

Quality and yield of wheat (*Triticum aestivum*) as influenced by irrigation scheduling and organic manures

H.P. VERMA¹, O.P. SHARMA², RAJESH KUMAR³, A.C. SHIVRAN⁴, R. SAMMAURIA⁵ AND B.L. DUDWAL⁶

Sri Karan Narendra Agriculture University, Jobner, Rajasthan 303 329

Received : September 2017; Revised accepted : February 2018

ABSTRACT

A field experiment was conducted on loamy sand soil during 2 winter (*rabi*) seasons of 2014–15 and 2015–16 at Jobner, Rajasthan, to study the effect of irrigation scheduling and organic manures on growth, yield and quality of wheat (*Triticum aestivum* L.). The treatments consisted of 5 irrigation scheduling, i.e. I₁ (irrigation at critical stages), I₂ (0.9 Irrigation water (IW) : Cumulative pan evaporation (CPE) ratio), I₃ (0.6 IW : CPE ratio at vegetative phase + 0.8 IW : CPE ratio at reproductive phase), I₄ (0.6 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase) and I₅ (0.8 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase in main plots) and 4 organic manures, viz. control (M₀), FYM @ 15 t/ha (M₁), vermicompost (VC) @ 6 t/ha (M₂) and FYM @ 7.5 t/ha + VC @ 3 t/ha (M₃) in subplots were replicated 4 times in split-plot design. The pooled data results showed that irrigation applied at 0.9 IW: CPE ratio (I₂) recorded the maximum values of number of grains/ear and yield (grain and straw) proved significantly superior to I₁, I₄ and I₃ except treatment I₅. The treatment I₂ exhibited the maximum consumptive use (395 mm). But the treatment I₅ attained significantly highest water-use efficiency (WUE) and excelled rest of the treatments. Irrigation applied at 0.9 IW : CPE ratio (I₂) resulted in the maximum chlorophyll content and was significantly superior to I₃, I₄ and I₅ except treatment I₁. However, that irrigation treatment did not bring any significant variation in protein content and protein yield. Significantly higher number of grains/ear and yield (grain and straw) was recorded with FYM at 7.5 t/ha + VC @ 3 t/ha (M₃), being at par with VC @ 6 t/ha and superior to rest of the treatments. The highest consumptive use (409 mm) by crop was shown by the treatment M₀. The significantly highest WUE was recorded under M₃. The maximum chlorophyll and protein content were recorded under the treatment M₃ (FYM @ 7.5 t/ha + vermicompost @ 3 t/ha), which remained at par with M₂, but significantly higher than M₀ and M₁. However, treatment M₃ resulted in the significantly highest protein yield over rest of the treatments. Scheduling of irrigation to wheat either at 0.9 IW: CPE ratio throughout the growth or 0.8 IW: CPE ratio at vegetative phase + 1.0 IW: CPE ratio at reproductive phase brought about significantly higher yield (grain and straw) and quality parameter (chlorophyll content). So far as saving of irrigation water is concerned, irrigating the crop with 0.8 IW: CPE ratio at vegetative phase + 1.0 IW: CPE ratio at reproductive phase was most effective as the above schedule besides resulting almost equal yields also curtailed 1 irrigation with highest water-use efficiency. Manuring the crop either at 7.5 t FYM + 3 t/ha VC or 6 t/ha VC were equally effective treatments with regard to yield (grain and straw) and quality parameters (chlorophyll content, protein content and protein yield).

Key words : Farmyard manure, Irrigation, Quality, Scheduling, Vermicompost, Wheat, Water-use efficiency, Yield

Wheat is one of the most important staple food crops of the world as well as India. It is cultivated under diverse

Based on a part of Ph.D. Thesis of the first author, submitted to Sri Karan Narendra Agriculture University, Jobner, Rajasthan, in 2016 (unpublished)

¹Corresponding author's Email: hppersoya.p@gmail.com

¹Senior Research Fellow (SRF), ⁶Assistant Professor, Department of Agronomy; ²Director Education, ³SRF, ⁴Professor, ⁵Professor, Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan 302 018

growing conditions of soil and climate. In India, it is the second most important food crop after rice. It is an excellent health-building food containing approximately 78% carbohydrates, 11–12% protein, 2% fat and minerals each and considerable amount of vitamins (Kumar *et al.*, 2011). Wheat is used for making chapatias, bread, cake, biscuits, pastry and other bakery products. Wheat is highly sensitive to water stress during the crown-root initiation (CRI) and flowering but excess irrigation may lead to heavy vegetative growth and shortening of reproductive period and

ultimately decrease in yield. Thus, timing the length of irrigation is necessary for increase the crop yield. In principle, irrigation should take place while the soil water potential is still high enough to enable soil supply water fast enough to meet the local atmospheric demands without placing the plants under stress that would reduce yield and quality of crop. Although, a high water status throughout the growing season is necessary to maintain unimpaired crop growth and high economic yield, the imposition of some stress by longer irrigation intervals during vegetative or maturation by way of narrowing or widening irrigation water (IW) : cumulative pan evaporation (CPE) ratio could attain similar economic yields as well as saving of irrigation water and improving water-use efficiency. In general, irrigation is being scheduled on the basis of climatological approach (IW : CPE ratio) during entire period of crop irrespective of the stage of growth. But proper scheduling of irrigation is necessary at both vegetative and reproductive phases to maintain the optimum moisture regime for better growth and development of crop in the changing climatic scenario where abrupt variation in temperature takes place. Application of organic manures not only improves the soil organic carbon for sustaining the soil physical properties but also increases supply of plant nutrients. In this context, farmyard manure (FYM) and vermicompost (VC) are of paramount importance for application in food crops. Addition of organic material to the soil such as FYM helps in maintaining soil fertility and productivity. It increases soil microbiological activities, plays key role in transformation, recycling and availability of nutrients to the crop. Hence a study was carried to evaluate the effect of irrigation scheduling and organic manures on growth, yield and quality of wheat.

MATERIALS AND METHODS

A field experiment was carried out during the winter (*rabi*) seasons of 2014–15 to 2015–16 at Sri Karan Narendra College of Agriculture, Jobner (26° 05' N, 75° 28' E, 427 m above mean sea-level), Rajasthan. The soil was sandy loam having bulk density 1.52 Mg/m³, pH 8.3. The soil was poor in organic carbon (0.23%), low in available nitrogen (130.5 kg/ha) and phosphorus (15.1 kg/ha) and medium in potassium (148.9 kg/ha). The experiment was laid out in a split-plot design with 4 replications. The treatments comprised 5 irrigation scheduling, viz. I₁, irrigation at critical stages; I₂, 0.9 IW : CPE ratio; I₃, 0.6 IW : CPE ratio at vegetative phase + 0.8 irrigation water : cumulative pan evaporation (IW : CPE) ratio at reproductive phase; I₄, 0.6 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase; and I₅, 0.8 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase, and 4 organic manures, viz. M₀, control; M₁, FYM

@ 15 t/ha; M₂, vermicompost (VC) @ 6 t/ha; and M₃, FYM @ 7.5 t/ha + VC @ 3 t/ha. Wheat variety 'Raj 4037' was sown on 16 December and 18 December during 2014 and 2015 and harvested on 8 April and 10 April during 2015 and 2016 respectively. Seed @ 100 kg/ha was sown with 22.5 cm row spacing. Crop was raised with recommended package of practices of weed management, viz. application of 2, 4-D @ 0.8 kg/ha 30 days after sowing used. The field plots of size 4.0 m × 2.7 m were separated from each other by using 0.50 m buffer rows. Irrigations were applied as per treatment on the basis of IW : CPE ratio approach using 4.5 cm depth of irrigation water. Six irrigations in I₁ (irrigation at critical stages), 7 irrigations in I₂ (0.9 IW : CPE ratio), 4 irrigations in I₃ (0.6 IW : CPE ratio at vegetative phase + 0.8 IW : CPE ratio at reproductive phase), 5 irrigations in I₄ (0.6 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase) and 6 irrigations in I₅ (0.8 IW : CPE ratio at vegetative phase + 1.0 IW : CPE ratio at reproductive phase) were applied. Recommended doses of fertilizer @ 90 : 30 : 0 kg N, P₂O₅ and K₂O/ha were applied basal with half dose of nitrogen and full dose of phosphorus through urea and diammonium phosphate, remaining dose of nitrogen top-dressed at the time of first and second irrigation. The FYM was applied 2 weeks before sowing and vermicompost just before sowing as per treatment. The NPK contents in FYM were @ 0.49, 0.28 and 0.42% and in vermicompost @ 1.21, 0.69 and 1.02% respectively. The crop was harvested manually with the help of sickle when grain almost matured and straw had turned yellow, and data on grain and straw yields were recorded. The straw yield was obtained by subtracting the seed yield from the biological yield. Consumptive use of water was worked out as per Dastane (1972) and from that water-use efficiency was calculated. Grain and straw yields (kg) were determined from the each plot and the yield in tonnes per hectare was calculated. All the observations during individual years as well as in pooled analysis were statistically analyzed for their test of significance using the *F*-test (Gomez and Gomez, 1984). The significant of difference between treatment means were compared with *t* critical difference at 5% level of probability. Water-use efficiency (WUE) was worked out as:

$$\text{WUE} = \frac{\text{Economic crop yield (kg/ha)}}{\text{Consumptive use (mm)}}$$

RESULTS AND DISCUSSION

Growth and yield attributes

Effect of irrigation scheduling: Irrigation scheduling treatments did not show significant influence on plant stand/m row length (Table 1). The maximum number of

grains/ear was recorded with the treatment I_2 which was significantly superior to I_3 and I_4 , but the former was at par with treatment I_5 . In treatments receiving frequent irrigations without any stress during reproductive phase, i.e. I_2 and I_5 , the higher reproductive efficiency was the main reason responsible for number of grains/ear (Nayak *et al.*, 2015).

Effect of organic manures: Organic manures treatments did not exhibit significant influence on plant stand/m row length. The treatment M_3 remaining at par with the treatment M_2 significantly increased the number of grains/ear over M_0 and M_1 (Table 1). The sink capacity of plant depends mainly on vegetative and reproductive growth of the plant which affected positively by application of organic manures and supply of photosynthates for the formation of yield component, i.e. number of grains/ear. These results are in agreement with those reported by Sepat *et al.* (2010).

Yield, consumptive use and water-use efficiency

Effect of irrigation scheduling: Significantly higher grain yield (4.45 t/ha) was recorded under treatment I_2 (4.37 t/ha) and proved significantly superior to rest of the treatments. It was also found that with sufficient moisture in the soil profile under higher irrigation frequency, plant nutrients particularly N, P and K were more which have resulted in production of more grain yield. Secondly, higher yield with higher levels of irrigation might be ow-

ing to its key role in root development by reducing mechanical resistance of soil, higher transpiration, greater nutrient uptake and more photosynthesis due to metabolic activities in plant (Bhunja *et al.*, 2006). The other reason of yield increase might be that scheduling irrigation at 0.9 IW : CPE ratio and 1.0 IW : CPE ratio at reproductive phase created longer reproductive period with larger photosynthetic surface and reproductive storage capacity to attain higher allocation of net photosynthates to grain yield (Mishra and Kushwaha, 2016).

The irrigation at 0.9 IW : CPE ratio (I_2) recorded the maximum straw yield (6.34 t/ha) which remained at par with I_5 but significantly higher than rest of the treatments. Higher straw yield under optimum level of irrigation schedules might be owing to healthy vegetative crop growth in terms of dry matter obviously resulted into more straw yield (Narolia *et al.*, 2016). The treatment I_2 (Irrigation at 0.9 IW : CPE ratio) exhibited the maximum value of consumptive use (398 mm) over all other treatments, while the minimum consumptive use was brought about by I_3 (369 mm). Thus consumptive use of water increased with the increasing in quantity of irrigation water. This might be owing to more number of irrigations which increased consumption of water because of better growth of crop and simultaneously the loss of water through evaporation under treatment I_2 (Bandyopadhyay and Mallick, 2003). Significantly highest WUE (11.34 kg/ha/mm) was recorded with treatment I_5 (Irrigation at 0.8 IW : CPE ra-

Table 1. Effect of irrigation scheduling and organic manures on plant stand, number of grains/ear, grain and straw yield, consumptive use and water-use efficiency of wheat (on pooled basis)

| Treatment | Plant stand/m row length | Grains/ear | Grain yield (t/ha) | Straw yield (t/ha) | Consumptive use (mm) | Water-use efficiency (kg/ha/mm) |
|------------------------------|--------------------------|------------|--------------------|--------------------|----------------------|---------------------------------|
| <i>Irrigation scheduling</i> | | | | | | |
| I_1 | 29.0 | 38.7 | 4.24 | 6.06 | 380 | 11.14 |
| I_2 | 29.3 | 40.8 | 4.45 | 6.34 | 398 | 11.20 |
| I_3 | 28.4 | 34.6 | 3.78 | 5.76 | 369 | 10.24 |
| I_4 | 28.7 | 37.2 | 4.14 | 6.05 | 378 | 10.95 |
| I_5 | 29.2 | 40.1 | 4.37 | 6.25 | 385 | 11.34 |
| SEM \pm | 0.53 | 0.67 | 0.07 | 0.07 | – | 0.04 |
| CD (P=0.05) | NS | 1.96 | 0.20 | 0.19 | – | 0.12 |
| <i>Organic manures</i> | | | | | | |
| M_0 | 28.4 | 35.7 | 3.48 | 5.12 | 409 | 8.53 |
| M_1 | 28.6 | 38.0 | 4.29 | 6.26 | 365 | 11.73 |
| M_2 | 29.2 | 39.0 | 4.43 | 6.42 | 379 | 11.79 |
| M_3 | 29.6 | 40.4 | 4.57 | 6.58 | 369 | 12.40 |
| SEM \pm | 0.34 | 0.56 | 0.06 | 0.06 | – | 0.03 |
| CD (P=0.05) | NS | 1.58 | 0.18 | 0.17 | – | 0.11 |

I_1 , Irrigation at critical stages; I_2 , 0.9 IW : CPE ratio; I_3 , 0.6 IW : CPE ratio at vegetative + 0.8 IW : CPE ratio at reproductive phase; I_4 , 0.6 IW : CPE ratio at vegetative + 1.0 IW : CPE ratio at reproductive phase; and I_5 , 0.8 IW : CPE ratio at vegetative + 1.0 IW : CPE ratio at reproductive phase; M_0 , control; M_1 , FYM @ 15 t/ha; M_2 , vermicompost @ 6 t/ha and M_3 , FYM @ 7.5 t/ha + vermicompost @ 3 t/ha

tio at vegetative phase + 1.0 IW: CPE ratio at reproductive), while the lowest WUE (10.24 kg/ha/mm) with treatment I_3 . The highest WUE in the treatment I_5 might be owing to the fact that crop was supplied with conserving soil moisture during reproductive phase. Moreover, the above treatment utilized lesser water consumptively as compared to I_2 . Hence proportionately higher yield with the judicious use of limited water resulted in significantly highest WUE (Bikrmatitya *et al.*, 2011).

Effect of organic manures: The significantly higher values (4.57 and 6.58 t/ha) of grain and straw yield were recorded with the application of FYM @ 7.5 t/ha + vermicompost @ 3 t/ha (M_3) which superseded the rest of the treatments, while it remained at par with M_2 (Table 1). It is well known that addition of FYM and vermicompost could increase the macronutrient as well as micronutrient concentration in the soil and increase the adsorption power of soil for cations and anions, particularly, phosphates and nitrates and they were released slowly for the benefit of the crop during entire growth period. These results are in close proximity with those of Singh and Agarwal (2004). The maximum consumptive use (409 mm) by the wheat crop was observed with treatment M_0 (control) over rest of the treatments. The minimum consumptive use was obtained in treatment where FYM 7.5 t + vermicompost 3 t/ha (M_3) was applied. Lower consumptive use in organic manure treated plots might be owing to better conservation of soil moisture and reduced evaporation as compared to no manure treatment (Vishuddha *et al.*, 2014). The significantly highest WUE was obtained under treatment M_3

(12.40 kg/ha/mm). The reason may be ascribed to the fact that proportionate increase in grain yield was greater than the evapo-transpiration owing to combined application of FYM and vermicompost. Thus, WUE enhanced significantly over sole application of organic manures or no organic manure treatment where increase in yield was lesser than the loss of water through ET (Ebtisam *et al.*, 2013).

Quality parameters

Effect of irrigation scheduling: Protein content and protein yield did not differ significantly due to irrigation schedules (Table 2). Treatment I_2 where irrigation was practiced with 0.9 IW : CPE ratio fetched significantly higher chlorophyll content over rest of the treatments and remained at par with I_1 . This may be attributed to better root growth, resulting in higher water and nutrient uptake which in turn resulted in increased chlorophyll content in leaves. Higher root density had a large influence on plant water status through its effect on water uptake from soil (Patidar and Mali, 2004).

Effect of organic manures: The maximum chlorophyll and protein content were recorded under the treatment M_3 (FYM @ 7.5 t/ha + vermicompost @ 3 t/ha) which remained at par with M_2 but significantly higher than M_0 and M_1 treatments (Table 2). This may be attributed to better root growth, resulting in higher water uptake which has resulted in increased chlorophyll content in leaves (Patidar and Mali, 2004). However, above treatment, i.e. M_3 , resulted in the significantly highest protein yield over rest of the treatments. Since protein contents in grain and protein

Table 2. Effect of irrigation scheduling and organic manures on quality parameters and net returns of wheat (on pooled basis)

| Treatment | Chlorophyll content (mg/g) | Protein content (%) | Protein yield (kg/ha) | Net returns (₹/ha) |
|------------------------------|----------------------------|---------------------|-----------------------|--------------------|
| <i>Irrigation scheduling</i> | | | | |
| I_1 | 2.18 | 9.51 | 403 | 51,021 |
| I_2 | 2.31 | 9.44 | 422 | 54,883 |
| I_3 | 1.82 | 9.72 | 371 | 44,071 |
| I_4 | 1.96 | 9.56 | 397 | 50,282 |
| I_5 | 2.00 | 9.53 | 416 | 53,861 |
| SEm± | 0.05 | 0.25 | 5.31 | 939 |
| CD (P=0.05) | 0.15 | NS | 16.22 | 2,740 |
| <i>Organic manures</i> | | | | |
| M_0 | 1.73 | 8.07 | 282 | 45,346 |
| M_1 | 2.17 | 9.58 | 411 | 55,179 |
| M_2 | 2.08 | 9.95 | 442 | 47,492 |
| M_3 | 2.24 | 10.58 | 484 | 55,276 |
| SEm± | 0.04 | 0.21 | 4.91 | 785 |
| CD (P=0.05) | 0.10 | 0.67 | 14.63 | 2,206 |

I_1 , Irrigation at critical stages; I_2 , 0.9 IW : CPE ratio; I_3 , 0.6 IW : CPE ratio at vegetative + 0.8 IW : CPE ratio at reproductive phase; I_4 , 0.6 IW : CPE ratio at vegetative + 1.0 IW : CPE ratio at reproductive phase; and I_5 , 0.8 IW : CPE ratio at vegetative + 1.0 IW : CPE ratio at reproductive phase; M_0 , control; M_1 , FYM @ 15 t/ha; M_2 , vermicompost @ 6 t/ha and M_3 , FYM @ 7.5 t/ha + vermicompost @ 3 t/ha

yield are essentially manifestation of nitrogen content, increased nitrogen content owing to organic manures resulted in higher protein content. The protein yield depends on grain yield and protein content in grain. It could be explained in terms of greater synthesis of amino acids for improvement in nitrogen content in grain which has also been reported by Channabasanagowda *et al.* (2008) and Ram *et al.* (2014).

Economics

Effect of irrigation scheduling : The treatment I₂ (irrigation at 0.9 IW : CPE ratio) fetched the maximum net returns (₹54,883/ha), while being at par with I₅ proved significantly superior to rest of the treatments.

Effect of organic manures : The treatment M₃ and M₁ giving almost same net returns proved significantly superior over M₀ and M₂. The treatment M₃ fetched higher net returns by ₹9,930 and 7,784/ha, respectively over M₀ and M₂.

Based on these results, it can be concluded that scheduling of irrigation to wheat either at 0.9 IW: CPE ratio throughout the growth or 0.8 IW: CPE ratio at vegetative phase + 1.0 IW: CPE ratio at reproductive phase and manuring the crop either @ 7.5 t FYM + 3 t/ha VC or 6 t/ha VC were the equally effective treatments brought about significantly higher yields, net returns and quality parameter. So far as saving of irrigation water is concerned, irrigating the crop with 0.8 IW: CPE ratio at vegetative phase + 1.0 IW: CPE ratio at reproductive phase was most effective as this schedule besides resulting in almost equal yields also curtailed 1 irrigation with highest water-use efficiency.

REFERENCES

- Bandyopadhyay, P.K. and Mallick, S. 2003. Actual evapo-transpiration and crop coefficient of wheat (*Triticum aestivum* L.) under varying moisture levels of humid tropical canal command area. *Agricultural Water Management* **49**(1): 33–47.
- Bhunia, S. R., Chauhan, R. P. S., Yadav, B.S. and Bhati, A.S. 2006. Effect of phosphorus, irrigation and rhizobium on productivity, water use and nutrient uptake in fenugreek (*Trigonella foenum-graecum*). *Indian Journal of Agronomy* **51**(3): 239–241.
- Bikrmeditya, Verma, R., Ram, S. and Sharma, B. 2011. Effect of soil moisture regimes and fertility levels on growth, yield and water use efficiency of wheat (*Triticum aestivum* L.). *Progressive Agriculture* **11**(1): 73–78.
- Channabasanagowda, N.K., Patel, B., Patil, B.N., Awaknavar, J.S., Ninganur, B.T. and Hunje, R. 2008. Effect of organic manures on growth, seed yield and quality of wheat. *Karnataka Journal of Agricultural Sciences* **21**(3): 366–368.
- Dastane, N.G. 1972. *A Practical Manual for Water Use Research in Agriculture*. 702 pp. Navbharat Prakashan Budhawar Path, Poona (now Pune), Maharashtra, India.
- Ebtisam, E., Hellal, F., Mansour, H. and Mohammed A.E.H. 2013. Assessment organic manures addition on some soil properties, nutrient content and wheat yield under sprinkler irrigation system. *Agricultural Science Digest* **4**(1): 14–22.
- Gomez, A.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*, edn 2. John Wiley & Sons, Singapore.
- Kumar, P., Yadav, R.K., Gollen, B., Kumar, S., Verma, R.K. and Yadav, S. 2011. Nutritional contents and medicinal properties of wheat: A review. *Life Sciences and Medicinal Research* **47**(2): 145–149.
- Mishra, G. and Kushwaha, H.S. 2016. Winter wheat yield and soil physical properties responses to different tillage and irrigation. *European Journal of Biological Research* **56**: 530–537.
- Narolia, R.S., Meena, H., Singh, P., Meena, B.S. and Ram, B. 2016. Effect of irrigation scheduling and nutrient management on productivity, profitability and nutrient uptake of wheat (*Triticum aestivum*) grown under zero-tilled condition in south-eastern Rajasthan. *Indian Journal of Agronomy* **61**(1): 53–58.
- Nayak, M.K., Patel, H.R., Prakash, V. and Kumar, A. 2015. Influence of irrigation scheduling on crop growth, yield and quality of wheat. *Journal of Agriculture Research* **2**(1): 65–68.
- Patidar, M. and Mali, A. L. 2004. Effect of FYM, fertility levels and biofertilizers on growth, yield and quality of sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy* **49**(2): 117–120.
- Ram, M., Davari, M.R. and Sharma, S.N. 2014. Direct, residual and cumulative effects of organic manures and biofertilizers on yields, NPK uptake, grain quality and economics of wheat (*Triticum aestivum* L.) under organic farming of rice-wheat cropping system. *Journal of Organic Systems* **9**(1): 16–30.
- Sepat, R.N., Rai, R.K. and Shiva, D. 2010. Planting system and integrated nutrient management for enhanced wheat (*Triticum aestivum*) productivity. *Indian Journal of Agronomy* **55**(2): 114–118.
- Singh, R. and Agarwal, S.K. 2004. Effect of organic manuring and nitrogen fertilization on productivity, nutrient use efficiency and economics of wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **49**(1): 49–52.
- Vishuddha. N., Singh, G.R., Kumar, R., Raj, S. and Yadav, B. 2014. Effect of irrigation levels and nutrient sources on growth and yield of wheat (*Triticum aestivum* L.). *Annals of Agricultural Research* **35**(1): 14–20.