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Water Management in Rice in Indo-Gangetic Plains

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Rice-wheat (RW) is the dominant cropping system of the Indo-Gangetic Plains (IGP) regions. It covers approximately 13.5 million ha of arable land which provides food to about 400 million people. There are groundwater-level variations, groundwater quality, and groundwater storage within the top 200 meters of the IGP aquifer system. It found that the water table within the IGP alluvial aquifer "is typically shallow (less than five meters below ground level) and relatively stable since at least 2000 throughout much of this region, with some important exceptions." In areas of high groundwater extraction – in northwest India – the water table can be more than 20 meters below ground level and is falling at rates of more than one millimetre every year.

Introduction

Rice is a semi-aquatic plant that requires near submergence. Submergence helps in suppressing weed growth and more availability of certain nutrients. This crop is strongly influenced by water supply. Water should be kept standing in the field throughout the growth period. Excess/limited/no water leads to a reduction in the yield of paddy. The daily consumptive use of paddy is 6-10 mm. The total water requirement of paddy is 1200-1400 mm. Finally, 2000-3000 liters of water are required to produce one kg of rice. Highly saline and brackish water not good for irrigation.

Critical stages of water requirement

Critical stage refers to a stage when water scarcity or deficit of water causes comparatively greater reduction in yields which cannot be made by favorable water supply at earlier or later stages. Hence, water deficit during these stages should be avoided. Following are the important critical crop growth stages for water stress.

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The growth stages of rice are tillering, panicle initiation, boot leaf stage, heading/panicle emergence, and flowering/anthesis (reproductive phase). During these stages, the soil moisture level should be maintained at saturation level. If soil moisture stress at the active tillering phase, then there is a 30% yield reduction, and if moisture stress at the reproductive phase, then 50-60% reduction in yield of paddy.

Table 1. Water requirement of rice crop at different growth stages

Stages of growth	Avg. water requirement (mm)	% of total water requirement (approx.)
Nursery	50-60	5
Main field preparation	200-250	20
Planting to Panicle initiation (PI)	400-550	40
P.I to flowering	400-450	30
flowering to maturity	100-150	5
Total	**1200-1460**	**100.0**

Table 2. Depth of water to be maintained during different crop growth stages of rice

Stage of crop	Depth of water (cm)
At transplanting	2-3cm (Shallow)
After transplanting (5 to 20 days)	4- 5cm
During tillering (22 to 42 days)	2-3cm (Shallow)
Reproductive stage, panicle emergence, booting, heading & flowering	4 -5cm
Ripening stage (21 days after full flowering), milk stage, dough stage & maturity	Drain the field gradually to Saturation Withdraw water 12 days before Harvesting

Recommendations of efficient water management in rice

Ploughing: Summer ploughing minimizes water requirement for land preparation. One ploughing by mould-board plough and puddling twice by disc harrow gave the best result in terms of crop establishment, water use efficiency, and yield.

Genotype: Rice genotype having crop duration of 120 days requires 100-120 cm of water for normal yields.

Leveling and puddling: Seepage and percolation are reduced to a considerable extent by

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puddling and perfect levelling (with laser land leveller). Thorough puddling creates impermeable layer which reduces deep percolation losses. Evaporation losses can be minimized by 50% when the soil is kept at saturation under levelled field conditions.

Fertilizer management: The application of FYM or compost or green manures reduces evaporation, percolation, and seepage losses in paddy crops. Application of FYM or incorporation of green manures reduces adverse effects of excess salts. Application of FYM or compost or green manures increases the water holding capacity of light-textured soils and thus saving water. Split application of potassium 50% at basal and 25% each at tillering and panicle initiation stage along with Azospirillum (seed inoculation, seedling dipping, or soil application) alleviates harmful effects of the soil moisture stress. Drain the field to the saturated stage before top dressing with N and re-flood the next day to reduce N-loss. The addition of clay or tank silt (to light textured soils only) @ 150 m3/ha reduces the percolation loss by 20-25%.

Irrigation management: Irrigation schedules of alternate wetting and drying or saturation till tillering followed by maintenance of 5 to 8 cm water thereafter could save 50% of water as compared to continuous submergence without affecting the yield of rice. Providing drainage in lowland rice at the early tillering stage is essential. Life irrigation should be given on the 3rd day and up to 7 days, 2 cm water level should be maintained. Gradually raise the water level to a depth of 5 cm up to the maturity of rice. Moisture stress during the rooting and tillering stage cause poor root growth leading to poor crop establishment and low yield of the crop. Higher transpiration results higher yield of rice crops. A normal crop of yield 4.5 t/ha with an irrigation period of 100 days consumes 6 mm/day by transpiration. When the figure declines to 1.4 mm/day the yield decreases to 1 t/ha when it increases 10.5 mm the crop yield will increase to 7.5 t/ha.

It should maintenance of water depths in the field as recommended for high water use efficiency and yield. High bicarbonate levels in irrigation water can cause Zn deficiency. High sodium water causes de-flocculation of soil particles leading to increase stickiness and compactness and decrease permeability. Studies conducted for evolving design criteria for different methods of irrigation for efficient use of water indicated that maximum water-use efficiency for rice can be obtained with check basins with sizes in between 250-300 m2 area. Recycling run-off water in flood-irrigated rice can irrigate 10% additional area. In command

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areas, where the field to field irrigation is common cost-effective recycling structures may be constructed for reusing drainage water. A mixture of fly ash and clay with 50% cement was found to be a suitable lining material for field channels.

Precautions for application of irrigation

- Withhold water for few days till the seedlings have established.
- Field-to-field irrigation should be avoided.
- Drain-off water for about 2 days before the application of fertilizers.
- A small bund may be formed parallel to the main bund of the field at a distance of 30 to 45 cm within the field to avoid leakages of water through the main bund crevices.
- To minimize percolation loss, the depth of stagnated water should be 5cm or less.
- In waterlogged conditions provide open drains about 60cm in depth and 45cm width across the field. Care should be taken not to allow the development of cracks.
- In the canal command area, conjunctive use of surface and groundwater may be resorted to for judicious use of water.
- Where irrigation facilities are not available, store all the rainwater in paddy fields by making 25 to 30 cm raised bunds.
- Maintain about 8-10 cm of water level in the fields at puddling time and subsequently, depth of ponded water may be maintained throughout the growing period.
- Drain-off water completely for 5 to 7 days following tillering and flowering stages. This helps to remove toxic substances like sulphides and regulates oxygen supply to the root.