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Popular Article

Technological Approaches for Water Saving in Agriculture

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Introduction

Water is nectar for life. It enriches plants with important minerals, salts and, most importantly, water itself. According to a study by the National Geophysical Research Institute, the largest depletion of groundwater in the world is happening in India, according to estimates, water scarcity can lead to loss of up to 6% of GDP by 2030. In coming years, Indian agriculture will need more water to produce enough food to satisfy changing needs of future. On the other hand, actual availability of water will reduce and supply is projected at just half by the end of 2030.

Sector wise Use	Year		
	2000	2025	2050
Irrigation	**541 (85.3 %)**	**910 (83.3 %)**	**1072 (74.1 %)**
Domestic	42 (6.6 %)	73 (6.7 %)	102 (7.0 %)
Industries	8 (1.3 %)	22 (2.0 %)	63 (4.4 %)
Thermal power	2 (0.3 %)	15 (1.4 %)	130 (9.0 %)
Others	41 (6.5 %)	72 (6.6 %)	80 (5.5 %)
Total	**634 (100)**	**1092 (100)**	**1447 (100)**

(Source: FAO, 2008)

Irrigation is major water consuming activity, because majority of cropped area is irrigated with surface methods and water use efficiency seldom exceeds 35 per cent. Declining availability of water for agriculture warrants for enhancing the water use efficiency and water productivity in agriculture. Crop irrigation is the largest user of water accounting about 70% of global freshwater withdrawals. However, there has been mounting pressure to limit water supply to irrigated agriculture and to produce more food with less water. Consequently, the search for technologies/measures to

conserve water in agriculture especially on crop production, some of the important technologies are narrated here.

Tillage Practices

Conservation tillage

It is any form of tillage and planting system that covers 30 % or more of the soil surface to reduce soil erosion by water and it increases water infiltration by as much as 30 to 45%. Conservation agriculture has three components: Minimum soil disturbance, Soil cover, Crop rotation/association.

Jakhar *et al.* (2017) reported that higher maize kernel yield (3.43 t ha^{-1}) and water use efficiency (12.27 kg ha^{-1} m^{-1}) were recorded in RF + CR (Crop residue) 4 t ha^{-1} treatment.

Land levelling

It is a process by which field is modified to a desired grade to provide a more suitable surface for efficiently applying irrigation water. It improves crop establishment, even water coverage of the field, increases farming area by 5-7 %, increases water productivity, even crop stand and maturation, increase nutrient use efficiency.

Jatt *et al*. (2004) reported that precision land levelling improves the yield and water productivity of rice grown as direct seeded/ puddled transplanted.

Conservation Agriculture

Land levelling

Planting Techniques

Ridge and furrow method

It acts as barrier to the free movement of the water which provide more infiltration time. It is the one of the various in-situ soil and water conservation methods for black and red soil which result in increased up to 15 % of crop yield. On an average about 30 % less irrigation water was required compared to flatbed method.

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Paired row technique

It is a method in which accommodating crop rows on both sides of furrow by increasing ridge spacing, thereby a common furrow is used for irrigation of two rows.

Mandal *et al.* (2019) found that ridge & furrow and paired-row methods increased the groundnut pod yield by 13 and 17% and saved irrigation water by 26.7 and 41.7%, respectively over flat-bed method.

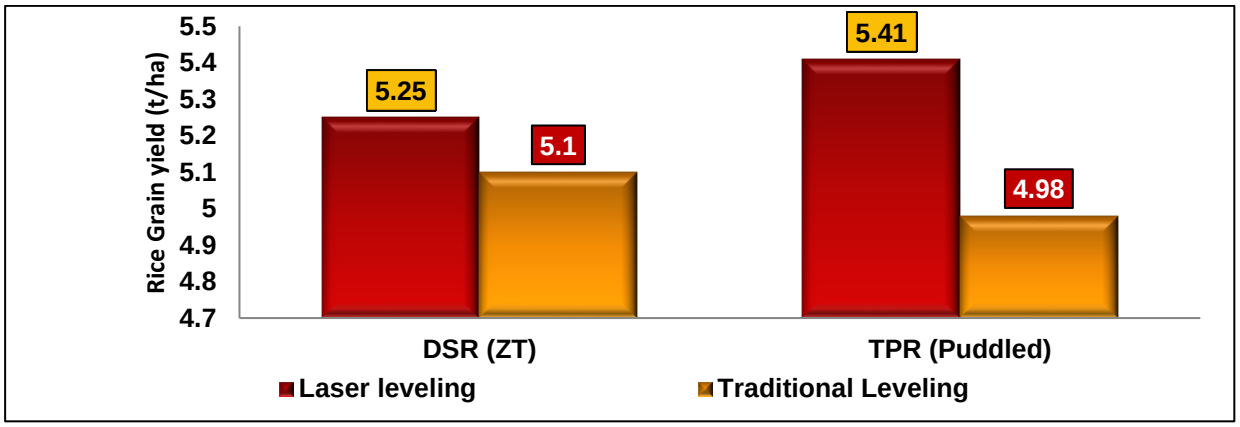
Direct seeded rice (DSR)

In this method, seeds are directly drilled into the fields. In contrast to the traditional water-intensive method of transplanting rice seedlings from a nursery to waterlogged fields, this method saves groundwater. There is no nursery preparation or transplantation involved in this method. It saves labour and requires less water with low production cost.

Ridge and furrow method

Direct seeded rice (DSR)

Pathak *et al.* (2011) showed that water productivity and net profit were increased in directed seeded rice as compared to conventional puddled transplanted rice without compromising yield.



Pathak *et al.* (2011)

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Resource Utilization Techniques

Intercropping

Inter cropping is a process of growing a short duration companion crops in between the spaces of widely spaced principal or main crop. Intercropping has been widely applied in arid and semi-arid regions due to efficient utilization of resources thereby mitigates water and wind erosion. It increases water use efficiency of crops via optimizing the soil moisture environment for crop development.

Vaghela *et al.* (2018) found that growing of groundnut + castor (2:1) as intercropping system produced higher castor equivalent yield (5141 kg ha^{-1}) and secured maximum net realization along with highest water productivity (10.3 kg ha^{-1} mm^{-1}).

Mulching

It is a practice of spreading any covering material on soil surface to reduce evaporation losses. The mulches will prolong the moisture availability in the soil and save the crop during drought conditions. Benefits of mulching are it conserves soil moisture, reduce evaporation, control weeds and run off.

Paul *et al.* (2013) revealed that the highest yield (28.7 t ha^{-1}) of capsicum was recorded under 100% net irrigation volume with drip irrigation whereas highest water productivity (114.5 kg ha^{-1} mm^{-1}) was recorded under the treatment of 60 % irrigation (Drip) + black LLDPE Mulch.

Intercropping

Mulching

Irrigation Scheduling Criteria

Irrigation scheduling is defined as frequency with which water is to be applied based on need of the crop and nature of the soil. “3R” system (Right time, right method and right quantity) should be employed for the efficient irrigation to the crops.

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Nayak *et al*. (2015) revealed that the highest grain yield (4380 kg ha^{-1}) and straw yield (4538 kg ha^{-1}) of wheat were recorded when irrigation was applied critical stages *viz.*, CRI, tillering, booting, flowering, milking and dough stage.

Micro Irrigation Systems (MIS)

Sprinkler irrigation

In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. Water saving to an extent of 35-40% compared to surface irrigation methods.

Kaur *et al.* (2020) observed that yield of tomato was obtained higher under micro sprinkler method while water use efficiency was maximum in drip irrigation method as compare to surface irrigation.

Drip irrigation

Drip irrigation also known as trickle irrigation system is a technique by which water and fertilizer including chemicals can be placed at the direct disposal of the root zone with the help of a specially designed dripper.

Shivashankar *et al.* (2015) reported that water saving of 28.6 %, 28.6 %, 33.3% and yield increment of 23.1 %, 28.0 %, 23.6 % were found in groundnut, garlic, chillies, respectively by sprinkler irrigation over boarder irrigation.

Sprinkler irrigation

Drip irrigation

Use of Anti-Transpirants

Anti-transpirant is a substance that is usually sprayed on plant surfaces (as of the leaves and stems) to reduce transpiration and inhibit water loss. e.g. Stomatal closing type: PMA, Film forming

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type: Silicone oils, Reflecting type: Kaoline and Growth retardant: Cycocel.

Kumar *et al.* (2018) revealed that higher seed yield, water use efficiency and net return observed higher under treatment of application of anti-transpirants (PMA+kaoline) in mustard.

Use of Plant Bioregulators

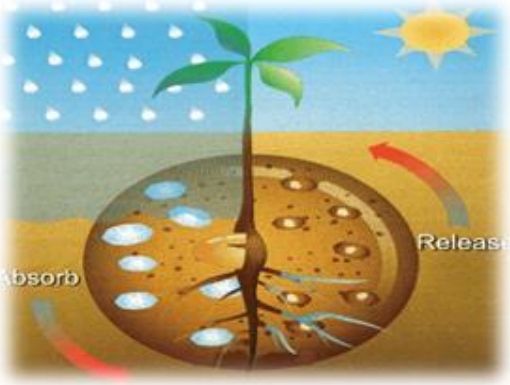
Plant bioregulators are unique agrochemicals in that they must be absorbed by the plant tissue and transported to a reaction site before the desired response can be achieved. Most plant bioregulators are applied as aqueous sprays to a variety of plant surfaces. Use of plant bioregulators has been shown to mitigate the impacts of water stress and benefit crops under water scarce conditions. Plant bioregulators (PBRs), like thiourea, salicylic acid and sodium benzoate, seem to play a vital role in enhancing yield and water productivity.

Wakchaure *et al.* (2016) reported that the application of plant bioregulators mitigated water stress and improved gain yield by 6.8–18.5%. SA was more effective under moderate stress while SB and TU were better under severe water deficits.

Use Of Polymer

The use of polymer in agriculture is gaining popularity in science, particularly in the field of polymer chemistry. Superabsorbent polymer hydrogels potentially influence soil permeability, density, structure, texture, evaporation and infiltration rates of water through the soils. Superabsorbent polymers/hydrogels are polymers that can absorb and retain extremely large amounts of a liquid relative to their own mass. It absorbs water 500 times its own weight. It increases their water-holding capacity, water use efficiency, enhances soil permeability and infiltration rates, reduces irrigation frequency and increases plant yield.

Anti-transpirants



Polymer

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Shankarappa *et al.* (2020) found that application of hydrogel at 5 kg ha^{-1} before sowing recorded a significantly greater number of pods per plant (38.0) and seed yield of lentil (1032.1 kg/ha) over the control (without hydrogel).

Conclusion

From the foregoing discussion it can be concluded that by adopting different water saving approaches like appropriate tillage practices, suitable planting techniques, system of crop intensification, proper scheduling of irrigation, use of precise irrigation techniques-MIS (drip and sprinkler), adopting resource conservation techniques *viz.*, mulching and intercropping, application of anti-transpirants, plant bioregulators and polymers or integration of more than one technique can save the water, enhance the yield and water use efficiency in agricultural crop production.

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