla MI. Effect of Tillage and Farm Yard Manure on Physical Properties of Soil. International Research Journal of Plant Science. 2010; 1(4):75-82.
18. Dejene M, Lemlem M. Integrated Agronomic Crop Managements to Improve Tef Productivity under Terminal Drought," In: I. Md. M Rahman, Hasegawa h. Eds, Water Stress, In: Tech Open Science, 2012, 235- 254.
19. Meshah EAE. Effect of irrigation regimes and foliar spraying of potassium on yield, yield components and water use efficiency of wheat in sandy soils. World Journal of Agricultural Sciences. 2009; 5(6):662-669.
20. Nawab K, Amanullah, Asad Ali. Response of Wheat to Farm Yard Manure, Potassium and Zinc under Rainfed Cropping Patterns. Middle-East Journal of Scientific Research. 2006; 1(1):01-09.
21. Nehra AS, Hooda IS, Singh KP. Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum*). Indian Journal of Agronomy. 2001; 46(1):112-117.
22. Pandey V, Patel HR, Karande BI. Impact analysis of climate change on different crops in Gujarat, India. Isprs Archives Xxxviii-8/W3 Workshop Proceedings: Impact of Climate Change on Agriculture, 2007, 60-67.
23. Patidar M, Mali AL. Effect of FYM, fertility levels and biofertilizers on growth, yield and quality of sorghum

(*Sorghum bicolor).* Indian Journal of Agronomy. 2004; 49(2):117- 120.

24. Prasad BK, Singh DN, Singh SN. Effect of long-term use of fertilizer, lime and manures on growth and yield of sweet corn. Journal of the Indian Society of Soil Science. 2003; 34:271-274.
25. Rane J, Nagarajan S. High temperature index for field evaluation of heat tolerance in wheat varieties. Agriculture system. 2004; 79:243-255.
26. Sain MK, Chaplot PC. Effect of nitrogen levels, organic manure and bio-fertilizers on nutrient uptake and quality of late sown wheat (*Triticum aestivum* L.) and soil nutrient status. Environment and Ecology. 2014; 32(2A):739-741.
27. Singh A, Singh D, Gill BS. Planting time, methods, and practices to reduce the deleterious effects of high temperature on wheat. In the Proceedings of International Conference on Preparing Agriculture for Climate Change, Punjab Agricultural university, Ludhiana, February 6-8, 2011, 338-339.
28. Singh M, Srivastava P, Srivastava N, Chaturvedi K, Singh D. Photosynthetic characteristics of flag leaf and grain yield in differentially sown four cultivars of *Triticum aestivum* (L.). Physiology & Molecular Biology of Plants. 2006; 12:283-287.
29. Tani F, Barrington S. Zinc and copper uptake by plants under two transpiration rates. Part I. Wheat (*Triticum aestivum* L.) Journal of Environmental Pollution. 2005; 138:549-548.
30. Tsonko T, Fernando JCL. Zinc in plants - An overview. Emirates Journal of Food and Agriculture. 2012; 24(4):322-333.
31. Verma VK, Singh V, Choudhary S, Tripathi AK, Srivastava AK. Effect of organic manures and microbial inoculants superimposed over inorganic fertilizers on production and profitability of wheat (*Triticum aestivum*). Current Advances in Agricultural Sciences. 20122012. 2015; 7(2):129-132.
32. Wang XJ, Jia ZK, Liang LY *et al*. Impacts of manure application on soil environment, rainfall use efficiency and crop biomass under dryland farming. Scientific Reports. 2016; 6:20994.
33. Wei Tan, Meng Q, Brestic M, Olsovska K, Yang X. Photosynthesis is Improved by Exogenous Calcium in Heat Stressed Tobacco Plants. Journal of Plant Physiology, 2011, 2063-2071.
34. www.iiwbr.org
35. Yadav DS, Kumar V, Yadav V. Effect of organic farming on productivity, soil health and economics of rice (*Oryza sativa*)– wheat (*Triticum aestivum*) system. Indian Journal of Agronomy. 2009; 54(3):267-271.
36. Zareian B, Naderi A, Jalal Kamali, MR, Modhej A. Determination of physiological traits related to terminal drought and heat stress tolerance in spring wheat genotypes. Intl J Agri Crop Sci. 2013; 5(21):2511-2520.
37. Zhao JH, Brunner EJ, Kumari M, Singh A, Hawe E, Talmud PJ *et al.* Longitudinal study of APOE polymorphism, socioeconomic status and cognitive function in later mid-life: the Whitehall II study. Soc Psychiatr and Psychiatr Epidemiol. 2005; 40: 557-563.
38. Zhao HJ, Tan JF. Role of calcium ion in protection against heat and high irradiance stress-induced oxidative damage to photosynthesis of wheat leaves. Photosynthetica. 2005; 43:473-476.