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Interactive Effect of Water Stress and Nitrogen on Yield and Biomass of Wheat (*Triticum aestivum* L.)

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Abstract
The interactive effect of water stress and nitrogen on yield and biomass of wheat varieties Inqulab "91" and Parwaz "94" were investigated. The objective of present study is to evaluate the compensating role of nitrogen fertilizer in relation to drought stress on the growth and yield of these wheat varieties. Urea as nitrogen fertilizer was applied before imposition of water stress in plots and water stress was imposed 25, 35 and 45 days after germination. The data reveal that sporadic stress and urea fertilizer have highly significant response. The effects of water stress were mostly reduced to greater extent at high nitrogen level (98 gm/plot). Nitrogen applied at higher rates had effectively balanced the adverse effects of water stress.

Introduction
One third of wheat cultivation is on rainfed area where the crop often suffers from severe moisture stress. Much of the remaining area which is canal irrigated also encounters drought especially critical stages of plant like tillering and grain filling, thus reducing the national yield (Anonymous, 1991). According to Yaidav (1991) increasing water supply from 0.4-0.8 (iw cpe) increased yield from 2.97 to 3.8 tons ha^{-1}.

Due to water stress stem length reduces by inhibiting the elongation of internodes and also reducing tillering capacity of plants (Aspinall *et al.*, 1964).

Drought also hastens the leaf area senescence and in general the more severe the stress the greater the reduction in leaf area. Most stress treatments have also resulted in lower root and shoot ratios than found in well watered controls as well as significant yield reductions (Dwyer and Stewart, 1987).

Lahiri (1976) has reported that under sporadic drought conditions the application of nitrogenous fertilizer urea has beneficial effects on plant growth. Major *et al.* (1988) suggested that number of spikes, number of grains/spike and grain weight increased with increased nitrogen and water supply.

Arnon (1975) suggested that under conditions of limited soil moisture nutrient deficiency may have adverse effects on plants. Fertilizer often induced increase in water use during the early vegetative period. Several researchers have reported that moisture stress at any growth stage reduces crop yield (Sarwar *et al.*, 1991; Hussain *et al.*, 1992).

Materials and Methods
The experiment was conducted in the experimental area of Department of Botany, University of Agriculture, Faisalabad during 1997 to study the interactive effect of nitrogen and water stress on the growth of two wheat (*Triticum aestivum* L.) varieties namely Inqulab "91" and Parewaz "94". The seeds were obtained from the Department of Agronomy, University of Agriculture, Faisalabad.

Urea as a nitrogen fertilizer was applied. The experiment was laid out in a split plot design with three replications having seven treatments including control and a plot size of 90 x 30 sq. ft. Water stress was imposed 25, 35 and 45 days after germination. Nitrogen fertilizer was applied one day before stress. The entire experimental area was divided into two main plots for two varieties. Each main plot was further divided into three replication, each sub plot had seven treatments having an area of 5 x 8 sq.ft. each. The following treatment schedule was observed.

T_0 = Control (normal watering + normal N_2).
T_1 = Nitrogen level 49 gm/sub plot and water stress after 25 days.
T_2 = Nitrogen level 49 gm/sub plot and water stress after 35 days.
T_3 = Nitrogen level 49 gm/sub plot and water stress after 45 days.
T_4 = Nitrogen level 98 gm/sub plot and water stre[ss] after 25 days.
T_5 = Nitrogen level 98 gm/sub plot and water stre[ss] after 35 days.
T_6 = Nitrogen level 98 gm/sub plot and water stre[ss] after 45 days.

The data collected were analysed statistically and treatme[nt] means were compared using LSD (least signific[ant] difference) test following the procedures adopted by St[eel] and Torrie (1984).

Results and Discussion
100 Grain Weight: The statistical analysis given in Tab[le] reveals that different treatments significantly reduced grain weight over control. Maximum grain weight recorded in untreated control.

Maximum decrease in 100 grain weight was observed i[n] whereas minimum value was calculated in T_1. Treatments T_5, T_4 and T_3 differed significantly from one another as well as from remaining treatments and control. Non-significant differences were observed amongst treatments T_1, T_2 and T_6. Maximum 100 grain weight was noted in T_0 while minimum (4.100 gm) was observed in T_1. The two varieties showed non-significant differences from one another, however variety V_2 produced more 100 grain weight than variety V_1.

Table 1: 100-grain weight (gm)

Treatments	Means
T_0	591.70a
T_1	134.20g
T_2	172.20f
T_3	409.20d
T_4	465.80c
T_5	516.70b
T_6	287.50e

Any two means having the same letter are statistically non-significant.

Table 2: Biomass/plant

Treatment	Treatment Means	Varieties	
		V1	V2
T_0	63.67a	62.67a	62.67a
T_1	35.08f	34.33g	38.33g
T_2	45.83e	42.00f	48.00de
T_3	49.00d	49.00cd	49.00c
T_4	52.67c	51.00c	54.33b
T_5	54.67b	54.33b	54.53
T_6	49.92e	45.33e	50.02cd

Any two means having the same letter are statistically non-significant.

V x T interaction was also non-significant which shows that the two varieties responded similarly to different treatments. It is evident from the results that application of half nitrogen dose to plants stressed 45 days after germination showed significant improvement over T_1 and T_2 where water stress was imposed 25 days after germination. Full nitrogen application retrieved the condition a bit.

It can be concluded from this investigation that nitrogen applied at higher rates can effectively balance the adverse effects of water stress. Similar results have been reported by Major *et al.* (1988). These results are in agreement with Agha *et al.* (1978) who reported that seed weight increase with the use of nitrogen fertilizer. Harder *et al.* (1982) worked on corn grain and reported that stress affect the seed weight depending on the time of stress. These results are also in agreement with the finding of researchers (Sarwar *et al.*, 1991; Hussain *et al.*, 1992). They found that restricted water supply at all growth stages has a depressing effect on grain. Malik and Ahmad (1993) similarly found that moisture stress at tillering, flowering and grain developmental stages reduce grain yield.

Biomass per plant (gm): The data pertaining to biomass/plant (Table 2) showed significant reduction in biomass plant due to different treatments as compared to control. Maximum value for biomass/plant was noted in T_0 while minimum value was observed in T_1. Treatments T_1 and T_2 drastically reduced biomass/plant and were followed by treatments T_3 and T_4 accounting for a reduction of 44, 28.02, 23.04 and 17.27 per cent respectively when compared to control (T_0). Similar results were reported by Flink *et al.*, (1996). Treatments T_6 and T_2 differed non-significantly from each other but significantly from remaining treatments and control. T_1 differed significantly from the treatments and control.

A minimum decrease of (14.13%) in biomass/plant was recorded in T_5 where water stress was imposed 35 days after germination and full nitrogen was supplied. These results are in agreement with the findings of Singh and Singh (1991). The two varieties differed significantly from each other and variety V_2 produced a significantly more biomass as compared to variety V_1.

V x T interaction was significant which means that the two varieties behaved differently towards different treatments. Treatments T_2 and T_6 produced significantly different results in two varieties. These results are in agreement with the findings of Ashraf and Khan (1993), who deduced that drought stress in ten wheat varieties at early stage significantly reduce shoot biomass.

References

Agha, K.H., M. Iqbal and G.Y. Solangi, 1978. Effect of nitrogen and time of planting on the yield and quality of sunflower. Pak. J. Agri. Sci., 15: 1-2.

Anonymous, 1991. Economic Survey 1991-92. Govt. of Pakistan, Finance Division, Economics Advisors Wing, Islamabad.

Arnon, I., 1975. Physiological aspects of dry land farming. Oxford and IBH, New Delhi, pp: 3.

Ashraf, M.Y. and A.K. Khan, 1993. Effect of drought stress on wheat plant in early stage. Pak. J. Agric. Res., 14: 261-266.

Aspinall, D., P. Nicholls and L.H. May, 1964. The effect of soil moisture stress on the growth of barley. Aust. J. Agri. Res., 15: 729-745.

Dwyer, L.M. and D.W. Stewart, 1987. Influence of photoperiod and water stress on growth, yield and development rate of barley measured in wheat units. Can J. Plant Sci., 67: 21-34.

Flink, M., R. Petterson and O. Andren, 1996. Growth dynamics of winter wheat in the field with daily fertilization and irrigation. J Agro. and Crop. Sci., 174: 239-252.

Harder, H.J., R.E. Carlson and R.H. Shaw, 1982. Yield, yield component and nutrient content of corn grain as influenced by post sucking moisture stress. Agron. J., 74: 275-278.

Hussain, N.M., M.S. Chaudhry, S.M. Malik and M. Nasir, 1992. Proceeding of the 3rd symposium, Soil Science Society of Pakistan.

Lahiri, A.N., 1976. Introduction of water stress and mineral nutrition on growth and yield. (A review and evaluation adaptation of plant to water and high temperature stress. N.C. Turner and P.J. Karamereds). John Wiley and Sons. NY 347-352.

Major, D.T., B.L. Blad, J.L. Hattifield, K.G. Habbard, E.T. Knemasu and R.J. Reginato, 1988. Winter wheat grain yield response of winter and nitrogen on the North American great plains. Agri. and Forest Meteorology, 44: 141-149.

Malik, M.A. and S. Ahmad, 1993. Moisture stress and fertilizer management interaction studies on yield of wheat varieties under irrigation conditions. Pak. J. Agric. Engg. Vet. Sci., 9: 16-20.

Sarwar, M.N. Ahmad, G. Nabi and M. Yasin, 1991. Effect of soil stress on different wheat varieties. Pak. J. Agric. Res., 12: 275-280.

Singh, S.P. and H.B. Singh, 1991. Effect of irrigation time and nitrogen levels on wheat under late sown conditions of Western Uttar Perdesh. Ind. J. Agro., 36: 41-42.

Steel, R.G.D. and J.H. Torrie, 1984. Principles and procedures of statistics. With special reference to Biological Science. McGraw Hill Book Co., Inc., New York.

Vaadia, Y., F.C. Raney and R.M. Hagan, 1961. Plant water defects and physiological processes. Ann. Rev. Plant Physiol., 12: 265-292.

Yaidav, G.L., 1991. Effect of irrigation regimes, nitrogen and zinc fertilization on consumptive use and water use efficiency of late sown wheat in vertisols. Ann. Agri. Res., 12: 394-397.