# Effect of mulch and irrigation on yield and water use efficiency of wheat under Patloi Nala micro-watershed in Purulia district of West Bengal

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**ABSTRACT**

*Irrigation and its scheduling is an important factor that governs the evapo-transpiration, water use efficiency, and moisture extraction pattern of the crop in a particular environment. The irrigation requirement may be changed due to use of different type of mulching material. Keeping this in view, present investigations were carried out for two consecutive years in a representative micro-watershed (Patloi Nala) to study the effect of different types of mulch and irrigation scheduling on yield, soil moisture status and water use efficiency of wheat crop grown in winter season. The results reveal that application of surface mulch enhance the productivity significantly by improving soil moisture status over no mulch treatment and use of white polythene mulch found to be better compare to black polythene as well as straw and leaf mulch. Water expense efficiency was also maximum under white polythene mulch. Application of mulch not only improves the productivity but also reduce the number of irrigations. However, due to the high price of synthetic mulch the economic gain was maximum under locality available mulch material i.e. straw and leaf mulch.Four irrigations each at crown root initiation, maximum tillering, flowering and milking stage enhanced the productivity, which was 498% higher than that of one irrigation given at crown root initiation stage. Water expense efficiency was maximum under four irrigation treatments.*

***Key words :*** Crop yield, irrigation, mulch and water use efficiency.

Among cereals, wheat is an important crop and being grown on 27 million hectare of land with the production of 72 million tones contributing about 34% to the total food grain production. In respect of area and production it occupies the second position being exceeded only by rice. The productivity of wheat is generally reduced due to lack of irrigation and water management owing to low moisture content in soil.

Irrigation plays an important role in improving the productivity of wheat. The irrigation requirement may be changed due to use of different type of mulching material. Mulching increases the infiltration of water in to the soil through run off control and increasing opportunity time to infiltration, reduces the evaporation loss and controls weed infestation (Acharya, 2002). Keeping this in view an attempt was, therefore, made to study the effect of irrigation scheduling and mulch on yield and water use efficiently of wheat crop under red and laterite zone of West Bengal.

## MATERIALS AND METHODS

The field trials were conducted during winter season for two consecutive years in the farmer's field at *Patloi Nala* micro-watershed in Purulia district of West Bengal under the National Agricultural Technology Project (RRPS-17), BCKV centre. The area falls under red and laterite agro-climatic zone of W.B. characterized by aberrant weather condition, undulating and rolling type of topography, light textured soil, highly variable soil moisture, regime, lack of irrigation potential, poor soil fertility status and susceptibility to severe land degradation. The bulk density, water holding capacity, field capacity and wilting point of the surface soil ranges from 1.55 to 1.6gm $cc^{-1}$ , 41 to 43%, 23.5 to 25.7%, 7 to 7.5% , respectively.

The experiments were laid in the randomized block design with four replications. Adjacent farmer's fields were selected as replication. The treatments consisted of mulch for the experiment-I are; $T_1$- black polythene mulch (100 µ), $T_2$-white polythene mulch (100 µ), $T_3$ –straw mulch @ 5 ton $ha^{-1}$ , $T_4$ – forest leaf mulch @ 5 ton $ha^{-1}$, $T_5$ –control (No mulch ).The treatments of irrigation scheduling for the experiment-II consisted of - $T_1$- One irrigation at crown root initiation(CRI)stage, $T_2$ –two irrigations each at CRI stage and flowering stage, $T_3$- two irrigations – each at CRI and panicle initiation(PI) stage, $T_4$ – three irrigations – each at CRI, maximum tillering (MT), and flowering stage, $T_5$ – Four irrigations- each at CRI, maximum tillering (MT), flowering and grain filling stage.

Wheat variety sonalika was sown during 2nd week of November with the spacing of 20cm x 5cm for both the experiment. The recommended fertilizer dose of 100:50:50: N: P: K kg $ha^{-1}$ was applied as basal except N which was applied in 3 split doses. The depth of irrigation was kept at 8cm for each irrigation for both the experiments. The total rainfall during crop growth period (November to March) in ist year and 2nd year was 6.06 and 0.84 cm, respectively. During experimentation, irrigation water from the water harvesting tank was taken to the site of demonstration plot through existing channels. Mulching material was applied after sowing. Soil

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moisture up to 60 cm depth was measured periodically from all the treated plots for calculation of soil moisture depletion during crop growth period. From the depletion values and economic yield, water expense efficiency of the various treatments was worked out. Necessary statistical analysis was worked out to interpret the effect of treatments of various observations.

## RESULTS AND DISCUSSION

### Effect of mulching on grain yield and soil moisture status

The data presented in the Table 1a and 1b, revealed that different mulching treatments, influenced the crop yield differently. On an average, application of different type of mulches improved the productivity of wheat by 85.5% over the farmers practice (control plot). Among the different type of mulching material, white polythene mulch found to be better in terms of grain yield as compared to black polythene, paddy straw and forest leaf mulch. Hence, grain yield of wheat under white polythene mulch was significantly higher in both the years (on an average it tuneed up to 4017 kg $ha^{-1}$) which was 123% higher than the control plot. Similar findings were also observed by Khera and Singh (1998) in case of maize yield in Punjab.

Total soil moisture depletion was minimum under white polythene mulch treatment followed by black polythene, paddy straw and leaf mulch. Water use efficiency was also maximum under white polythene mulch followed by black polythene, straw and leaf mulch .So grain yield and water use efficiency were positively correlated, where as water use efficiency and total soil moisture depletion weree negatively correlated. Applications of mulch not only improved the productivity but also reduced the number of irrigations. This might be due to less evapo-transpiration in mulched plots compared to unmulched (control)plots.

However, due to high price of synthetic mulch economic gain was less under white and black polythene mulch and it was subsequently maximum under paddy straw and forest leaf mulch.

### Effect of irrigation on grain yield and soil moisture status

The results of the field experiment (Table 2a and 2b) revealed that the highest grain yield of wheat was obtained with four irrigations (scheduled at 8-10cm depth) each at crown root initiation (CRI), maximum tillering(MT), flowering and grain filling stage, which was 498%, higher than the control plot where only one irrigation (8 cm depth) was applied. The results also revealed that when there was provision of two irrigations it was better to skip irrigation at panicle initiation (PI) stage but irrigation at CRI stage followed by flowering stage was most important. Thus irrigation applied at PI stage was found to be less effective in comparison to flowering stage where there was provision of two irrigations specially in red and laterrite zone of West Bengal. Similar findings were also reported by Zaman *et al* (2006). Irrigation application also found to be effective at grain filling stage in addition to CRI and MT stage.

The highest soil moisture depletion and water use efficiency were found to be 26.18 cm and 107.45 kg $ha^{-1}$ $cm^{-1}$ respectively with four irrigations each at CRI, MT, flowering and grain filling stages.

The variation in grain yield, moisture use (soil moisture depletion) and water use efficiency with different irrigation levels might be due to better utilization of available soil moisture under water application at critical growth stage. The application of water increased soil water content, which in turns improved plant water status, stomata width and leaf area index (LAI) as reported by Yadav (1979). Greater flow of water from soil layer to atmosphere through plant systems due to smaller stomata resistance and greater LAI might have increased the transpiration rate in wheat at various as well as similar water supply at different physiological growth stage.

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**Table 1a: Effect of mulch on grain yield of wheat**

| Treatments | Grain yield (Kg ha$^{-1}$) | | | Increase over control (%) | Surplus over cost * (A)ha$^{-1}$ (Rs.) | Average economic gain over control (%) |
|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Pooled | | | |
| $T_1$-Black Polythene | 3625 | 3785 | 3705 | 105.83 | 9650 | 1.05 |
| $T_2$.-White Polythene | 3987 | 4048 | 4017 | 123.16 | 10419 | 9.09 |
| $T_3$-Paddystraw | 2915 | 3020 | 2967 | 64.83 | 11964 | 25.27 |
| $T_4$-Forest leaf | 2628 | 2709 | 2668 | 48.22 | 11100 | 16.23 |
| $T_5$- Control (no mulch) | 1725 | 1875 | 1800 | - | 9550 | - |
| **SEd** | **4.83** | **3.36** | - | - | - | - |
| **LSD(0.05)** | **10.53** | **7.32** | - | - | - | - |

**Table 1b: Effect of mulch on soil moisture depletion and water use efficiency of wheat**

| Treatments | No. of irrigation | | Total soil moisture depletion (cm) | | Water use efficiency (kg ha$^{-1}$cm$^{-1}$) | |
|---|---|---|---|---|---|---|
| | $Y_1$ (Rainfall 6.6cm) | $Y_2$ (Rainfall 0.84cm) | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$-Black polythene(100µ) | 3 | 3 | 17.14 | 22.82 | 211.49 | 165.86 |
| $T_2$.-White polythene(100µ) | 3 | 3 | 16.59 | 21.69 | 240.32 | 186.62 |
| $T_3$-Paddystraw | 3 | 3 | 18.81 | 23.18 | 154.97 | 130.28 |
| $T_4$-Forest leaf | 3 | 3 | 19.66 | 24.86 | 133.67 | 108.97 |
| $T_5$- Control(no mulch) | 4 | 4 | 22.95 | 26.22 | 75.16 | 71.51 |

**Table 2a: Effect of irrigation scheduling on grain yield of wheat**

| Treatments | Grain yield (kg ha$^{-1}$) | | | Increase over control (%) | Surplus over cost * (A)ha$^{-1}$ (Rs.) | Average economic gain over control (%) |
|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Pooled | | | |
| $T_1$- One irrigation at (CRI) | 398 | 452 | 425 | - | 1260 | - |
| $T_2$.- Two irrigation (CRI, PI) | 746 | 880 | 813 | 91.29 | 18.90 | 50 |
| $T_3$- Two irrigation (CRI, FS) | 1010 | 1180 | 1095 | 157.64 | 3350 | 165.87 |
| $T_4$ -Three irrigation (CRI, MT, GSF) | 1500 | 1686 | 1593 | 274.82 | 6750 | 435.71 |
| $T_5$- Four irrigation (CRI, MT, FS, GFS) | 2466 | 2620 | 2543 | 498.35 | 11500 | 812.69 |
| **SEd** | **3.32** | **1.84** | - | - | - | - |
| **LSD(0.05)** | **7.23** | **4.02** | | | | |

**Table2b: Effect of irrigation scheduling on soil moisture depletion and water use efficiency of wheat**

| Treatments | No. of irrigation | | Total soil moisture depletion (cm) | | Water use efficiency (kg ha$^{-1}$cm$^{-1}$) | |
|---|---|---|---|---|---|---|
| | $Y_1$ (Rainfall 6.6cm) | $Y_2$ (Rainfall 0.84cm) | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$- One irrigation at (CRI) | 1 | 1 | 10.70 | 11.40 | 37.19 | 39.65 |
| $T_2$.- Two irrigation (CRI, PI) | 2 | 2 | 15.60 | 16.77 | 47.82 | 52.47 |
| $T_3$- Two irrigation (CRI, FS) | 2 | 2 | 16.59 | 17.14 | 60.88 | 68.84 |
| $T_4$ -Three irrigation (CRI, (MT, GSF) | 3 | 3 | 19.70 | 21.31 | 76.14 | 79.11 |
| $T_5$- Four irrigation (CRI, MT, FS, GFS) | 4 | 4 | 22.95 | 26.18 | 107.45 | 100.07 |

$Y_1$ = 1$^{st}$ year, $Y_2$=2$^{nd}$ year CRI-crown root initiation, PI-panicle initiation , FS-flowering stage, MT- maximum tillering,

*cost (A) =cost of cultivation without family labour charges

GSF-grain filling stage.