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Effect of Bio-fertilizer and Organic fertilizer on physiological characteristics of Bread Wheat [*triticum aestivum L]*.

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Abstract In the present study the effect of Bioferilizer (*Azotobacter sps.*) and organic fertilizer I,e farmyard manure and Jinong an organic liquid fertilizer containing Humic Acid applied alone or in combination on physiological characters of wheat *Triticum aestivum* L. VarietyK-9107 (Deva)] was studied. The study performed during Nov. 2009 to April 2011 at Christ Church College, Kanpur, spread over investigation concerned with the effect of Biofertilizer and to compare it with organic fertilizers. The Biofertilizer [*Azotobacter]*and farmyard manure was applied as soil treatment. Jinong Based on preliminary experiments 0.2% Jinong and 0.3% Jinong were applied at soaking seed stage and three sprays at intervals of 14 days, the first spray being 20 DAS (days after sowing). (since 0.2% Jinong gave better result it was used for combined treatments with Biofertilizer / farmyard manure. Summarizing the entire investigation one can conclude that Biofertilizer (*Azotobacter sps.*) treatment applied alone was very effective in promoting physiological parameters. When Biofertilizer was added to FYM the effect was better .Treatment of Jinong (J), the liquid organic fertilizer containing humic acid applied alone was very effective compared to Biofertilizer alone, FYM alone or Bf + F. Application of 0.2% J was generally better than 0.3% J. Moreover, Jinong + Biofertilizer was more effective than Biofertilizer + FYM except chlorophyll a, Addition of FYM to 0.2% J proved to be the best among the test applications. Combined treatment of Bf + FYM + Jinong showed very less or negative effect.

Introduction; In a bid to increase food crop excessive farming is done. Fertility of soils has been declining due to extensive use of land and chemical fertilizers in quest of producing more food for ever increasing population. The organic content of most soils is below the critical level. Extensive use of chemical fertilizers has been inflicting adverse effect on the environment causing pollution and damaging beneficial soil flora and fauna, causing erosion and lower crop quality (Kumar *et al.*, 2000). Globally wheat is a leading source of vegetable protein in human food and in terms of total production is currently second to rice as main food crop. Use of organic farming has emerged as an important priority over the chemical fertilizers in order to meet the growing demand of food in the world. Application of organic manures or biofertilizers is the only option to improve soil organic carbon for sustenance of soil quality and future agricultural productivity (Ramesh, 2008). Biofertilizer when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. The microorganisms in Biofertilizers restore the soils natural nutrient cycle and build soil organic matter. Organic fertilizer ie Jinong, recommended by China Green Food Development Center, Under the Agricultural Ministry, Govt. of China (www. cfcl_india.com /jinong-haolf.html) is an organic liquid fertilizer, whose main constituent is humic acid. Humic acid fertilizer is the essence of farm manure, its effect on increasing crop yield is more significant than chemical fertilizer and manure. Jinong organic liquid fertilizer contains – 65.54 g/l humic acid; 20.58 g/l of N; 23.69 g/l of P; 21.67 g/l of K; 2.03 g/l of Cu + Fe + Zn + Mo + Mn + B; 2.8% of water and pH is 4.3. The humic substance in the soil have multiple effects (Sangeetha *et al.,* 2006). It may have direct and indirect effects on plant growth (Chen and Aviad, 1990). Indirect effects involve improvement of soil properties such as aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability. Direct effects are those which require uptake of humic substance into the plant tissue resulting in various biochemical effects (Chen and Aviad, 1990). Singer *et al.* (1998) found that application of Delta mix (a fertilizer containing humic acid substance with micronutrients B, Zn, S, Mn, Fe and Cu) enhanced the growth with food quality of common bean. It was also observed in the present study that Biofertilizer and organic fertilizers used induced various physiological characters like relative water content[RWC], canopy temperature depression[CTD,] quantity of chlorophyll a, b, total chlorophyll, chlorophyll intensity, chlorophyll stability index and injury percentage.

Canopy Temperature Depression (CTD) is usually expressed as Canopy Temperature minus Ambient Temperature and this value is higher and a positive number in a well irrigated crop. CTD is affected by biological and environmental factors (Reynold *et al.,* 2001). It is a known fact that CTD determines the temperature of canopy of the crop. The crop which shows high vegetative growth shows low canopy temperature because of large water content. So higher vegetative growth with Biofertilizer and Jinong treatments, lower the canopy temperature and higher the CTD. CTD has been used as selection criteria for tolerance to drought and high temperature stress in wheat (Amani, *et al.,* 1996; Reynold's *et al.,* 2001). Munjal and Rana (2003) have reported that cool canopy during grain filling period in wheat is an important physiological principle for high temperature stress tolerance. CTD was positively correlated with grain yield of wheat (Amani *et al.,* 1996; Fischer *et al.,* 1998 and Bahar *et al.,* 2008) and such a conclusion can also be drawn in the present study. Gowda *et al.,* (2011) has expressed that there was a definite positive relationship between CTD, RWC and grain yield in durum wheat (Karimizadeh and Mohammadi, 2011) and bread wheat (Pinter *et al.,* 1990)

It is reported that high Relative Water Content (RWC) is a resistant mechanism to drought and that high Relative Water Content is the result of more osmotic regulation or less elasticity of tissue cell wall (Ritchie *et al.,* 1990). Teulat *et al*., 1997 observed in barley that if Relative Water Content decreased growth parameters also decreased. Decrease of Relative Water Content close stomata and also after blocking of stomata will reduce photosynthetic rate (Cornic, 2000). Thus it can be assumed that increase in RWC has increased the rate of photosynthesis with treatments which in turn must have increased growth and yield in *Triticum aestivum* L. A positive relationship was observed between grain yield and RWC at the grain filling period (Tahara *et al.*, 1990) as was also observed in the present study.

Based on Yamamato *et al.* (2002) studies, using SPAD 502 for estimation of chlorophyll content in leaves was more useful method as compared to chemical analytical methods. Many researches were conducted on the usefulness of SPAD 502 as a non destructive analysis method for determination of chloroplast pigments (Azia and Stewart, 2001; Bonneville and Fyles, 2006; Jangpromma *et al.*, 2010; Ling *et al.*, 2011). The SPAD 502 gives a value that is proportional to the amount of chlorophyll (Uddling *et al.*, 2007) but not the absolute chlorophyll content / unit leaf area or per mass of leaf tissues. It was observed in the present study that there was a significant correlation between the readings of SPAD 520 (more recent model of 502) values and readings obtained by chemical method (spectrophotometrically) indicating the usefulness of SPAD 520 in taking a quick idea of the chlorophyll content. It was also observed that the values of both the method showed parallel increased trend with use of Biofertilizer and Jinong treatments as compared to control.

Limited water availability is the main factor limiting crop production (Seghatoleslami *et al.*, 2008) and an occasional cause of losses of agricultural production (Ceccarelli and Grando, 1996). Sivasubramaniawn (1992) related the drought resistance of plants to the chlorophyll stability index that has been employed to determine the thermo-stability of chlorophyll. Use of fertilizer has increased chlorophyll index and yield (Oad *et al.*, 2004; Zeid, 2008).

Electrical conductivity has been used as an index of membrane stability to identify heat tolerant genotypes in wheat (Blum and Ebercon, 1981) and for screening of heat tolerant genotypes in different crops (Blum, 1988). When tissues are subjected to high temperature, electrical conductivity increases due to damage to the cell membrane and consequent solute leakage. Plant physiological processes differ in their response to heat stress (Fischer, 1985). Shanahan, *et al.* 1990; Fokar *et al.*, 1998 reported that there was a strong positive association between yield and heat tolerance. Thus, the effect of bio fertilizers and organic fertilizers were such that the wheat plant was able to stand stress. Jinong treated plants were better than Biofertilizer treated ones. Treatments of both Biofertilizer and Jinong induced better RWC, CTD, thermostability index and heat tolerance which could be related to better yield as also reported by Gowda *et al.*, 2011. Humic acid containing Jinong which is new to the market should be promoted and further research on this be encouraged

Materials and methods

The seeds of *Triticum aestivum* L. var. K-9107 (Deva) were obtained from Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

Preparation of Biofertilizer

The Biofertilizer (*Azotobacter sp*) in packets of 200 g each were bought from the Microbiology Dept. of C.S.A. University, Kanpur.

Preparation of farmyard manure

Farmyard manure was bought from the local market.

Preparation of solutions of Jinong

Jinong also called Zinong is an organic liquid fertilizer, manufactured by Yangling Techteam Jinong Humic Acid Products Co., Ltd. China was obtained from dealers of Elegant Fashion Fiber Chemicals Ltd.

For preparation of the experimental chemicals 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 c.c. Jinong was taken and made to 100 c.c. with distilled water in clean measuring flask and continued to 1000 ml for 0.5%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% solutions.

In order to find the most suitable concentration of Jinong i,e 0.05%, 0.1%, 0.2%, 0.3%, 0.4%, and 0.5% preliminary experiments were conducted under controlled laboratory conditions in the Department of Botany, Christ Chruch College. The experiments on seed germination and seedling growth were conducted by Garrad's Technique (1954) in test tube. For Garrad's technique seeds were placed in test tubes between blotting paper and wall of the tubes. The level of water and experimental solutions of 0.05%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5% Jinong were made upto the marked level every alternate day. ***Treatment of Biofertilizer***

The Biofertilizer *Azotobacter* was applied as soil treatment. For this soil was mixed with *Azotobacter* powder as 50 mg for 10 kg soil as recommended. In preliminary experiments soils treatment and seed treatment were compared. For seed treatment two kg wheat grains were treated in a mixture of 40 g *Azotobacter* + 10 g Jaggery. However, soil treatment being more effective this was chosen as mode of application in the present study

Treatment of Farmyard manure

Two handful of manure was added per pot wherever it was considered as application.

Treatment of Jinong

Based on preliminary experiments and experiments on seedling growth 0.2% Jinong and 0.3% Jinong were applied alone or in combinations at soaking seed stage and three sprays at intervals of 14 days, the first spray being 20 DAS (days after sowing). (since 0.2% Jinong gave better result it was used for combined treatments with Biofertilizer / farmyard manure

Spraying of Experimental Jinong Solutions

Solutions were prepared as mentioned earlier. A few drops of teepol were added as wetting agent in each solution, followed by vigorous shaking. The solutions thus prepared were throughly sprayed on the plants with the help of a 600 ml hand sprayer. The spraying machine was thoroughly cleaned, rinsed several times with the solution intended to be sprayed next to avoid any admixture of the experimental solution.

The first treatment was done by seed soaking in the respective solutions. This was followed by the first spray 20 DAS. Two more sprays of the respective solutions were made at intervals of 14 days. Control plants were sprayed with distilled water having few drops of teepol. Plants in each pot (5 sample) were drenched with approx. 100 c.c. of solution, remaining falling to the soil.

. **Ten treatments were applied as follows:**

1.	Control	6.	FYM
2.	Biofertilizer	7.	Biofertilizer + FYM
3.	0.2% Jinong	8.	0.2% Jinong + FYM
4.	0.3% Jinong	9.	0.3% Jinong + FYM
5.	Biofertilizer + 0.2% Jinong	10.	Biofertilizer + 0.2% J + FYM

Experimental Layout; For all experiments, earthenware pots (9") were arranged in randomized block design, having three blocks of two rows each.

Two pots were randomly selected in each block for each treatment. Each pot had 5 plants growing in them. Two plants in each pot were tagged for regular observations. Where observations with detached leaf or plants were required the other samples in each pot was selected. Observations were recorded fortnightly.data on various physiological characters I.e,Relative Water Content, Canopy Temperature Depression, Chlorophyll Content(a,b and total chlorophyll),Testing for Heat Tolerance (injury%)and Chlorophyll Stability Index(CSI) Testing for Drought Tolerance was recorded.All observations were made 12 days after final spray and recorded as DAS.

Results And Discussion;

Relative Water Content

Table 8 reveals the Relative Water Content (RWD) in *Triticum aestivum* L. when control was showing value almost 70%. Bf caused increase was better in RWC to 71.37% Bf + 0.2% J was better (71.82% than Bf + F). Among the treatments applied alone it was maximum (74.74%) with 0.2% J dose as compared to 70.80% in the control. With FYM, RWC was (71.04%). Among the combined doses 0.2% J + F induced maximum (75.77%) effect. With higher dose of Bf + 0.2% J + F the RWC decreased to 69.97%.

Table 8 (data in parenthesis) reveals the percentage increase over control of the RWC. Among Bf treatments Bf + 0.2% J was best (by 1.44%). With 0.2% J it was 5.56% percentage increase. Application of FYM alone increased the percentage increase to 0.33%. Among the combined treatments 0.2% J + F promoted maximum RWC i.e. 7.02% increase over control. Dose of Bf + 0.2% J + F further decreased it to -1.17%.

Canopy Temperature Depression

Canopy Temperature Depression (CTD) (Table 8) was also on the rise with all treatments and this increase was significant except with FYM, Bf + 0.2% J + F. With Bf alone it was 3.74ºC Bf + 0.2% J was more (4.00ºC) than Bf + F. Comparison of treatments applied alone indicated that 0.2% J induced maximum (4.30º C) CTD as compared to 3.00ºC in the control. With FYM treatments the reading was 3.30ºC. Adding FYM with Jinong induced higher value of CTD and was maximum (4.77ºC) with 0.2% J + F. Application with a higher dose (Bf + 0.2% J + F) decreased the value to 3.06ºC.

Figure 8a reveals the percentage increase over control of CTD which ranged from 2.00 to 59.00. Among the Bf applications Bf + 0.2% J Treatment of 0.2% J and 0.3% J induced 43.34 and 35.33 percentage increase over control respectively. FYM caused 10.00 percentage increase over control. Combination of Jinong + FYM promoted it further and was maximum (59.00) percentage with 0.2% J + F. The percentage increase was only 2.00% with Bf + 0.2% J + F **Chlorophyll content**

Chlorophyll 'a': All treatments with the experimental Biofertilizer increased chlorophyll 'a' and was best with Bf + F (1.41) (Table 9). With treatments applied alone chlorophyll 'a' was maximum (1.50 mg/g) with 0.2% J as compared to 1.28 mg/g in the control. However, with FYM applications the value was 1.31 mg/g. With combination applications the range was higher than when Jinong and FYM were given alone and was 1.31 to 1.59 mg/g. It was best with 0.2% J + F and minimum with Bf + 0.2% J + F.

Table 9 (data in parenthesis) reveals the percentage increase over control of chlorophyll 'a'. Comparison of Bf treatments showed that Bf + F was best (10.15%). Among the Jinong treatments applied alone it was best with 0.2% J (17.18%). Looking at the FYM treatment sprayed alone the increase was only 2.34%. A comparison showed that the percentage increase over control was more with combined (J + F) treatments than Jinong and FYM applied. With 0.2% J + F. The percentage increase was maximum (24.21 mg/g).

Chlorophyll 'b' : Treatments of Biofertilizer and Jinong also increased chlorophyll 'b' (Table 9). With treatments applied alone the amount ranged from 0.38 to 0.43 mg/g as compared to 0.32 mg/g in control. It was maximum (0.43 mg/g) with 0.3% J. FYM application given alone stimulated chlorophyll 'b' to 0.39 mg/g. With combination of treatments the values were lesser so much so that the highest value (0.40 mg/g) was with Bf + 0.2% J. It was observed that Jinong + FYM treatments were less effective than Jinong and FYM given alone.

As seen in Table 9 (data in parenthesis), 0.3% J increased the percentage increase over control of chlorophyll 'b' to 34.37 and this was maximum among Jinong treatments applied alone. Among Biofertilizer treatments Bf + 0.2% J was best and showed was 25% increase. FYM treatment given alone induced 21.87% increase over control. The percentage increase over control was same (3.12%) with 0.2% J + F and 0.3% J + F applications and there was no increase with Bf + 0.2% J + F. The combined treatments were less effective than when given separately.

Total chlorophyll

All treatments except Bf + 0.2% J + F increased the total chlorophyll (Table 9) of *Triticum aestivum* L. and increase ranged from 1.81 mg/g to 1.95 mg/g as compared to 1.80 mg/g in control. The increase was significant with 0.3% J, 0.2% J + F, 0.3% J + F. When treatments were given alone the total chlorophyll was maximum (1.86 mg/g) with 0.3% J. When FYM was applied alone the total chlorophyll increased insignificantly to 1.82 mg/g. Combination of Jinong + FYM increased the total chlorophyll more than all other applications and was best with 0.2% J + F (1.95 mg/g). Bf + 0.2% J + F there was no increase.

Figure 9a shows the percentage increase over control of total chlorophyll. Comparison of Biofertilizer treatments reveals that Bf + 0.2% J was best (1.66% increase). Among the Jinong treatments applied alone it went up to 3.33 percentage with 0.3% J. With FYM treatments applied alone the percentage increase over control of total chlorophyll was 1.11%. Comparing the combined treatments it was observed that Jinong + FYM showed better effects than Jinong and FYM when applied alone. Comparing the combination treatments the percentage increase over control was best (8.33 mg/g) with 0.2% J + F. Dose of Bf + 0.2% J + F did not increase the total chlorophyll any further.

Chlorophyll intensity

The total chlorophyll intensity with treatments as observed by chlorophyll intensity meter (SPAD 520, Plate 4 b) showed the same trend as the values of total chlorophyllobtained by treatments (Table 9).

Treatments increased the chlorophyll intensity with all treatments except Bf + 0.2% J + F but the increase was significant only with 0.2% J + F and 0.3% J + F. Among the treatments given alone 0.3% J showed its maximum effect of 40.44 SPAD unit as compared to 38.80 SPAD unit in control. Among Biofertilizer treatments Bf + 0.2% J was best (40.17 SPAD units). With FYM treatment applied alone it chlorophyll intensity was 39.10 SPAD units. With combination of Jinong + FYM chlorophyll intensity was still better and it went upto 43.80 SPAD unit with 0.2% J + F. However, Bf + 0.2% J + F showed slight decrease (37.94 SPAD unit) which was significantly less as compared to the latter treatment.

Figure 9a reveals the percentage increase over control of the chlorophyll intensity. 0.3% J was best among treatments applied alone and it was 4.22 percentage. With FYM the increase was 0.77 percentage. Treatment of 0.2% J + F was best (12.88% increase over control) among the combined treatments. The highest dose of Bf + 0.2% J + F showed decrease in value (2.21).

Chlorophyll Stability Index

Treatments of Biofertilizer and Jinong decreased the values of Chlorophyll Stability Index (CSI) except with Bf + 0.2% J + F indicating the treated plants could stand more stress (Table 10).

Among Biofertilizer treatments the value were better with Bf + 0.2% J and Bf + F (43.67). Among treatments applied alone the best value (40.14) was with 0.2% J. With FYM it was 44.60. Combined treatments of Jinong + FYM were better and it was best (38.17) with 0.2% J + F.

Figure 10a shows the percentage increase over control of Chlorophyll Stability Index. Among the Biofertilizer treatments the value was 6.82% less as compared alone, CSI value was 14.35% less (best) than control. Comparing the combination treatments 0.2% J + F was able to without drought tolerance to the best (18.56% less than control). Addition of Biofertilizer to the latter had a negative effect as compared to control.

Heat tolerance test (% injury):

Treatments of Biofertilizer and Jinong were effective in helping the *Triticum aestivum* L. plants in tolerating heat stress Table 10. Among Biofertilizer treatments Bf + J was the best (46.57). Comparing

treatments applied alone 0.2% J was best (30.89). Among the combined treatments 0.2% J + F was most effective (22.42).

Figure 10a reveals the percentage increase over control of percentage injury with treatments of Biofertilizer and Jinong. Treatment of 0.2% J was best (-40.95) among treatments given alone. Comparing Biofertilizer treatment the increase went upto -10.99 with Bf + 0.2% J. For combination treatment maximum effect was observed with 0.2% J + F (-57.14).

Thus It was observed in the present study that Biofertilizer and organic fertilizers used (Chart B) induced RWC, CTD, chlorophyll content and the ability of wheat plant to stand stress. The percentage increase on over control of RWC, CTD, quantity of chlorophyll a, b, total chlorophyll, chlorophyll intensity, chlorophyll stability index and injury percentage with biofertilizer(Bf) alone, was 0.80%, 24.67%, 6.25%, 18.75%, 0.55%, 0.44%, 0.42% and -7.78% respectively. Treatment of 0.2% jinong(J) when applied alone was more promotory than Biofertilizer alone and percentage increase over control in RWC was 5.56%, in CTD was 43.34%, in chlorophyll a was 17.18%, in chlorophyll b was 28.12%, in total chlorophyll was 2.22%, in chlorophyll intensity was 4.04%, in chlorophyll stability was 16.76% and in % injury was -40.95%. When Biofertilizer and Jinong treatment were applied together the effect was better than the effect of Biofertilizer in case of RWC (1.44% increase) CTD, (33.30% increase), chlorophyll b (25%), total chlorophyll (1.66% increase), chlorophyll intensity (3.50%), increase chlorophyll stability index (8.79% increase) and % injury -10.99% increase over control).

Biofertilizer application alone was better than FYM alone in promoting CTD, chlorophyll a, chlorophyll stability index.

Application of Farmyard manure with Biofertilizer was more effective than both applied alone in inducing RWC, CTD, chlorophyll a, total chlorophyll, chlorophyll intensity and injury %. Application of Bf + 0.2% J was a better combination than Bf + F. However when Jinong was added to Bf + F as combination there was a decline in the promotory effect. Jinong was very effective in promoting the quantity of chlorophyll and also for the plant to overcome stress. Jinong applied alone was better than Biofertilizer applied alone. Addition of Farmyard manure to Jinong brought maximum promotory effect and increase over control of RWC was 7.02%, CTD was 59.00%, chlorophyll a was 24.21%, chlorophyll b was 3.12%, total chlorophyll 8.33%, chlorophyll intensity 12.88%, chlorophyll stability index 21.07% and injury % was -57.14%.

These results are in conformity with that obtained by shaharoon *et al.*, 2006, who reported that the Biofertilizers significantly affect growth characters. Addition of organic fertilizer to Biofertilizer has enhanced growth in potato (Awad, 2002); rice (Naseer and Bali, 2007).

The increased amount of chlorophyll content in leaves indicates the photosynthetic efficiency, thus it can be used as one of the criteria for quantifying photosynthetic rate Yoshida (1972) stated that higher chlorophyll is one of the most important factor for better yield.

Chart B: Comparative effect of Biofertilizer with organic fertilizers on growth parameters as compared to control.

Parameters	Control	Treatments								
		BF	0.2% J	0.3% J	BF + 0.2% J	FYM	BF + F	0.2% J + F	0.3% J + F	BF + J + F
RWC (%)	70.80	0.80	5.56	2.22	1.44	0.34	1.43	7.02	3.35	-1.17
CTD (ºC)	3.00	24.67	43.34	35.33	33.30	10.00	30.00	59.00	36.67	2.00
Chl a (mg/g)	1.28	6.25	17.18	4.68	6.25	2.34	10.15	24.21	8.59	2.34
Chl b (mg/g)	0.32	18.75	28.12	34.37	25.00	21.87	6.25	3.12	3.12	0.00
Total Chl. (mg/g)	1.80	0.55	2.22	33.33	1.66	1.11	1.11	8.33	7.22	1.11
Chl. intensity (SPAD unit)	38.80	0.44	4.04	4.22	3.50	0.77	1.80	12.88	10.82	-2.21
Chl. Stability Index	40.14	0.42	16.76	10.11	8.79	4.01	8.79	21.07	11.11	-4.98
Injury %	52.32	-7.78	-	-	-10.99	-2.90	-7.81	-57.14	-38.37	-1.66

			40.95	19.01						

Data shows % increase over control

Table 8 Influence of Biofertilizer and organic fertilizer s on Relative Water Content and Canopy Temperature Depression of *Triticum aestivum* L.

S.No.	Treatment	Relative Water Content (%)	Canopy Temp. Depression (ºC)
1	Control	70.80	3.00 ±0.20
2	Bf	71.37 (0.80)	3.74* ±0.40
3	0.2% J	74.74 (5.56)	4.30* ±0.26
4	0.3% J	72.37 (2.22)	4.06* ±0.21
5	Bf + 0.2% J	71.82 (1.44)	4.00* ±0.30
6	FYM (F)	71.04 (0.33)	3.30 ±0.40
7	Bf + F	71.60 (1.13)	3.90* ±0.10
8	0.2% J + F	75.77 (7.02)	4.77* ±0.50
9	0.3% J + F	73.17 (3.35)	4.10* ±0.10
10	Bf + 0.2% J + F	69.97 (-1.17)	3.06 ±0.25

C.D. at 5% level ….. ….. ….. …..
0.44
* Significant at 5% level from control,
Bf = Biofertilizer; J = Jinong; FYM/ F = Farmyard Manure
Data in parenthesis is % increase over control.
For % increase over control of RWC and CTD see following figure.

Table 9: Influence of Biofertilizer and organic fertilizer s on Chlorophyll a, b, Total Chlorophyll and Chlorophyll intensity of *Triticum aestivum* L.

S.No.	Treatment	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (mg/g)	Chlorophyll intensity (SPAD unit)

1	Control	1.28	0.32	1.80 ±0.03	38.80 ±1.19
2	Bf	1.36 (6.25)	0.38 (18.75)	1.81 ±0.01	38.97 ±0.93
3	0.2% J	1.50 (17.18)	0.41 (28.12)	1.84 ±0.02	40.37 ±0.40
4	0.3% J	1.34 (4.68)	0.43 (34.37)	1.86* ±0.02	40.44 ±0.71
5	Bf + 0.2% J	1.36 (6.75)	0.40 (25.00)	1.83 ±0.05	40.17 ±2.16
6	FYM (F)	1.31 (2.34)	0.39 (21.87)	1.82 ±0.02	39.10 ±2.98
7	Bf + F	1.41 (10.15)	0.34 (6.25)	1.82 ±0.03	39.50 ±1.54
8	0.2% J + F	1.59 (24.21)	0.33 (3.12)	1.95* ±0.02	43.80* ±4.97
9	0.3% J + F	1.39 (8.59)	0.33 (3.12)	1.93* ±0.005	43.00* ±0.66
10	Bf + 0.2% J + F	1.31 (2.34)	0.32 (0.00)	1.80 ±0.006	37.94 ±1.33

C.D. at 5% level …. ……

0.04 ….. 3.46

* Significant at 5% level from control,

Bf = Biofertilizer; J = Jinong; FYM/ F = Farmyard Manure

Data in parenthesis is % increase over control.

For % increase over control of total chlorophyll and chlorophyll intensity see following figure.

Table 10

Table 10: Influence of Biofertilizer and organic fertilizers on chlorophyll stability index and heat tolerance test of *Triticum aestivum* L.

S.No.	Treatment	Chlorophyll stability index (CSI)	Heat tolerance test or injury (%)
1	Control	46.87 ± 0.29	52.32 ± 0.41
2	Bf	44.20 ± 0.51	48.25* ± 0.28
3	0.2% J	40.14* ± 1.99	30.89* ± 0.27
4	0.3% J	42.72* ± 0.74	42.37* ± 0.31
5	Bf + 0.2% J	43.67 ± 0.85	46.57* ± 0.38
6	FYM (F)	44.60 ± 0.42	50.80 ± 0.88
7	Bf + F	43.67 ± 0.85	48.23* ± 0.25
8	0.2% J + F	38.17 * ± 0.34	22.42* ± 0.45

9	0.3% J + F	41.75* ± 10.92	32.24* ± 0.57
10	Bf + 0.2% J + F	48.60 ± 0.46	51.45 ± 0.31

C.D. at 5% level ….. 3.46 ……
3.26

* Significant at 5% level from control,

Bf = Biofertilizer; J = Jinong; FYM/ F = Farmyard Manure

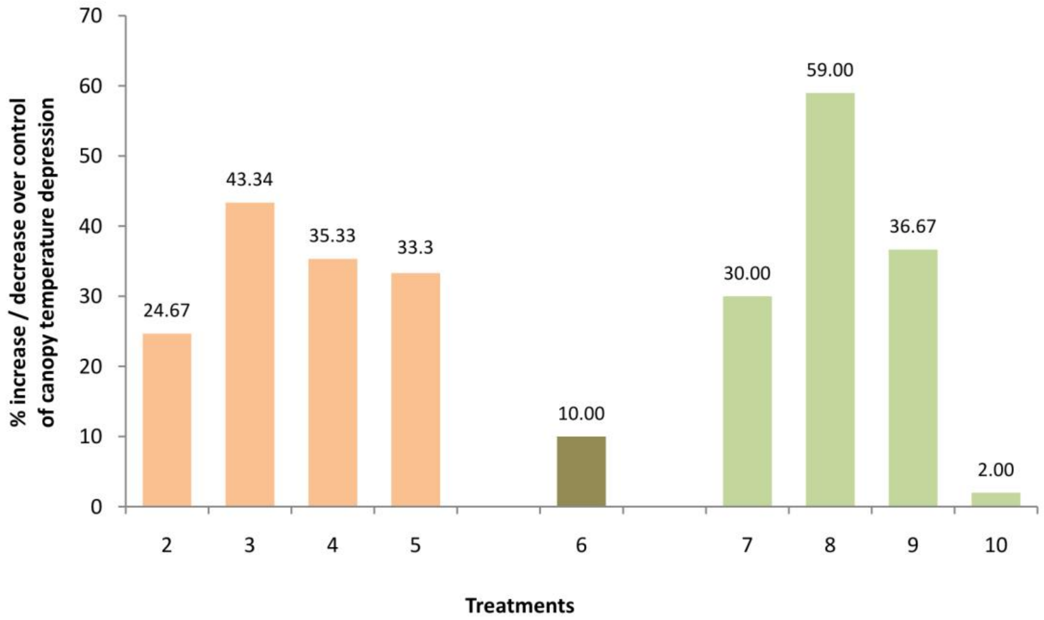
Data in parenthesis is % increase over control.

For % increase over control of CSI and injury % see following figure.

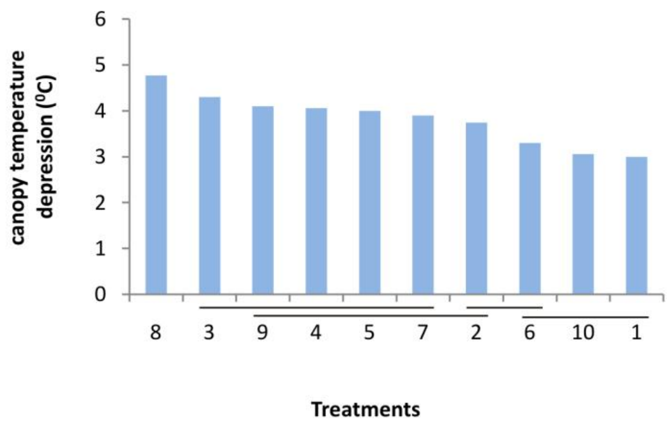
Figure 8

Fig *Comparison of Biofertilizer with organic fertilizers on Canopy Temperature Depression of Triticum aestivum L.*

(a) % increase/ decrease over control



(b) L.S.D. comparision at 5% level



L.S.D. is from mean data as seen in respective table

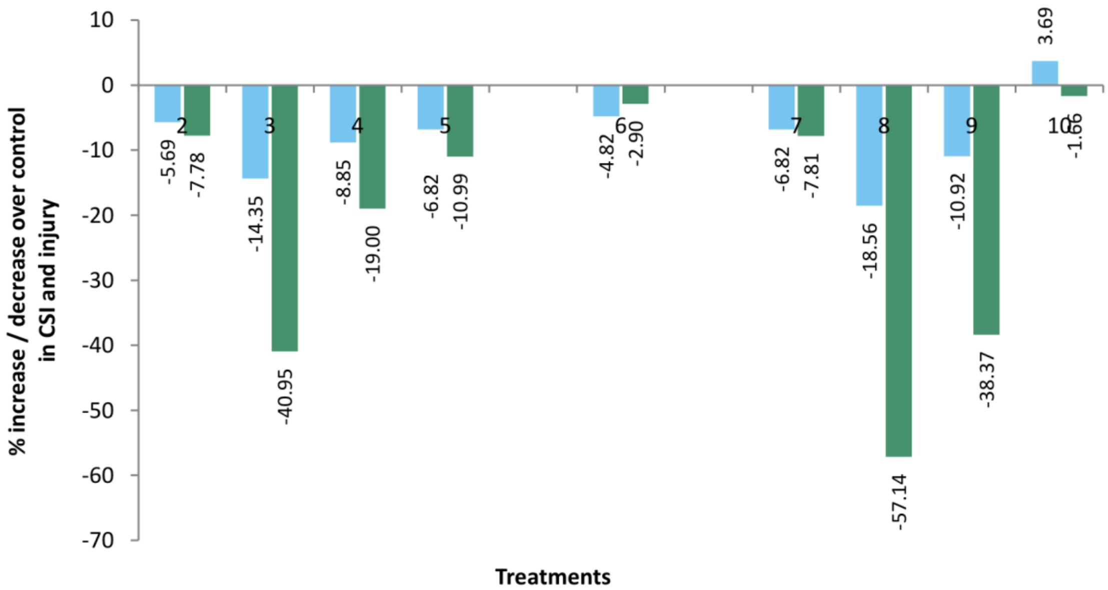
1.	**Control**	**4.**	**0.3% J**	**7.**	**Bf + F**
2.	**Bf = Biofertilizer (Azotobacter)**	**5.**	**Bf + 0.2%**	**8.**	**0.2% J+F**
3.	**0.2% J (Jinong)**	**6.**	**FYM(F)**	**9.**	**0.3% J+F**
				10.	**Bf + 0.2% J+F**

FYM / F = Farmyard Manure

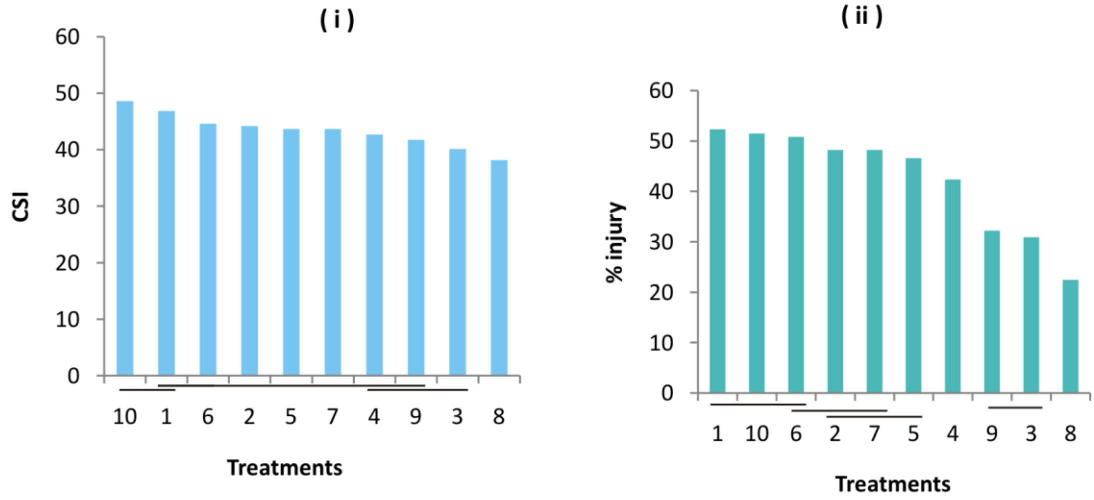
Figure 10

Comparison of Biofertilizer with organic fertilizers on Chlorophyll Stability Index (CSI) and heat tolerance test (injury%) of Triticum aestivum L.

(a) % increase over control



(b) L.S.D. comparision at 5% level



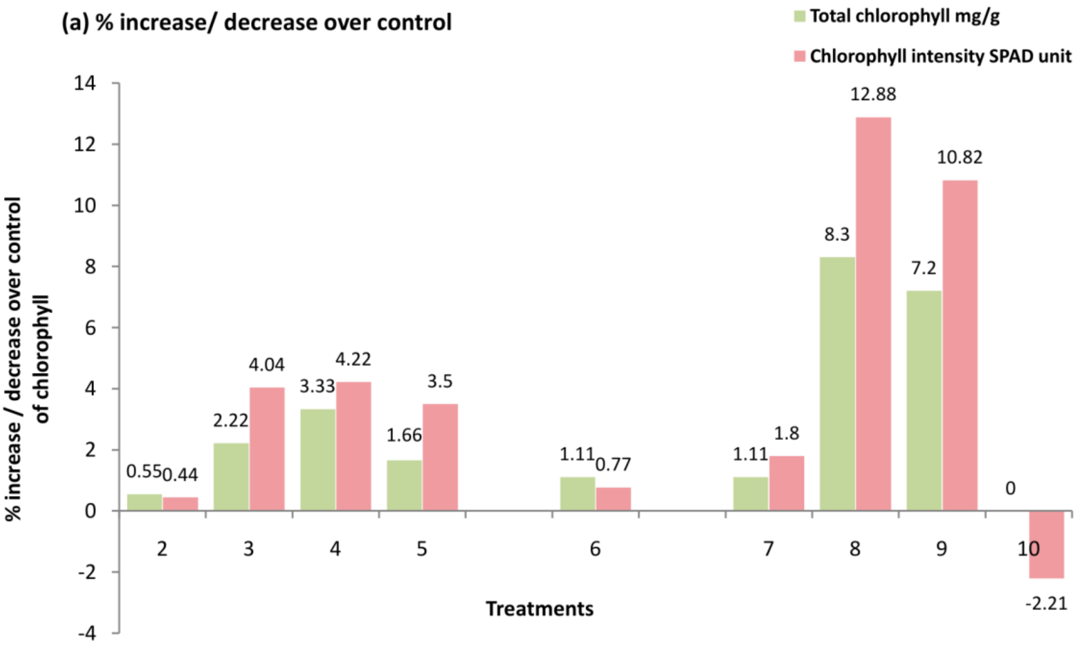
L.S.D. is from mean data as seen in respective table

1.	Control	4.	0.3% J	7.	Bf + F
2.	Bf = Biofertilizer (Azotobacter)	5.	Bf + 0.2%	8.	0.2% J+F
3.	0.2% J (Jinong)	6.	FYM(F)	9.	0.3% J+F
				10.	Bf + 0.2% J+F

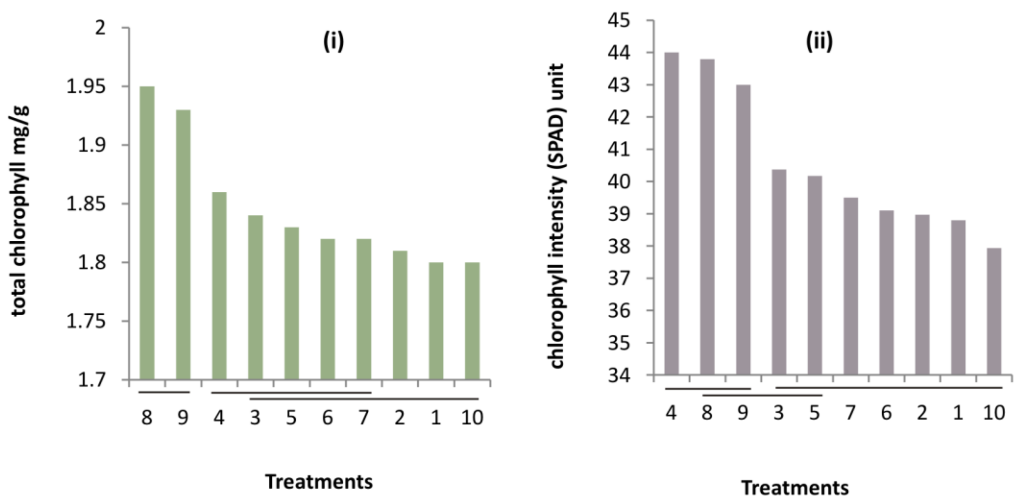
FYM / F = Farmyard Manure

Figure 9

Comparison of Biofertilizer organic fertilizers on total chlorophyll and chlorophyll intensity of Triticum aestivum L.



(b) L.S.D. comparision at 5% level



L.S.D. is from mean data as seen in respective table

1.	Control	4.	0.3% J	7.	Bf + F
2.	Bf = Biofertilizer (Azotobacter)	5.	Bf + 0.2%	8.	0.2% J+F
3.	0.2% J (Jinong)	6.	FYM(F)	9.	0.3% J+F
				10.	Bf + 0.2% J+F

FYM / F = Farmyard Manure

REFERENCES

Amani, I.; Fischer, R.A. and Reynolds, M.P. (1996). Canopy temperature depression association with yield of irrigated spring wheat cultivars in hot climate. J. Agron. Crop Sci. **176** : 119-129.

Awad, E. M. (2002). Effect of compost and some bio-fertilizers on growth, yield and quality of potato crops (*Solanum tubersum*, L.). *J. Agric. Sci, Mansoura, Univ*. **27**(8): 5525 – 5537.

Azia, F., and Stewart, K. A. (2001). Relationships between extractable chlorophyll and SPAD values in muskmelon leaves. *Journal of Plant Nutrition.* **24** (6): 961-966.

Bahar, B.; Yildirim, M.; Barutcular, C. and Genc, I. (2008). Effect of Canopy Temperature Depression on Grain Yield and Yield Components in Bread and Durum Wheat. Not. Bot. Hort. Agrobot. Cluj. **36** (1): 34-37

Blum, A. (1988). Plant Breeding for Stress Environments. *CRC Press, Inc*., Boca Raton, Florida, pp. 223.

Blum, A. and Ebercon, A. (1981). Cell membrane stability as a measure of drought and heat tolerance in wheat. *Crop Science*. **21**: 43-47.

Bonneville, M.C. and Fyles, J. W. (2006). Assessing Variations in SPAD-502 Chlorophyll meter measurements and their relationships with nutrient content of trembling Aspen Foliage. *Communications in Soil Science and Plant Analysis.* **37**: 525-539

Ceccarelli, S. and Grando, S. (1996). Drought as a challenge for the plant breeder. *Plant Growth Reg*. **20**: 149-155

Chen, Y. and Aviad, T. (1990). Effects of humic substances on plant growth, 161–186. *In* : *MacCarthy*, P.; Clapp, C.E.; Malcolm, R.L. and Bloom P.R. (eds.). Humic Substances in Soil and Crop Sciences: Selected readings. *Amer. Soc. Agronomy, Madison*, WI.

Cornic, G. (2000). Drought stress inhibits photosynthesis by decreasing stomatal aperture-not by affecting ATP synthesis. *Trends in Plant Sci*. **5:**187-188

Fischer, R.A. (1985). Number of kernels in wheat crops and the influence of solar radiation and temperature. *Journal of Agricultural Sciences*, **105** : 447-461.

. Fischer, R.A.; Rees, D.; Sayre, K.D.; Lu, Z.M.; Condon, A.G.; Larque and Saavedra, A. (1998). Wheat yield progress associated with higher stomatal conductance and photosynthetic rate, and cooler canopies. *Crop. Sci.* **38**: 1467-1475

Fokar, M.; Blum, A. and Nguyen, H.T. (1998). Heat tolerance I *Spring Wheat*. II. *Grain filling*. *Euphytica*. **104** : 9–15

Garrad, A. (1954). The effect of 1-Indole-acetic acid on the germination of certain members of Cruciferae. *New Phytol*. **53**: 165-176.

Gowda, D.S.S.; Singh, G.P. and Singh, M. (2011). Relationship between canopy temperature depression, membrane stability, relative water content and grain yield in bread wheat (*Triticum aestivum*) under heat-stress environments. *Ind. J. Agric. Sci.* **81**(3):427

Jangpromma, N.P.; Songsri, S.; Thammasirirak, and Jaisil, P. (2010). Rapid Assessment of chlorophyll content in sugarcane using a SPAD Chlorophyll Meter across different water stress conditions. *Asian Journal of Plant Sciences*. **9**: 368-374.

Karimizadeh, R. and Mohammadi, M. (2011). Association of canopy temperature depression with yield of durum wheat genotypes under supplementary irrigated and rainfed conditions, *Australian J. Crop Sci*. **5**(2):138-146.

Kumar, M.V.N. and Kumar, S.S. (2000). Studies on character association and path co-efficient for grain and oil content in maize (*Zea mays* b.) *Annals of Agri*., **21** : 73-28

Ling, Q.; Huang, Weihua; Jarvis and Paul, (2011). Use of a SPAD-502 meter to measure leaf chlorophyll concentration in *Arabidopsis thaliana. Photosynthesis Research.* **107** (2): 209-214

Munjal, R. and Rana, R. K. (2003). Evaluation of physiological traits in wheat (*Triticum aestivum* L.) for terminal high temperature tolerance. Proceedings of the Tenth International Wheat Genetics Symposium, Poestum, Italy **2** Sec. 3, *Classical and Molecular Breeding*. 804-805.

Naseer, A.D. and Amarjit, S. Bali (2007). Influence of bio-fertilizers and nitrogen levels on transplanted rice (*Oryza Sativa* L.) under temperate agro-climatic conditions of Jammu and Kashmir. *Journal of Research, SKUAST–J*. **6** (1): 67-72

Oad, F.C.V.; Buriro, A. and Agla, S.K. (2004). Effect of organic and inorganic fertilizer application maize fodder production. *Asian J. Plant Sci*. **3**: 375 377.

Pinter, P.J.; Zipoli, G.; Reginato, R.J.; Jackson, R.D.; Idso, S.B. and Hohman, J.P. (1990). Canopy temperature as an indicator of differential water use and yield performance among wheat cultivars. *Agric. Water Manage.* **18**:35-48.

Ramesh, P. (2008). Organic farming research in M.P. Organic farming in rain fed agriculture: *Central institute for dry land agriculture*, Hyderabad. 13-17.

Reynolds, M. P.; Nagarajan, S.; Razzaque, M. A. and Ageeb, O. A. A. (2001). Breeding for adaptation to environmental factors, heat tolerance. *In* : Application of Physiology in Wheat Breeding, Reynolds, M.P., J.I. Ortiz-Monasterio, A. McNab (eds)*Cimmyt, Mexico*, DF. 124-135.

Ritchie, S.W.; Nguyen, H.T. and Holaday, A.S. (1990). Leaf water content and gas exchanges parameters of two wheat genotypes differing in drought resistance. *Crop Sci*. **30**: 105-111.

Sangeetha, M.; Singaram, P. and Devi, U. (2006). Effect of lignite humic acid and fertilizers on the yield of onion and nutrient availability. *18th World Congress of Oil Science*. July 9-15, Philadelphia, Pennsylvania, USA.

Seghatoleslami, M.J.; Kafi, M. and Majidi, E. (2008). Effect of drought stress at different growth stage on yield and water use efficiency of five proso millet (*Panicum miliaceum L*.) genotypes. *Pak. J. Bot*. **40**(4): 1427- 1432.

Shanahan, J.F.; Edwards, I.B.; Quick, J.S. and Fenwick, J.R. (1990). Membrane thermostability and heat tolerance of spring wheat. *Crop Science*. **30**:247-251

Shaharoona, B.; Arshad, M.; Zahir, Z.A. and Khalid, A. (2006). Performance of *Pseudomonas* spp. containing ACC-deaminase for improving growth and yield of maize (*Zea mays* L.) in the presence of nitrogenous fertilizer. *Soil.Biol.Biochem*. **38 :** 2971–2975.

Singer, S.M.; Sawan, O.M.; AbdelMouty, M.M. and Salman, S.R. (1998). Study of the effects of the Delta mixTM and organic matter on growth and productivity of bean plants grown under calcareous soil conditions. *Egyptian J of Hortic*. **25:** 335–47

. Sivasubramaniawn, K. (1992). Chlorophyll stability index: methods for determining drought hardiness of *Acacia* species. *Nitrogen Fixing Tree Res. Rep*. **10**: 111-112.

Tahara, M.; Carver, B.F; Johnson, R.C. and Smith, E.L. (1990). Relationship between relative water content during reproductive development and Winter wheat grain yield. *Euphytica*. **49**:255-262.

Teulat, B.; Monneveux, P.; Wery, J.; Borries, C.; Souyris, I. and Charrier, A. (1997). Relationships between relative water content and growth parameters under water stress in barley: a QTL study. *New Phytologist*. **137** : 99-107.

Uddling, J.; Gelang-Alfredsson, J.; Piikki, K. and Pleijel, H. (2007). Evaluating the relationship between leaf chlorophyll concentration and SPAD-502 chlorophyll meter readings. *Photosynth. Res.* **91** : 37–46.

Yamamato, A.; Nakamura, T.; Adu-Gyamfi, J.J. and Saigusa, M. (2002). Journal of Plant Nutrition. Relationship between chlorophyll content in leaves of sorghum and pigeonpea determined by extraction method and by chlorophyll meter (SPAD-502). *Journal of Plant Nutrition.* **25**(10): 2295-2301.

Yoshida, S. (1972). Physiological aspects of grain yield. *Ann. Rev. Plant Physiol.* **23** : 437-484.

Zeid, I.M. (2008). Effect of arginine and urea on polyamines content and growth of bean under salinity stress. *Acta Physiologiea Plantarum*, **10**: 201-209.