Rice

Drip irrigation and fertigation protocol

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Introduction

Rice is an important staple for over 60% of the world's population. Traditionally rice cultivation involves transplanting seedlings into puddled fields that are continuously submerged by 5-10 cm of water throughout the growing season. Unproductive water loss in the form of seepage and percolation from submerged rice fields accounts for 50-60% of the total water inputs in the field.

A drip irrigation system is the most effective irrigation methods for:

- Increasing water use efficiency by minimizing all unproductive water losses
- Increasing fertilizer use efficiency
- Increasing crop yield
- Minimizing field preparation costs
- Lowering greenhouse gas emissions
- Reducing arsenic uptake and accumulation

Drip System Solutions for Rice

Soil type	Lateral spacing (m)	Dripper spacing (m)	Dripper flow rate l/h
Heavy	0.8 – 0.9	0.4 – 0.5	1.0 – 2.2
Medium	0.7 – 0.8	0.3 – 0.4	1.0 – 2.2
Light	0.6 – 0.7	0.3 or less	1.0 – 2.2

Choose the dripper type according to the terrain level:

Normal flat land (<1% slope) – non-pressure compensated (NPC) dripper: Streamline, Typhoon, Arias

Sloped land (>1% slope) – pressure compensated (PC) dripper: Dripnet PC

NPC dripline for normal flat land

PC dripline for sloped/undulating field

Irrigation & Fertigation Protocol

Maintaining enough moisture through the growing season and nutrient application, is very important for yield improvement. Since the following irrigation and fertigation guidelines are general in nature, we recommend to adjust your plan according to your soil type, planting pattern, climate and rice variety.

Irrigation Guidelines

The planting method can be conducted based on field preparation, soil condition, and water availability.

- Medium-heavy soil field with fine tilth: dry direct seeding of rice (**dry DSR**)
- Heavy soil, rough tilth and small clods/paddy field: wet direct seeding of rice (**wet DSR**)
- Heavy-clay soil, difficult to get fine tilth/puddle conditions: transplanting

Planting methods irrigation guidelines

Dry DSR	Wet DSR	Transplanting
Plan irrigation for the seeding period to saturate the field, and then continue with regular irrigation.	Maintain saturated moisture in the field while seeding.	Maintain more than saturated moisture while transplanting. If after final field preparation there are soil clods, you can plan a single conventional irrigation to break them up and facilitate transplanting.
Until germination, maintain moisture in between field capacity and saturated condition. Until seedling, maintain saturated moisture to minimize weed growth and to create a good seed bed.		Saturated moisture can be extended up until the establishment of seedlings (i.e. 10 days after transplanting).

Regular Irrigation scheduling based on ET can be started after seedling stage/establishment of seedlings.

Irrigation duration

Irrigation duration is calculated according to the ETo values of your region. Follow these guidelines:
Irrigation duration (hour/shift/day) = ETc / application rate
Irrigation/application rate (mm/hour) = emitter flow rate (l/h) / (emitter-line spacing (m) x emitter spacing (m)
Crop evapotranspiration (ETc) (mm/day) = ETo x Kc (crop coefficient)

For example

Evapotranspiration (ETo)	6 mm
Crop coefficient (Kc)	1.2 mm
Emitter-line spacing	0.9 m
Emitter spacing	0.4 m
Emitter discharge	1 l/h
Irrigation/application rate	$\frac{1}{0.9 \times 0.4} = 2.77\ ^{mm}/_{hour}$
Irrigation duration	$\frac{\text{Crop evapotranspiration}}{\text{Irrigation/application rate}} = \frac{7.2}{2.77} = 2.59$ hours/shift/day

General Irrigation Program Guideline

Stage	Seeding	Germination		Seedling		Tillering	
Graphic presentation							
Phases	Vegetative						
Days after sowing	0	10	20	30	40	50	
Kc	Above field capacity (saturated condition)*					1.1 - 1.25*	
Irrigation interval (days)				1	1	1	

* In high irrigation demand areas, adjust the water amount using soil texture data, water holding capacity and rooting pattern.

Irrigation program model

	June	July	August	September
ET	4.8	5.0	4.3	4
Kc	1.1	1.25	1.3	1
ETc	5.3	6.3	5.6	4
Irrigation freq. days	1	1	2	2
Irrigation plan	5.3	6.3	11.2	8

Calculation example for:
Daily consumption (mm/day) ETc = ETo x Kc = 4.3 x 1.3 = 5.6 mm/day
Irrigation plan = irrigation frequency x ETc = 5.6 x 2 = 11.2mm / every 2 days

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	Stem elongation	Panicle initiation	Booting	Flowering	Milky	Doughy	Mature grain
							
		Reproductive phase			Ripening		
60	70	80	90	100	110	120	130
		1.25 - 1.5*			1		
1	1	1	1	1	1	1	1

Fertilization Guidelines

Fertigation Facts and Figures

P Phosphate

- Phosphate is essential for root development, enhances the uptake of other elements (especially N), and boosts flowering and grain formation.
- The full amount, or 60%, of phosphate demand can be applied as basal application in the soil at sowing / transplanting.
- Balance P can be applied with fertigation before the tillering and flowering stage.

N Nitrogen

- Nitrogen is a key nutrition elementthat impacts plant biomass, protein production and yield.
- In low-N soils, 20-25 % of the total nitrogen demand can be applied as basal application in the soil.
- The full amount of N demand can be delivered through fertigation. 100% can be applied until the heading stage.
- In dry seeding of rice (DSR), basal N application should be carried out very carefully. A high level of basal N application can enhance weed growth. Plan the N fertigation after seedling emergence rather than after soil application.

K Potassium

- Potassium is the osmo-regulator of the plant, and is crucial for plant health and durability.
- In low-K soils, 25% of the total K demand can be applied by basal application.
- The full amount of K demand can be delivered through fertigation - 60% until the heading stage, and the rest throughout the maturity phase.

Zn Fe Micronutrients

- The base application of zinc sulfate is 25kg/Ha and ferrous sulfate is 35-50kg/Ha.
- The base application can be applied separately or mixed with organic manure.
- Zn and Fe deficiency can be corrected by fertigation or foliar spray with a chelated/soluble fertilizer: Zn at 0.5%, and Fe at 1% concentration 2-3 times at an interval of 7-10 days.

Stage	Kg/Ha					Duration (days)
	N	P_2O_5	K_2O	Zn ($ZnSO_4$)	Fe ($FeSO_4$)	
Base application	10*	40	10	25	35-40	
Germination and seedling	40					40
Tillering	50	5	10			20
Stem elongation	25		5			10
Penicle initiation to flowering	35	5	20			30
Ripening			20			30
Total	160	50	65	25	35-40**	130

Fertilisers can be combined based on compatibility. Foliar spray can be carried out deficiency symptoms are detected.

* In low N status soil, some of the N can be applied as a starter dose by using complex fertilizers.

** Basal $FeSO_4$ can be applied only where soil pH is in over 7.5

Fertigation Rules of Thumb

- Before fertigation, ensure good soil moisture for spreading the nutrients. In existing paddy fields, nutrient movement (mainly N) is affected by the clay content and the cracking pattern due to the dryness at the time of harvesting and the previous crop.
- Monitor soil pH before fertilizer application to enhance nutrient availability.
- Ensure the solubility and dissolution of the fertilizers in the fertilizer tank before application; at least 3 liters of water are required to solubilize each kg of the fertilizer. Extra water can be added according to the fertigation duration.
- Make sure that the fertilizers in the mixing tank are compatible; fertilizers incompatibility will result in heavy sedimentation, dripper clogging and irregular fertigation.
- Select the fertilizer sources based on the salinity level of water and soil. If you select a chloride-based fertilizer (e.g. potassium chloride) for high saline water/soil areas, it will again induce the salinity level in the root zone and minimize nutrient uptake to the plants.
- Plan the fertigation intervals according to soil texture and water quality. A higher fertigation frequency will enhance fertilizer use efficiency, crop yield and quality. Reduce fertigation frequency in light soil and high salinity water/soil.
- After completing the fertigation cycle, flush the system for 15-20 minutes with clean water.

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