

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.708.277>

Effect of Irrigation Methods on Yields Attributes and Water Productivity of Wheat in Vertisol of Betwa River Basin Commands of Vidisha District of M.P, India

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A B S T R A C T

Keywords

Border irrigation,
Pressurized
sprinkler irrigation,
Water productivity,
Water use
efficiency

Article Info

Accepted:
15 July 2018
Available Online:
10 August 2018

The studies were carried out on farmer's field in few villages of Ganjbasoda block in Vidisha district to evaluate different irrigation technologies (surface border, sprinkler pressurized method) for their effect on yield attributes and water productivity of wheat in vertisol of Vidisha district of Betwa river command. Results revealed that water saving of about 12.5% higher in case of pressurized sprinkler irrigation method as compare with the surface border method. The growth and yield attributing components were considerably improved under pressurized sprinkler irrigation method compare to surface border method. The grain yield was 16.22% higher in pressurized sprinkler method than that in surface irrigation border method. Data also revealed that water productivity of sprinkler irrigated wheat was 30.76% more than the border irrigated wheat.

Introduction

Food, fodder and fiber have emerged as challenges for the ever increasing population globally. Wheat is the most important staple food grain in Indian diet and main source of population while wheat straw is a valuable livestock feed. Wheat is the second most important cereal crop followed after rice in India and it was cultivated on 30 million ha area with production of 93.5 million tonnes and productivity of 3093 kg/ha while in MP it was cultivated on 5.3 million ha area with

production of 13.3 million tonnes and productivity of 2509 kg/ha. The problem is further aggravated due to the rising scarcity of natural resources like land and water. While increasing population in driving demand, climate change and other hydrological extremes are impacting the water productivity in space and time. Therefore water productivity plays important role in modern agriculture which aims at increase in the crop yield per unit of water supplied for irrigation. Among global resources, water is emerging as the most critical and misused natural resource.

It is an important input to agricultural production. India's water resources, particularly in the context of agriculture, are facing extreme water stress at different critical stages of wheat crop during its growth period. The country sustains 16 % of the world's human population and 20% livestock population with having just 3% of the world's water. India's scenario most of the area under wheat crop is presently irrigated by surface irrigation method viz. flood, borders with very poor water use efficiencies obtained. Available estimates indicated that water use efficiencies under surface method of irrigation lies in between about 35 % to 40% limited due to the huge conveyance and distribution losses. Among the irrigation methods, pressurized sprinkler irrigation method permit more efficient use of irrigation water as compare to surface irrigation method. Therefore, the present study was conducted to determine feasibility of pressurized sprinkler irrigation method under vertisol of Betwa river basin and also to assess its effect on yield of wheat crop and water productivity.

Materials and Methods

The study was conducted on farmer's field under "world bank funded – Madhya Pradesh Water Sector Restructuring Project" jointly implemented by the Water resources department, Govt. of MP Bhopal and functioning under the overall administrative control of JNKVV Jabalpur. The irrigation method consisted of surface irrigation method and pressurized sprinkler irrigation method. The tank command of Ghatara babaji, jajon and Bhawankhedi were selected to test the said irrigation technologies in Betwa river basin of MP. Research site lies between 23° 51'N 77° 56'E with elevation of 399 m above the mean sea level. The climate of the study area was tropical and annual temperature was 25.6° C and average annual rainfall of the area was as 1159.7 mm. The soil of the study

area was clay loam soil with contain clay 40.82%, silt 35.20% and sand 28.63%. It is also indicated that the basic infiltration rate is ranging between 0.2 cm/hr to 2.4 cm/hr in this study area. Wheat (GW 322) was sown by the tractor drawn seed cum fertilizer seed drill at a seed rate 100kg/ha with 20 cm row to row spacing. Recommended fertilizer dose RDF 120:60:40 of N:P:K was applied at the time of sowing and remaining N was supplied in three equal dose after 25, 50, 75 days from respective sowing. The amount of irrigation water was calculated on the basis of crop water requirement by the formula mentioned below.

$$D = PE * Pc * Kc * IE$$

Where,

D - Net depth of irrigation (mm)

PE – Pan Evaporation (mm/day)

Pc - Pan coefficient

Kc – Crop Coefficient

IE – Irrigation Efficiency

At harvest, a random sample from (1m length x 1m width plot area) were taken from each location to determine growth and yield attributing parameters from whole area of experiment and then converted to yield per hectare. Water productivity was calculated with following formula (Mane *et al.*, 2006) as under:

$$\text{Water productivity} = \frac{\text{Grain yield (kg /ha)}}{\text{Total water applied (cm)}}$$

Concept of Water Use Efficiency (WUE) and water productivity

Water productivity is measured as crop yield per unit of irrigation water supplied or as the ratio of yield to evapotranspiration during entire crop span. Water use efficiency (WUE) and water productivity (WP) are two terms used quite frequently and are confused most

of the times. WUE is the % of water supplied to the plant that is effectively taken up by the plant i.e. that was not lost to the drainage, bare soil evaporation or interception. Mathematically,

$$E_f = V_u/V_e, \quad \text{where,}$$

V_u =Volume utilized, m^3 and
 V_e =Volume extracted from the supply source, m^3

The various types of water efficiency used in irrigation are storage efficiency, conveyance efficiency and irrigation efficiency etc. On the other hand, water productivity aims to increase the yield production per unit of water used, both under rainfed and irrigated conditions. This can be achieved either by marketable yield of the crop for each unit of the water transpired, by reducing outflow / losses, or by enhancing the effective use of rainfall/ water stored in the soil and of marginal quality of water. All these option lead to the on –farm management aspect of crop growth through the best crop management practices which will permit the use of less water for irrigation, decrease evaporation losses, optimize fertilizer supply allow better pest control and improve soil conditions. In other terms, the increase in

WUE would lead to better WP and would help the farmer in improving the economic returns from the investments in the irrigation water supply, and not the other way around. Thus, WUE is a dimensionless ratio of the total amount of water used to the total amount of water applied, whereas WP is not a dimensionless term as it reflects the crop production per unit water. In broader sense, WP defines the net benefit from the crop, forestry, livestock and mixed agriculture systems to the amount of water consumed to produce those benefits.

Results and Discussion

Results (Table 1) revealed that the highest grain yield and straw yield was observed with pressurized sprinkler irrigation method. Data indicated that grain yield was 16.22% and test weight was 10.36% was more in the pressurized sprinkler irrigation than the surface borders irrigated wheat. High irrigation and fertilizer use efficiency in sprinkler method of irrigation as less water was lost in runoff, percolation etc. in comparison with surface irrigation method. Beside this, sprinkler irrigation also provided an ideal seed bed for the young plants and minimized the effect of crust formation on the young shoots.

Table.1 Effect of irrigation methods on growth, yield attributes and water productivity of wheat crop

S.No.	Parameters	Irrigation method	
		Borders irrigation	Pressurized Sprinkler
1.	Plant height (cm)	84.40	88.56
2	No. of tillers /m ²	382.5	396.8
3	Ear length (cm)	8.05	9.10
4	1000 grain wt. (gm)	40.12	44.28
5	Biological yield (q/ha)	90.28	104.11
6	Grain yield (q/ha)	39.50	45.91
7	Straw yield (q/ha)	50.78	58.20
8	Total irrigation water applied (cm)	45.00	40.00
9	Water productivity (kg/ha/cm)	87.77	114.77

Data also revealed that water productivity of sprinkler irrigated wheat was 30.76% more than the surface border irrigated wheat. This type may be in pressurized sprinkler irrigation, water is allow to fall on the land surface in a uniform pattern at a rate less than the basic infiltration rate of the soil.

The uniform pattern of the spray is developed by the flow of water under pressure through nozzles. Thus, root zone depth received the irrigation water applied at a rate to suit the infiltration of these soils of the tank command area under study, thereby obtaining efficient water use efficiencies.

In conclusions, observed data and attributed evaluation and analysis proceeding towards the application priorities of pressurized sprinkler irrigation, as an alternative method in comparison to surface irrigation borders prepared by the farmers, may be an effective method for rationalizing irrigation water and maximizing water use efficiencies and increased yield.

By using pressurized sprinkler irrigation in wheat (GW 322) can save 12.5% irrigation

water and increased yield by 16.22% over surface border irrigation method.

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How to cite this article:

Satish Kumar Sharma, P.K. Mishra, Raju panse and Ghanshyam Jamliya 2018. Effect of Irrigation Methods on Yields Attributes and Water Productivity of Wheat in Vertisol of Betwa River Basin Commands of Vidisha District of M.P., India *Int.J.Curr.Microbiol.App.Sci.* 7(08): 2670-2673. doi: <https://doi.org/10.20546/ijcmas.2018.708.277>