RICE WITH DRIP

A Sustainable Approach

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Our Company, Jain Irrigation Systems Limited (JISL) with it's motto 'Small Ideas, Big Revolutions' with more than 11,782+ associates worldwide and revenue of $USD 1.2 Billion, is an Indian multinational company with manufacturing plants in 33 locations across the globe. JISL, its subsidiaries and associates are engaged in providing solutions in agriculture, piping, infrastructure through manufacturing of Micro Irrigation Systems, PVC Pipes, HDPE Pipes, Plastic Sheets, Agro Processed Products, Renewable Energy Solutions, Tissue Culture Plants, Financial Services and other agricultural inputs since more than 35 years. It has pioneered a silent Productivity Revolution with modern irrigation systems and innovative technologies in order to save precious water and has helped to get significant increase in crop yields, especially for more than 8.5 million small farmers. It has also ushered in new concept of large scale Jain Integrated Irrigation Solutions (JIIS). 'More Crop Per Drop™' is the company's approach to water security and food security.

JISL is early pioneer for IOT in the agri–sector and is leading efforts to create global solutions with precision agriculture. It's food brand 'Jain FarmFresh' is well known all over the world for quality and consistency.

All the products and services of JISL help create a sustainable future while fulfilling its vision to 'Leave this world better than you found it'.

Jain R&D and Demostration Farms, Jalgaon (MH) India.

RICE PROFILE

Rice is the world's most important food. It is the second most widely cultivated cereal in the world and is a staple food of over half of the world's population. According to FAO, 2017, world produced 759.6 million metric ton of Paddy, in 166.0 million ha, second highest cereal produced after Corn. The per capita rice consumption is around 54.24 kg per year.

In much of Asia, rice is so central to the culture that the word rice is almost synonymous with food. Though Asian population forms major fraction of the rice consuming world; and rice is treated as the most economically important food crop in many developing countries in this decade, it is also becoming a major crop in many developed countries where its consumption has increased considerably, particularly in North America and the European Union (EU) due to food diversification and immigration.

It is necessary to meet the demand for rice of the world's current population growth rate. The least costly means for achieving this goal is to increase rice productivity. Many rice-producing countries still have a large gap between their present and potential yield. Therefore, efforts should be focused on identifying the causes of this gap especially in the area of crop management. The main challenge encountered by scientists involved in rice research and production in the world is to find appropriate solutions for major issues such as problems of water use efficiency, availability of land, major biotic stresses, and environmental pollution from the production systems, and high costs of production.

India contributes 21% of the global rice production, which heavily depends upon monsoon rains. Current year (2017-18) it is predicted that rice production would be 107 million tons from 101 million ha. Nearly 42% of the rice crop (18 million ha) is still unirrigated. The crux of the matter is that any increase in irrigated area depends upon water conservation practiced in the presently irrigated 58.7% rice area. This necessitates urgency in enhancing water use efficiency in rice culture. Many other rice growing countries share this pattern of reality.

PREFACE

Keeping in line with the Jain proposition of **Doing Well By Doing Good,** drip-fertigation for rice has been promoted by Jain Irrigation Systems Ltd., since 2007-08. Improving water use efficiency in rice production is one of the challenges in rice cultivation as mentioned in crop profile. Technologies for enhancing water use efficiency would result in production of more rice per unit water consumed. This process would liberate more water for irrigation. Drip-fertigation technology has proven its impact in reducing the water consumption of many other irrigated crops.

JISL has been at the forefront of developing water and nutrient efficient cultivation technologies for several crops. They began work in testing drip fertigation technology for rice cultivation over 12 years back. After initial encouraging results the company went ahead and tested the technology in several rice ecologies across India. The changed water application method may offer unique opportunities to improve productivity, food security and livelihood in environments where water is limited. Drip systems allow the provision of water, plant nutrients, herbicides and soil-acting pest control agents with higher efficiencies and with more precision than other currently practiced application methods. The drip technology application would ensure **"More Crop Per Drop"** in other words enhance rice yields with lesser input of water, fertilizer and energy.

Jain pioneered the concept of **"Rice with Drip"**. As a part of Jains' efforts to bring in sustainable practices in rice cultivation, since 2010 Jain Irrigation and IRRI have been engaged in collaborative research on micro irrigation for rice through an MoU.

At IRC 2014, JISL collaborated with IRRI and organised a workshop on Rice Cultivation on Drip Irrigation as a side event. Recent research has shown that the traditional practice of puddling and transplanting of rice can be avoided by growing rice without soil tillage followed by direct seeding – referred as dry direct seeding or aerobic culture. Much progress has been made in perfecting this technology and in developing a package of practices. Not only does aerobic rice culture save water and labor, it also allows crop residue recycling (which is otherwise burnt), reduces much of methane emissions, lowers energy use and increases farmers' profits. Avoiding puddling also improves soil structure which is an essential soil health requirement for subsequent aerobic crops such as wheat, maize and vegetables.

Jains have similar collaborative research programme with major agriculture universities in India to further study different aspects of drip-fertigation use in rice cultivation. Having standardized the new package of practices for drip-fertigated rice, Jain now would be an active partner in the DSR consortium to take these efforts to develop precision and sustainable resource management (water, energy, fertilzer and labour) practices in Direct Seeded Rice cultivation, both in dry and wet seeded situations.

Precise water management is crucial not only to address the growing water scarcity but to also break the yield barrier through optimal weed control and accurate nutrient delivery to the plants. There is increased interest to use pressurized irrigation methods to grow rice. Studies in Asia have shown that drip and sprinkler systems have potential to improve on-farm irrigation efficiency up to 90% in several crops, including rice. Perhaps sub-surface drip irrigation (along with fertigation and chemigation) holds the real potential to bring next Green Revolution. Experiences from the USA, Brazil and India demonstrate the technical and economical feasibility of the sub-surface drip system in rice. Even though some of these studies show potential, however, much needs to be explored to understand the impact of drip with respect to environment (Methane gas generation & nitrate leaching), health (soil & human), & quality of Rice (grain size & millability).

The concept of Rice with Drip has a huge untapped potential that should be explored in close collaboration with various partners, especially in the scientific institutions & private sector.

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More Crop per Drop

TECHNICAL PAPER IRC 2018, SINGAPORE.

ABSTRACT

Rice is in ever-increasing demand in India, and in South, South East Asian and African countries. A hectare of rice in conventional puddle cultivation uses 1300-1600 mm per season as per the literature. But in actuality farmers use much more volume (up to 2000 mm) in many delta areas in India. As the demand for water for domestic, municipal, industrial and environmental purposes rises in the future, less water will be available for agriculture. Water availability for agriculture in India which is 83.3% of total water used today, will shrink to 78.2% in 2010, to 71.6% 2025 and to 64.6% in 2050. We are almost exhausting irrigation water to bring any more land under conventional irrigation.

The future of rice production which consumes a lion's share of water (85% in India) used in irrigated agriculture will therefore depend heavily on developing and adopting technologies and practices which will use less water with highest use efficiency. Rice is cultivated usually in a puddled soil condition with large volumes of water and grown in standing water. The water productivity is hardly 0.15 kg/m³ of water which is very low. Way back in 2008 we began introducing drip irrigation (both surface drip and sub surface drip systems) and fertigation for rice cultivation. During the last 10 years, this input management method is tried over several rice ecologies in India and over several rice varieties spanning both Dry seeded (DSR) and Transplanted rice (TPR) growing systems (sole rice or rotation with other crops).

Drip-Fertigated Rice Field – Jalgaon District, Maharashtra (India)

Under drip –fertigation, the water productivity rose to 0.46 to 0.67 kg/m³ across varieties and locations. Rice yields were higher (13-80%) across varieties compared to the yields recorded in the respective conventional methods. Panicle number, grain number and test weights (grain) were found to be superior under water and fertilizer management through drip systems. Similarly, higher N, P and K efficiencies were also recorded under drip –fertigation. A standard rice growing package with drip fertigation is made available to farmers.

The benefit costs worked out in individual farms ranged from 1.4 to 2.1 across varieties when the seasonal cost of drip system (major investment) is taken as a fraction of its life (field durability of 7 years or 14 seasons).

Considering the direct water, power and yield benefits, the state governments in India are slowly warming up to the idea of subsidising the investment cost of the irrigation system to rice farmers; in Andhra Pradesh, Tamil nadu and Haryana states of India in this financial year.

This work also generated a number researchable issues: (1) Drip-Water management effect on methane gas emission from rice fields and its impact. (2) Are there any specific adaptation traits among rice to drip method of soil wetting. (3) Can fertigation help in reducing excess nitrogen entry to surface water in rice ecosystems. (4) Can drip method, and associated micro climate influence the disease and pest spectrum affecting rice crop / alternate follower crop etc.

Summarised From

P.Soman, Balkrishna Yadav, Sarwan Singh and Prasad.M.S. *2018. Presented at the Current International Rice Congress, Singapore 15-17 October 2018.*

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EVALUATION OF THE PERFORMANCE OF AEROBIC RICE USING DRIP IRRIGATION TECHNOLOGY UNDER TROPICAL CONDITIONS

Abstract

Purpose

More than 90% of global rice is produced from conventional lowland irrigated system, seedlings transplanted on puddled soil, with standing water 5-10 cm, throughout its growth period, till just few days before harvest. Also, lowland rice is common in coastal areas under rain-fed conditions, using puddling to prepare the soil for transplanting/direct sowing. While upland direct seeded rice is produced during wet season under dryland aerobic conditions, without puddling or standing water, supported by supplementary irrigation. In recent times specially evolved aerobic rice varieties, tolerant to drought, high yielding is used under aerobic conditions. Approximately 80% of fresh water is used for irrigation of agricultural crops. 30% of irrigation water is used for cultivation of rice under conventional lowland rice system. On an average, rice fields use 1400 L of water by evaporation and transpiration to produce 1 kg rice as per few published papers. Exploitation of surface and ground water has reached its maxima in many States, that unless water saving technologies are used, it will be impossible to practice, sustainable agriculture in coming years. Realizing that more than 90% of rice is produced under inundated lowland system, extensive field trials were carried out using specially evolved aerobic rice varieties and genotypes under upland aerobic conditions using drip system to maximize yield and water productivity.

Drip Fertigated Rice Field - Medak Dist., Telangana (India)

Approach and Methods

Investigations were carried out during monsoon season of 2010 and 2011 in sandy clay soil with good drainage, pH-7.66, E.C 0.21 DSM-1, in Jains experimental farm, Udumalpet, Tamil Nadu, India.

During first year only one rice hybrid ADT-45 while second year five hybrids namely 27P-31, 27P-63, PHB-71, Arize-6444 & Arize-6129 were used.

Two 16 mm laterals with 4 lph dripline spaced at 50 cm were laid at an interval of 40cm in each bed.

Key Results

- Drip irrigation saved 50-61% water along with increased yield and water productivity in all the genotypes.
- Water productivity in flood irrigated control ranged between 0.097 to 0.224 kg/m³ the same was close to three to five times higher under drip ranging from 0.365 kg/m³ to 0.714 kg/m³.
- Yield of different varieties ranged from 4.5 t to 8.19 t/ha under drip than 17.7 to 22.2 % over flood irrigated.
- Water productivity was highest 0.713 kg/m³, indicating that genotypes such as 27p31 have used barely around 1400 L water to produce one kg of rice which is approximately the crop loses by way of evapotranspiration only, to produce one kg grain, indicating water use efficiency more than 95% (WUE) under aerobic drip irrigated using plastic mulch conditions.

Synthesis and Application

The value of this research and its findings are very timely as the global rice production is facing the biggest challenge of declining water availabilities. Technologies like drip and fertigation are going to be answers for the challenges on water and overall need for high efficiency input management and higher production efficiencies.

Varieties such as ADT-45, 27p31, PHB-71, 27p63, arize 6444 can be cultivated profitably, using drip and paddy husk/polythene mulch with water saving about 50-60%.

Summarised From

Soman P.*, Singh Sundar, Balasubramaniam V.r. And Choudhary Amol *2018. International Journal of Agriculture Sciences Vol. 10 (14) : 6040-6043.*

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Full text avaliable at - www.blog.jains.com

Drip-Fertigated Rice Field – Coimbatore District, Tamilnadu (India)

EFFECT OF DRIP IRRIGATION AND FERTIGATION ON THE PERFORMANCE OF SEVERAL RICE CULTIVARS IN DIFFERENT RICE ECOSYSTEMS IN INDIA

Abstract

Purpose

Ninety percent of rice cultivation is done under low land rice system in the world. Under lowland puddled soil and transplanted rice system, weed growth is minimal, as the transplanted seedlings gets head-start in their fight with weeds. Under low land system, water is consumed as much as 2295 mm/ha and 3000- 5000 litres utilized by the crop to produce one kg of grain. The water productivity is as low as 0.15 kg/m³ in some cases. The unsustainable use of irrigation water for rice production is a major socioeconomic, environmental and health concern for the region. Rice is also cultivated as dry land crop under rainfed conditions. The seeds sown directly (DSR) and the soil moisture maintained to field capacity throughout the period of crop growth. Aerobic rice genotypes displayed greater adaptation to water-limited cultivation. Compared with traditional low land rice system, water inputs in aerobic rice system were less than 50% (470-650 mm), water productivity 64-88% higher, and labour use was 55% lower. Exploding demand for water is the critical challenge agriculture faces. Climate change, prolonged droughts, water supply limits, continued population growth have put pressure on the availability of water, and forced to intensify the search for measures to conserve water in irrigated agriculture, the world's largest water user.

The main objectives are, 1) To determine yield stability and pattern of response of genotypes to drip irrigation and fertigation treatments across varied ecosystems and 2) To demonstrate the efficacy of drip and fertigation technology in saving water and fertilizers, increasing yield and improving quality to wide spectrum of farmers in the country and motivate them to use water and fertilizer saving technologies.

Approach and Methods

The demonstration trials were carried out in farmers' field in seven States

1) Andra Pradesh (AP) covering Vizag, Kadapa, Kurnool, East Godavari and Vijayanagaram districts (South India)
2) Telengana covering Medak, Karimnagar, Nalgonda districts (Central India)
3) Chhattisgarh, Durg district (East India)
4) Rajasthan, Kota district (North India)
5) Punjab, Patiala, and Ludhiana districts (North India)
6) Tamil Nadu, Cuddalore, Tiruvannamalai, Madurai districts, and (South India)
7) Maharashtra, Raigarh district (Western India)

Cropping Season

Year : 2009 to 2014.

Season : Monsoon or *"Kharif"* June-July sowing, and Winter or *"Rabi"* Oct-December sowing done.

Planting Method : Direct seeded rice (DSR) and Transplanted rice. (TPR)

Key Result

- Under drip irrigation yield varied between 5.93 to 11.61 t/ha which was 7.34 to 29.90% higher than flood irrigation.
- In Telangana (Central India) yield under drip varied between 6.42 to 9.38 t/ha which was 15 to 30% higher than flood irrigation.
- In Andhra Pradesh (Southern India) yield under drip irrigation varied between 7.16 to 9.38 t/ha which was 25.07 to 28.70% higher than flood irrigation.

- In North India (Punjab and Rajasthan) yield under drip irrigation varied between 5.83 to 8.50 t/ha which was 7.34 to 21.4% higher than flood irrigation.
- In other states yield varied between 5.93 to 1.61 t/ha which was 20 to 27% higher than flood irrigated fields.
- In direct seeded (DSR) and drip irrigated system yield varied between 5.93 to 9.63 t/ha while under transplanted and drip irrigated system yield varied between 7.41 to 9.39 t/ha.
- For coarse grain varieties yield under drip irrigation varied between 7.41 to 9.63 t/ha which was 5.68 to 7.41 t/ha in flood irrigation.
- For fine grain and Basmati type varieties yield under drip irrigation varied between 5.83 to 11.61 t/ha which was 4.69 to 9.13 t/ha in flood irrigation.

Synthesis and Applications

In a water starved country like India, drip fertigation technology as found suitable for different rice cultivars in different rice ecologies would be an appropriate solution for continued cropping of rice.

Summarised From

Soman P.*, Prasad M.S., Balasubramaniam V.R., Singh Sarwan, Dhavarajan C., Patil V.B. and Jha Sanjeev.
2018. International Journal of Agriculture Sciences Vol. 10 (14) : 6672-6675.
Email : dr.soman@jains.com

Full text avaliable at - www.blog.jains.com

Drip-Fertigated Rice Field – Tiruvannamalai District, Tamilnadu (India)

BREAKING YIELD BARRIER OF RICE AND WHEAT THROUGH DRIP IRRIGATION IN INDO-GANGETIC PLAINS OF INDIA

ABSTRACTS

Rice-Wheat is a pre dominant cropping system of Indian sub continent with 17 mha area. The average productivity of Rice and Wheat is low. Rice and Wheat are the two major crops which consume maximum water and rice crop alone consumes 150-200 cm of water depending upon the crop duration. Rice is still being cultivated in India as transplanted in puddled soil leads to water losses through percolation, run off and evaporation from the soil surface. In India, 70 % of total available fresh water is being used in agriculture of which maximum is used by rice crop only causing decline in ground water table over the years. The present declining rate of ground water is around 40-60 cm per year leading to use of more energy to pump the ground water. Conventional method of puddling and transplanting also deteriorate soil health, increased cost of field preparation for succeeding wheat crop due to soil compaction. To overcome declining water table, soil productivity and increased cost of production there is a need to investigate the feasibility of using modern methods of rice and wheat cultivation with pressurized irrigation techniques for saving/conserving water and environment.

INDO-GANGETIC PLAINS

Key Results

Recent results of the trials conducted at G.B. Pant University of Agriculture and Technology, Pantnagar in Uttarakhand and farmer field in Haryana have shown that higher yields of rice could be taken by sowing the seeds directly into the moist seed bed as direct seeding on surface or on raised bed and irrigating and fertigating through the drip. These trials led to saving of 50-70% of water in rice/wheat as compared to conventional system. All the growth parameters, yield attributes, fertilizer use efficiency, water use efficiency were found to be higher in drip irrigated crops based on 20-50% cumulative pan evaporation on 2-4 days interval. The benefit cost ratio was also higher in direct seeded rice with drip irrigation.

Synthesis and Applications

For breaking the present yield barrier of rice/wheat by adopting precision farming technology in farmer's field as direct seeding and irrigating and fertigating with drip irrigation is the need of the hour. The direct rice seeding generally require laser leveled plot and practical knowledge(such as field preparation, quality planting material, time of seeding, moisture condition of soil, depth of sowing and seed rate) for achieving higher yield.

Precise irrigation management through drip irrigation is the need of the hour for restoring declining ground water table. Drip irrigation not only resulted in providing water to the plant root as per need but also provides nutrients as per its requirement. This might lead to the possibility of reducing the fertilizer requirement because of increased fertilizer use efficiency , protecting environment by reducing methane emission from rice fields. The direct seeding coupled with drip Irrigation is a cost effective technology for attaining higer yield of rice/wheat. The soil health of the rice cultivating area may be maintained by adopting such modern technologies.

Eco-friendly drip irrigation with fertigation system in rice based cropping system such as rice-wheat or sugarcane has potential to increase the yield levels of rice by 10-20 % and up to 5-10% in wheat with 50-70 % saving of irrigation water.

Summarised From

Bhardwaj ,A.K., Pandiaraj T, Chaturvedi, Sumit, Singh, T.C, Soman P., Bhardwaj A.K. and Labh B. *2018. Growth, Production Potential and Inputs Use Efficiency of Rice under Different Planting Methods in Drip Irrigation. Current Journal of Applied Science and Technology. Vol.26(6): 1-9.*

Singh, T.C., Prajapati, B. and Bharadwaj A K *2018. Effect of Drip Irrigation on Growth and Yield of Direct Seeded Rice (Oryza sativa L.). International Journal of Chemical Studies. Vol 6(1)161-164.*

Singh, D.K. Kumar, P and Bharadwaj, A.K. *2014 Evaluation of Agronomic Practices on Farmers' Field Under Rice-Wheat Cropping System in North India. International Journal of Agronomy.Vol. 2014:2-5. http://dx.doi.org/10.1155/2014/740656.*

Bhowmik, T., Bhardwaj, A.K., Pandiaraj, T. and Roy A. *2018. Productivity, Water Use Efficiency and Profitability of Drip Irrigated Wheat (Triticum aestivum) in Indo-Gangatic Plains of Uttarakhand, India. Int.J.Curr.Microbiol.App.Sci (2018) 7(2): 3185-3191. https://doi.org/10.20546/ijcmas.2018.702.383.*

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Drip-Fertigated Rice Field – Medak District, Telengana State (India)

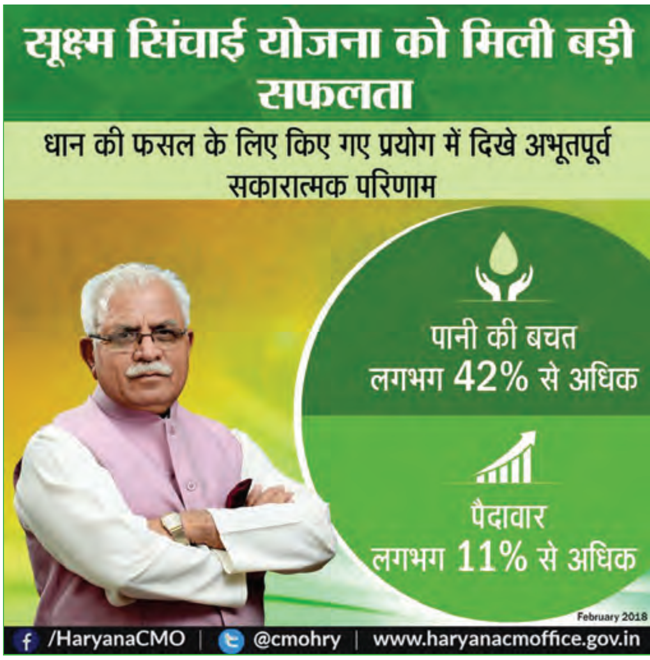
A PRAGMATICAL APPROACH ON THE RICE FIELDS DEMONSTRATING INCREASE IN YIELD AND WATER SAVING BY USING MICRO IRRIGATION TECHNOLOGY : A FIELD EXPERIENCE IN KURUKSHETRA, HARYANA (INDIA)

Abstract

Purpose

The future of rice production which consumes a lion's share of water (85%) used in irrigated agriculture will therefore depend heavily on developing and adopting technologies and practices which will use less water with highest use efficiency. Rice is cultivated usually in a puddle condition with large volumes of water and grown in standing water.

The paper mainly discusses, the experimental trial is an effort to commercialise a package of micro irrigation technology for growing rice. A Pilot Project, "Installation of Community Based Solar/Grid Powered Micro Irrigation Infrastructure in existing canal commands in various districts of Haryana" was prepared by the Command Area Development Authority (CADA), Haryana to boost the reach of Micro Irrigation technologies among the farmers. Project was commissioned & executed by Jain Irrigation Systems Ltd. Jalgaon, Maharastra, India on turnkey basis. Accordingly a demonstration plot of rice crop on experimental basis has sown to motivate the farmers towards Micro Irrigation Technology. Irrigation was done in one acre through conventional flood and in two acres with micro irrigation systems (Drip and Mini Sprinkler System).



Key results

Although Micro irrigation technology for rice production was being demonstrated in farmers' fields since 2008 where irrigation systems were installed by the companies and operated by farmers but here in this case after providing necessary training on operation and maintenance to the farmers regular monitoring was done by Command Area Development Authority Haryana, Agronomist of Jain Irrigation system ltd., Scientists and farmers of nearby area till harvesting. This on farm trial was conduct on VAR–PR 126 in the fields of Sardar Karanjeet Singh of village Gumthala Garhu (Dera Fateh Singh)district Kurukshetra, Haryana. Appreciable results were obtained as yield was increased by 11.65% in drip irrigation by saving of water which amounts to 42.03%.

Synthesis and applications

It was common belief that water-saving irrigation techniques often run the risk of yield reduction because of possible drought-stress on the crop. On this demonstration plot, it has been proved pragmatically beyond doubt that for cultivating rice in water-limited condition and by following advanced water saving techniques such as drip irrigation system has assured to sustain the productivity under water scarce situation. There is huge saving of water up to 42.03% to tackle the issue of overexploited blocks and increase yield by 11.65% which is establishing that water can be reduced without compromising the yield even in rice production. Low cost drip irrigation cum fertigation system could become a boon to small & marginal farmers, moreover capacity building and training for effective adoption of micro irrigation technology needs to be addressed.

Sprinkler - Fertigated Rice Field – Kurukshetra District, Haryana State (India)

Drip-Fertigated Rice Field – Kurukshetra District, Haryana State (India)

Summarised From

Neeraj Sharma, S N Singh, Rajiv Bansal, Barjinder Singh, *2018, International Journal of Applied Engeneering Research Vol. 13 : 5197-5200*

ON-FARM DRIP IRRIGATION IN RICE FOR HIGHER PRODUCTIVITY AND PROFITABILITY IN HARYANA, INDIA

Abstract

Micro irrigation systems endow lot of water saving for future crop and expand the land under cultivation which sustains the soil health for sustainable growth towards achieving growing food grain demand. Keeping this, the present on-farm trial was conducted in a farmer field of Gumthala Garhu village of Kurukshethra district, Haryana state. For assessment of rice yield, three different irrigation methods viz. drip, sprinkler and flood irrigation methods were adapted. The experiment was tested with PR 126 rice variety. The results revealed that rice grain yield (6950 kg ha^{-1}) was significantly increased by drip irrigation method compared to flood irrigation (6225 kg ha-1) method. Sprinkler irrigation method gave a lower yield. Also, drip irrigation method of paddy cultivation was recorded considerable higher water use efficiency (17.1 kg ha mm^{-1}) followed by sprinkler method (11.5 kg ha mm^{-1}). Consistently, due to higher yield, higher net return was showed in drip irrigation method.

Drip-Fertigated Rice Field – Pehowa District, Haryana State (India)

Approach and Methods

Trial was conducted in Kurukshethra district of Haryana received 337 mm rain fall during cropping season.

Variety PR 126 was used for experiment.

Three irrigation treatments namely drip irrigation, sprinkler irrigation and flood irrigation.

Key Results

- Rice yields ranged from 4.80 to 6.95 t/ha under transplanted rice of different irrigation systems. Drip irrigation produced maximum yield which was 11.65% more as compared to flood irrigation and 44.79% more than the sprinkler.
- The total water use (inclusive of effective rainfall) in flood irrigation was 587.4 mm whereas it was only 407.3 mm and 419 mm in drip and sprinkler irrigation methods, respectively.
- There was 30.7% and 28.7% of water saving under drip and sprinkler methods, respectively as compared to flood practice.
- The finding indicated that the higher net return (Rs.33787 per acre) was obtained under drip irrigation method followed by flood irrigation method of irrigation (Rs. 29711 per acre).
- Drip irrigation produced 12% more net income than flood irrigation method, and 40% higher net income as compared to sprinkler irrigation system.

Summarised From

P.Soman, Sarvan Singh, A.K. Bhardwaj, T. Pandiaraj and R.K. Bhardwaj. *2018. International Journal of Current Microbiology and Applied Sciences. Vol. 7 (2)*

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NEW PARADIGMS OF GROWING RICE TO ADDRESS EMERGING SHORTAGES OF WATER AND LABOR

Abstract

Purpose

Asia is the home of about 4.3 billion people and 920 millions living in less than $1.25 per day. Intensive cereal system which is the lifeline of vast majority of Asians facing dual challenges – shortages and untimely availability of water and labor. Among the cereals, rice is the most important food crop and heavily depends on large amounts of water and labor because of the way it is grown. Globally rice is grown by transplanting on puddled (wet tilled) soil in more than 100 million ha annually. Rice consumes about 50% of total irrigation water in Asia and accounts for about 24-30% of the withdrawal of world total freshwater. To grow a kg of rough rice, on average 2500 l of water are applied. The seasonal water input to rice fields is the combination of water used in land preparation and to compensate for evaporation, transpiration, seepage, and percolation losses during crop growth. Most of the water applied during crop growth is not used directly for transpiration, and is therefore considered lost from fields. The water productivity of rice in terms of evapotranspiration (ET) is not different from other C_3 cereals such as wheat. The higher water application in rice is also due to water requirements for puddling and losses associated with continuous flooding such as seepage and deep percolation losses to groundwater. Rice transplanting largely done manually is highly labor intensive requiring 25-50 person-days ha^{-1}. Rapid economic growth in Asia has increased the demand for labor in non-agricultural sectors, resulting in reduced labor availability for agriculture. For example, labor forces in agriculture are declining at 0.1% to 0.4%, with an average of 0.2% per year in Asia leading to sharp increases in the labor wages.


Maturing panicle under Drip-Fertigated Rice

Although this practice of growing rice is highly capital and energy-intensive, it survived for centuries since it provides certain advantages notably weed control. It is argued that this has been a most sustainable crop production system on earth but whether under the emerging scenarios of acute shortages of water and labor, it would maintain sustainability in future is highly uncertain.

Key results

Recent research has shown that the traditional practice of puddling and transplanting of rice can be avoided by growing rice without soil tillage followed by direct seeding – referred as dry direct seeding or aerobic culture. Much progress has been made in perfecting this technology and in developing a package of practices. Not only, aerobic rice culture saves water and labor, it allows crop residue recycling (which is otherwise burnt), reduces much of methane emissions, lowers energy use and increases farmers profit. Avoiding puddling also improves soil structure which is an essential soil health requirement for the succeeding aerobic crops such as wheat, maize and vegetables.

Synthesis and applications

Although we have perfected aerobic rice technology, our ability to manage irrigation water is far from perfect.

Precise water management is crucial not only to address the growing water scarcity but to also break the yield barrier through optimal weed control and accurate nutrient delivery to the plants. A large area of the rice-upland crop (such as rice-wheat) cropping system of South Asia is irrigated primarily from groundwater. Any attempt to reduce deep drainage losses in these areas would neither save water nor reduce groundwater decline because often that water is reused/pumped. However, reductions in deep percolation losses can save energy (energy needed to pump) and reduce groundwater pollution. To have a significant impact on true water savings, we need technologies that can reduce ET and increase water productivity of evapotranspired water (WPET).

Recently, interest has been increasing in using pressurized irrigation method to grow rice. Limited studies in the region have shown that drip and sprinkler systems have potential to improve on-farm irrigation efficiency up to 80% in other crops including rice. Perhaps sub-surface drip irrigation along with fertigation and chemigation holds the real potential to bring next green revolution. Experiences from USA, Brazil and India demonstrate technical and economical feasibility of sub-surface system in rice. Although some of these studies show potential, much needs to be explored to understand the feasibility and economics of pressurized irrigation methods in farmers' fields when land holdings are small. This area seems to have huge untapped potential which should be explored in close collaboration with various partners, especially in the private sector.

Summarised From

J.K. Ladha *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

Drip-Fertigated Rice Field Ludhiana District, Punjab (India)

DRIP FERTIGATION FOR RICE CULTIVATION JAIN'S EXPERIENCES

Abstract

Purpose

As the demand for water for domestic, municipal, industrial and environmental purposes rise in the future, less and less water would be available for irrigation. In India, for example 83.3% of total water is used for irrigation; it is predicated that this share of irrigation water will shrink to 71.6% 2025 and to 64.6% in 2050 (Min. Agriculture, GOI).

A hectare of rice in conventional puddle cultivation uses 1300-1600 mm per season as per the literature. But in actuality farmers use much more volume (up to 2000 mm) in many delta areas in India. Water availability for agriculture is dwindling over the years. The future of rice production will therefore depend heavily on developing and adopting technologies that will result in highest water use efficiency. Rice is cultivated usually in a puddled condition with large volumes of water and grown in standing water. The water productivity is hardly 0.15 kg/ m^3 water, which is very low. In the case of several other so called high water user crops - sugarcane, banana, vegetables, etc. using drip –fertigation, we could find that actual water need is found to be 50 -60% less than what are thought of the water requirements. In this method, the crop also performs close to its genetic potential and yields are enhanced.

Approach and methods used

The Research wing of Jain Irrigation has been working since 2009 to develop an innovative method of irrigating and fertigating rice crop. The drip-fertigation technology is tested in the traditional wet rice and the dry seeded rice (DSR) first in its own R& D farm and later in several rice growing areas spread throughout India.

Inline drip tubes were kept at 60 cm apart on the soil surface. Each drip line has emitters at 50 cm apart and with 4 liter per hour emission rate. Daily irrigation quantum is estimated using Pan Evaporation and crop and canopy factors. This provided an irrigation schedule matching the ETP of the crop that varies with climate and age of the crop. This way crop received adequate moisture and not excess at any time.

Fertigation is practiced in each trial. Fertilizer quanta are as per local recommendation. But instead of splitting the fertilizers in to three or four as in the conventional method, small doses of fertilizers are dissolved in irrigation water and applied through the drip emitters. Fertigation was carried out every two days till grain fill and the schedule was matched with the specific element requirement at each crop growth stage.

Weeds were controlled by a combination of pre-emergence weedicide application one hand weeding.

Key results

In the R&D field trials, the yields were 2.8 t/acre in flood irrigated and 3.4 t/acre in the drip fertigated plots. Additionally, a saving of 66% water and 52% power (pumping) were also recorded. The water use efficiency was found to increase to 0.45 - 0.55 kg/m^3 water.

The trials repeated in several states-Andhra Pradesh, Tamilnadu, Karnataka, Punjab, Maharashtra also showed yield superiority and lower water use under drip fertigation. This difference could be observed both under DSR and Wet transplanted paddy. Jain also collaborated with Universities and Research Institutions in studying the effect of micro-irrigation on rice cropping. Economic analysis of the results indicated a B:C ratio of 1.5 to 2.2 for drip fertigated crop.

Synthesis and applications

Results from last 5 years work clearly showed the positive effect of drip fertigation for paddy cultivation. However basic studies are required to show other benefits like effect of drip in methane emission, nitrate dynamics etc. Fertigation schedule needs to be standardized and effects of changing nutrient scenario and its economics have to be studied for preparing standard package of practices.

Summarised From

P. Soman *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th International Rice Congress, Bangkok, 27-31 October 2014.*

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DRIP IRRIGATION IN PADDY IN PUNJAB, INDIA: EXPLORING THE NEW HORIZONS FOR SUSTAINABLE AGRICULTURE

Abstract

Purpose

Given the persistence of massive poverty, high demand for rice, and an acute shortage of water in South Asia, it is imperative to reduce water consumption and increase the productivity of dry direct-seeded rice (DSR). It was hypothesized that drip irrigation as a scientific technology in DSR will bring a threefold transformation in cultivating rice in India with high water-use efficiency.

Approach and methods

A study was conducted at Punjab Agricultural University, Ludhiana to evaluate the performance of drip-irrigation on grain yield and water-use efficiency (WUE) in DSR. The experiment was laid out in a split plot design having treatment combination of four irrigation regimes [farmers' practice and drip irrigation at 1.5, 2.25, and 3.0 evapotranspiration (ETc)] and three nitrogen (N) rates (120, 150 and 180 kg ha-1).

Key results

Statistically, grain yield of DSR remained similar in response to different irrigation regimes and N levels. It varied from 7.3 to 8.4 t ha^{-1} in different combinations of irrigation regimes and N levels. Water saving with drip irrigation at 1.5 ETc, 2.25 ETc, 3.0 ETc in DSR was to the extent of 47.8 %, 34.5 %, and 21.3%, respectively as compared to flood irrigation in farmers' practice. With N application of 120 and 150 kg ha^{-1}, WUE decreased with increasing the drip irrigation threshold level from 1.5 to 3.0 ETc. At 180 kg N ha^{-1}, however, WUE remained similar at drip irrigation threshold levels of 2.25 and 3.0 ETc. Interestingly, WUE at drip irrigation of 2.25 ETc supplemented with 150 kg N ha^{-1} was similar with the WUE at drip irrigation of 1.5 ETc supplemented with 120 kg N ha^{-1}. It was concluded from the study that drip irrigation DSR is technically viable.

As the investments on drip irrigation system are much higher there is a need to identify the cropping sequences so that the drip irrigation system can be utilized year round. At Punjab Agricultural University, Ludhiana, number of field crops rotations as well as vegetable crop sequences have been identified. One such cropping rotation is DSR-potato-spring maize rotation. The benefit cost ratio of this cropping rotation with drip irrigation comes out to be 2.24.

Energy requirement for pumping of water is directly proportional to the water requirement and as such the saving in water is saving of power. The electricity thus saved during the paddy growing period can be diverted to other sectors having higher paying capacity. Higher water use efficiency will result in lesser withdrawal of groundwater thus addressing the problem of declining water table. Lesser investments in the power requirement and reduction in costs of cultivation and also the 48% saving of water by drip irrigation results in bringing additional area under cultivation.

Fertigation, the technique of application of fertilizers with the irrigation water is another advantage of drip irrigation which helps in not only increasing the fertilizer use efficiency but also helps in saving of fertilizers. Moreover when irrigating the crop with drip irrigation application of fertilizers along with the irrigation water becomes necessity as the broadcasting the fertilizers with drip irrigation will result in lower fertilizer use efficiencies. Precise nutrient management of plants as per the age and requirement of the crops can be achieved.

Synthesis and applications

Micro irrigation, more specifically the drip irrigation is the future of irrigated agriculture which needs to be strengthened by optimizing the technology for the crops and bringing down the costs of the system. Shifting from traditional method of irrigation to drip irrigation system entails a cost and this cost of drip irrigation system is a major impediment. Since in drip irrigation the irrigator is meeting the daily requirement of the crop by operating the system daily or on alternate days, ensured supply of power is the second hurdle. However the overall advantages of the system offset the initial investments. Solar photo voltaic pumping systems is a technology which can be

integrated with drip irrigation system and will help in meeting power requirement making the system more energy viable. Financial help to the farmers in the initial stage in the form of subsidies for adopting drip irrigation systems along with solar photovoltaic pumping system will go a long way in addressing the issues of declining water table, electricity deficit during the paddy growing season, environmental pollution due to burning of fossil fuels and meeting the food requirements of the ever growing population under climate change scenario.

The results from this study suggest that use of micro irrigation in DSR has the potential to increase irrigation WUE by matching the water requirement of the crop, reducing runoff, deep drainage losses, energy saving and water table decline while ensuring the food security. The physical water and energy productivity in DSR is significantly high in drip over the flood method of irrigation. Thus, our policy focus may be tilted towards the promotion of drip irrigation in those regions for DSR where scarcity of water is alarming.

Summarised From

Rakesh Sharda*, Gulshan Mahajan, Mukesh Siag, Angrej Singh and BS Chauhan *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

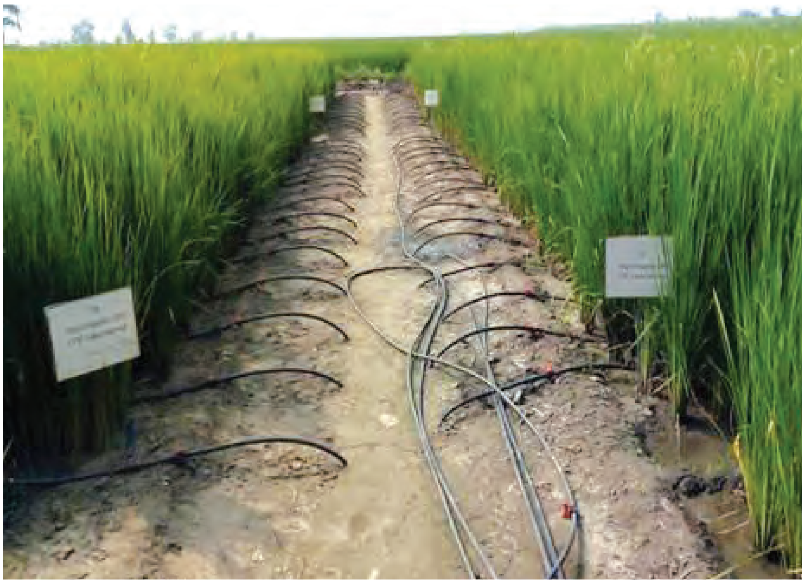
Drip-Fertigated Rice Field Meerut District, Uttar Pradesh (India)

MICRO IRRIGATION IN RICE - WHEAT CROPPING SYSTEM AS A PARADIGM FOR SAVING WATER: A FIELD EXPERIENCE IN UTTARAKHAND, INDIA

Abstract

Approach and methods used

A Research trial and field demonstrations were conducted at the University Farm of G.B.P.U.A.&T., Pantnagar in Collaboration with Jain Irrigation System Pvt. Ltd. during 2011-12 and 2012-13 to investigate the possibility of irrigation with drip system under direct seeded rice (DSR) and zero till wheat (ZTW) in Mollisols of Indo Gangetic Plains of Uttarakhand, India. Initially, field demonstration with surface drip irrigation system was carried out in 0.4 ha area with lateral pipes lay out after every third row of rice and wheat sown at 20 cm distance. Direct seeding of rice cv. PR 113 and wheat cv. HD-2629 was used for trial. Fertigation with drip irrigation was done at critical stages in wheat and throughout crop duration in rice where as in control plots conventional method of flood irrigation was used.



Drip Irrigated Rice and Wheat crop at Pantnagar (Uttarakhand), India

Key results

The results of demonstration of direct seeded rice and zero tillage wheat were encouraging as drip based fertigation enhanced crop growth, grain yield, fertilizer use efficiency (FUE) and water use efficiency (WUE). In wheat crop, the yield difference due to drip irrigation and conventional irrigation were not much but 40% less water was used under drip system.

Second year results revealed that crop growth of direct seeded rice HKR-47 in terms of dry matter, root length, LAI, CGR and yield attributes viz., number of panicles, grain/ panicle, filled spikelets, spikelet sterility and 1000 grain weight and grain wt./ panicle were significantly higher under drip treatments. Significantly higher total dry matter and grain yield was observed with drip treatments and the average yield benefit was about 25% (ranging 15 to 38%) compared to conventionally transplanted and flooded crop. Water saving was higher with drip irrigated rice as it consumed only 124 -350 mm of irrigation water excluding effective rainfall (453.4 mm) and it was reflected into higher crop and field water use efficiency. Higher nutrient uptake with higher fertilizer use efficiency and B: C ratio was observed with drip irrigated treatments. Among drip irrigation treatments, drip irrigation at 20% CPE at one day gap was found to be the best treatment in terms of crop growth, yield, WUE, FUE and monetary returns.

Synthesis and applications

Low cost drip irrigation system could become a boon to small and marginal farmers constituting 84% of total land holdings in India and majority being rainfed, if it is tested and adopted with the support of government where a farmer can enhance its productivity of cereals, pulses, oils seeds, vegetables, orchard sugarcane and green fodder with limited water. However, ways are still to be found to overcome the high initial cost of establishment of drip system and difficulty in adjusting laying out drips for closed and wider spaced crops. Folding drip pipes before seed bed preparation after the harvest of each crop is another problem and to increase life of drip pipes (>10 years) to make it economic and affordable is another big challenge which needs attention.

Summarised From

A.K. Bhardwaj, T.C. Singh, Lalji Sharma, Sumit Chaturvedi and R.L. Arora 2*014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

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DRIP IRRIGATION AND FERTIGATION IN DIRECT SEEDED AEROBIC RICE IN KARNATAKA, INDIA- RESEARCH STATUS

Abstract

Purpose

Rice, an important staple food crop of Karnataka, cultivated mostly under puddled transplanted condition. Among the irrigated crops, rice shares more than 47 per cent of irrigated water, which necessitated to develop production system for enhanced grain yield and water productivity. The University of Agricultural Sciences, Bangalore initiated work on assessing the performance of rice varieties/hybrids for drip irrigation, scheduling of drip irrigation, fertigation frequency and fertigation scheduling in aerobic rice during 2011.

Approach and methods used

The studies were conducted during wet and dry season. The soil under study was red sandy loam with medium soil fertility status. The irrigation was given through PVC pipe after filtering through the screen filter by 7.5 HP motor from the bore well. The pressure maintained in the system was 1.2 kg cm^{-2}. From the sub main in-line laterals of 16 mm were laid at a spacing of 0.6 m with 4 lph discharge rate emitters positioned at a distance of 40 cm. Drip irrigation was scheduled based on the open pan evaporation. However, under surface irrigation for aerobic rice and puddled transplanted rice, irrigation was scheduled based on recommended package of practices.

Drip-Fertigated Rice Field Coimbatore District, Tamil Nadu (India)

Key results

The results on performance of rice varieties / hybrids revealed that all the high yielding varieties (HYV) including aerobic rice varieties and hybrids recorded significantly higher grain yield. Among the entries, KRH^{-4} hybrid recorded significantly higher grain yield of 10.92 t ha^{-1} under drip irrigation, which was significantly higher (15%) over puddled transplanted rice (9.28 t ha^{-1}). Higher grain yield in drip irrigation was associated with higher productive tillers hill-1, number of grains panicle^{-1}, grain weight per panicle and grain yield hill^{-1}. Similar trend was observed in other varieties MTU-1001, IR-64, Rasi and MAS-946^{-1}. Mean while, drip irrigation recorded substantial water saving (58%). The water used in drip irrigation was 905 ha mm as compared to 2090 ha mm in puddled transplanted rice. The main reasons for higher water saving under drip irrigation was due to reduced crop duration of 10-12 days across the varieties and precise use of water.

Among the drip irrigation scheduling, E pan at 125 per cent during early growth stages + 150 percent during panicle initiation to emergence and 200 per cent from grain filling to maturity during dry season recorded significantly higher grain yield of 11.46 t ha^{-1}. The higher grain yield in drip irrigation was attributed to more number of productive tillers hill^{-1}, grain no. panicle^{-1}, grain weight panicle^{-1} and grain yield hill^{-1}, which was ascribed to favourable condition provided for water nutrient supply under drip irrigation cum fertigation.

The results on fertigation frequencies showed that fertigation once in two days recorded higher grain yield (11.92 t/ha) and which was on par with fertigation once in four days and significantly higher over once in eight days. Supply of 50 per cent of recommended dose of fertilizer through fertigation recorded higher grain yield and resulted in

50 per cent fertilizer saving as compared to soil application of 100 per cent recommended dose of fertilizers (125:62.5:62.5 NPK kg/ha).

The data on power consumption indicated 42 per cent power saving under drip fertigation as compared to puddled transplanted rice which was mainly attributed to 58 per cent water saving under drip irrigation cum fertigation. As per the cost of the drip irrigation material, one hectare drip irrigation including head unit costs Rs.1,65,000. In view of higher yield under drip irrigation the cost incurred for installation of drip could be realized within 3 to 4 years of cropping season.

Synthesis and applications

During the course of investigation major constrains noticed in drip irrigated aerobic rice were micronutrient deficiency particularly, iron, zinc and manganese, isolated termite, root aphids and root grub incidence. Moreover, high initial cost on installation of drip irrigation might forbid the farmers in adopting drip irrigation technology.

Popularization and adoption of drip irrigation cum fertigation in rice requires major thrust on optimization of lateral distance and discharge rate, herbigation and chemigation for effective control of weeds, disease and insect pests, fertigation duration and frequencies based on crop demand including micro nutrients and suitable crop rotation for sustaining soil health and enhancing production and profitability of drip fertigation aerobic rice. Capacity building and training for effective adoption of drip irrigation technology needs to be addressed.

Summarised From

Nagaraju, S. Anusha, Kombli Gururaj, B.Rekha, T. Sheshadri and M.A. Shankar *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

Drip-Fertigated Rice Field Mandya District, Karnataka (India)

DRIP IRRIGATION IN RICE: OBSERVATIONS FROM FIELD TRAILS IN ANDHRA PRADESH, INDIA

Abstract

Purpose

In recent years, unfavourable weather conditions (mainly drought) are causing water stress in several rice producing regions resulting in reduction in rice yield and total production. Consequently, various methods of irrigation and management practices have been developed to meet the crop water demand. Practices like rice intensification through alternate wetting and drying, direct seed sowing, limited irrigations etc., have been introduced and are being adopted by farmers in the Krishna basin, Andhra Pradesh, India through the ongoing ClimaAdapt project implemented by International Water Management Institute (IWMI) and Bioforsk, Norway with partners from state agricultural departments and agricultural universities. As a follow up, micro irrigation through drip and sprinklers in rice cultivation has also been experimented in selected locations in the recent years due to its higher irrigation efficiency.

Drip-Fertigated Rice Field – Nalgonda District, Telengana State (India)

Approach and methods

IWMI and Jain Irrigation SystemsLimited (JISL) have conducted rice drip irrigation research trials in farmers' fields at Chinnaganapur village (Kulcharam Mandal) of Medak district, Andhra Pradesh. Two seasonal research trails with rice (MTU 1010) were conducted during the Rabi and Kharif seasons of 2010-2011. Drip system used 16mm J-Turbo Aqura with 4 litres per hour emitter at 50 cm intervals for medium and 40 cm interval for light soils. Ventury device was installed for fertigation purposes.

Key results

The results showed that the water consumption has been reduced by about 40% with the drip irrigation (e.g. 617 mm water used under drip compared to 1080 mm under flood irrigation excluding rainfall). The improved plant growth has resulted in increased number of tillers compared to the flood irrigation. Application of fertilisers has also reduced by adopting drip fertigation schedules at different stages of crop growth. The cost benefit ratio worked out to be 1.21 for Kharif and 1.75 for Rabi seasons. Exposure visits to farmers in the nearby villages were also organized. The constraints include: high initial cost of the drip system, skills needed in adopting fertigation schedules and lack of awareness among farmers.

Synthesis and applications

Capacity building programs to farmers on drip rice, incorporation of rice crop for availing micro irrigation subsidy, field trials with farmer participatory mode are suggested in cluster of villages for up-scaling the adoption of rice drip system. Continuous monitoring of the rice-drip fields is also suggested. Future research in rice-drip will cover nutrient uptake, water balance in field, weed growth, low cost drip design and economics.

Summarised From

K. Palanisami and Krishna Reddy Kakumanu *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

SUB-SURFACE DRIP IRRIGATION OF RICE IN TEXAS, USA

Abstract

Approach and methods used

Research was conducted at the Texas A&M AgriLife Research Center in Beaumont, Texas to determine the feasibility of using sub-surface drip irrigation on rice crops. Two sets of experiments were conducted. Small-plot experiments (3.6 m x 23 m plots) was conducted from 2001 through 2003, and large-plot experiments (0.47 ha/plot) were conducted from 2006 through 2008. The small-plot experiments included 3 treatments, 2 drip-irrigated treatments with tape spacing of 0.8 and 0.4 m, and a flood-irrigated control. The large-plot research included 2 treatments, a drip-irrigated treatment with tape spaced 0.76 m apart and a flooded control. Rice was drill-seeded during each year.

For the small plot experiments, water was applied to the drip-irrigated plots when the soil surface began to show dry areas. The amount of water used for the drip-irrigated plots in 2001 was calculated as emitter runtime x emitters per plot x water delivery rate per emitter. In 2002 and 2003 flow meters were installed to measure the amount of water applied to the 0.8 and 0.4 m drip-irrigated treatments. Flow meters were not used to measure water applied to the conventional flood plots during 2001 through 2003, instead water use estimates were provided by the Lower Colorado River Authority for rice main crop production. In 2006, 2007 and 2008, water was applied to the drip-irrigated plots three times per week (Monday, Wednesday and Friday). The irrigation rate was dependent on pan evaporation and rainfall for the period. For instance, the water applied on a Monday was equal to pan evaporation for the previous Friday, Saturday and Sunday (minus any rainfall that may have occurred).

Nitrogen application to the drip and flood-irrigated plots was 135, 202, and 202 kg N ha^{-1} in 2001, 2002, 2003, respectively and 224 kg N ha^{-1} in 2006, 2007 and 2008. Fertilizer applications to the drip-irrigated plots in 2001 were applied to the surface, while in the remaining years nitrogen was applied through the drip irrigation system. Fifty-six kg N ha^{-1} was aerially applied to each treatment at planting in 2006, 2007 and 2008. Beginning with permanent flood (approximately 30 days after emergence), 1.12 to 6.72 kg N ha^{-1} $application^{-1}$, were applied three times each week through the subsurface drip irrigation system until total N use reached 224 kg N ha^{-1}. Nitrogen was aerially applied to the conventional flood irrigated plots at permanent flood (90 kg N ha-1) and panicle development (78 kg N ha^{-1}).

Key results

Yield from the small-plot experiments was not significantly different comparing treatments. Years were significantly reduced in 2001 due to the first year of planting being extremely late and in 2003 due to weed problems. Yield from the large-plot experiments was not significantly different comparing the drip-irrigated and conventionally flood treatments. The year effect was again significant due to low yields occurring in 2008. The blocks effect was also significant. The field used for the large plot experiment had been laser leveled in late 2005 and deep cuts were made to one end of the field, which consistently produced lower yields. Analysis of all years combined failed to detect significant differences between treatments. Year was again significant due to the reasons already mentioned.

Water applied to the drip-irrigated treatments averaged 43% that of the flooded control. Water usage in 2001 was only 17% of the flooded control, due to the very short season, percolation through the newly formed levees of the flooded control plots, and the higher amount of rainfall that year. In 2008 water applied to the drip-irrigated treatments was only 38% of that applied to the flooded control, due mainly to limited rainfall and warmer than usual temperatures. In the remaining years of the study, water usage for the drip-irrigated treatments ranged from 46% to 54% that of the flooded control.

Synthesis and applications

Problems encountered over the six-year period of the experiments included line breaks and weeds. Line breaks were usually due to rodents chewing holes in the drip irrigation tape or due to tractors puncturing the tape. Once a

break occurred, the section had to be cut out and the tape spliced. Fittings used for splicing usually began to leak that same season. Weeds can be controlled, but with drip irrigation it is a season long problem. In contrasts, the conventionally flooded control did not experience major weed problem once paddies were flooded.

Applying fertilizer through the drip irrigation was not a problem on the small-plot experiments. For the large-plot experiments, fertilizer initially did not spread sufficiently to reach the area between the rows of drip tubing, resulting in yellow and green-strips of stressed and vigorous plants across the field. Water had to be applied for a longer period of time to spread the fertilizer to achieve uniform growth.

Summarised From

J.C. Medley and L.T. Wilson *2014. Presented in workshop on "Drip Irrigated Rice" (side event) at 4th Internation Rice Congress, Bangkok, 27-31 October 2014.*

Drip-Fertigated Rice Field – Nalgonda District, Telengana State (India)

Mr. V. Ravichandran is a Farmer Who has Been Growing Rice for over 32 years in his village.

Village: Poonkulam., **Taluka:** Nannilam, **District:** Thiruvarur, **State:** Tamil Nadu, India. **Email:** vkvravi@gmail.com

His farm falls in a major rice production area of the state where water from Cauveri river is provided through canals. In the recent years because of paucity of rain fall the water in the river got reduced and the command has been shrinking. Introducing a low water consuming technology for rice is considered a great boon to the farmers here.

In his own words "in the Cauveri delta the water availability is so scarce that our farmers who took up two rice crops and one pulse crop few decades back are worried whether they would get enough water to grow at least one rice crop. Rice during summer would yield more because of longer day time and bright sun shine. **We are unable to benefit from the seasonal advantage because of water shortage"**

He came to know about drip irrigated rice cultivation from website.

With technical guidance from Jain Irrigation experts, he grew rice during the summer months with drip irrigation.

Ravichandran observed that:

"1) **With my bore well source I can grow rice in 2 acres of land. With the same source I can extend my rice area under drip to 8 acres.**

2) Land use efficiency increase as I bring more area under rice by installing drip.

3) Nutrient use efficiency increases as every plant gets its due share of nutrition at the right place at the right time and with the right dose.

4) Crop stand was uniform throughout my field.

5) In our area BPH often devastates our rice crop under flooded condition. But in drip as we maintain just moist level and as water does not stagnate BPH is the thing of the past.

6) In flooded conditions algae suppreses the crop and inhibits tiller formation. In aerobic (and drip) condition I could witness profuse tillering."

Crop Details

Rice Varieties CO -51 (105 days) in 0.5 acre and Arize Nano (120 days) in 0.5 acre.

Land Preparation

- Cattle penning before ploughing
- Two times plough with multi tine cultivator
- Rotavation
- Land levelling
- Formation of bed (0.9 m wide) and furrow (0.3 m) and 0.15 m height
- Rice planted at spacing of 15 x 15 cm on the bed.
- Planting in April 1.

Drip System

- Single 16 mm dia. drip lateral on each bed
- Emitter at 60 cm spacing and 4 lph emission rate.

Drip Irrigation

Daily as per the schedule

Fertigation

every alternate day till 78 days of growth as per schedule. Weeds managed by two weedicide application and one hand weeding

Yield Data

Variety	ton/acre
Arize Nano (drip)	2.46
CO-51 (drip)	2.17
CO-51 (Flood)	1.88

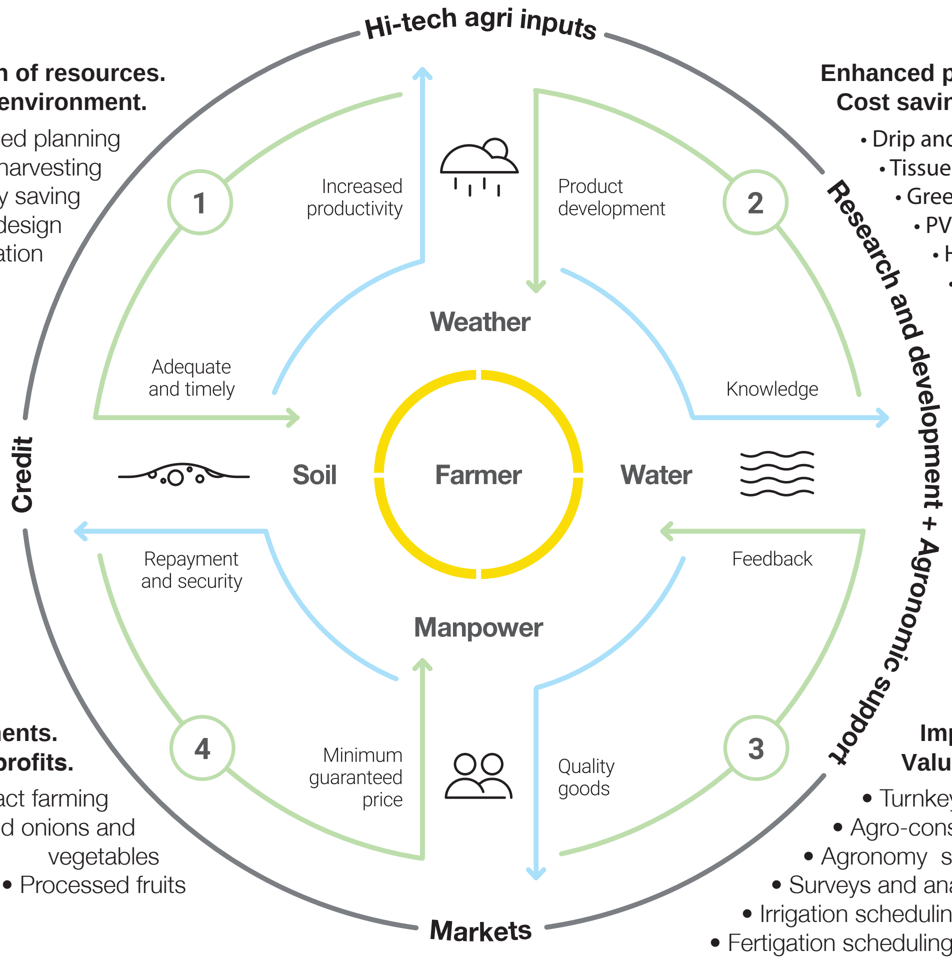
Jain Value Creation Model

Conservation of resources. Sustainable environment.

- Watershed planning
- Water harvesting
- Water/Energy saving
- Water resource design
- Waste land reclamation

Enhanced productivity. Cost savings.

- Drip and Sprinkler Irrigation
- Tissue culture plants
- Green houses
- PVC piping systems
- HDPE piping systems
- Solar pumps



More investments. More profits.

- Contract farming
- Dehydrated onions and vegetables
- Processed fruits

Improved product quality. Value added.

- Turnkey Projects
- Agro-consulting
- Agronomy services
- Surveys and analysis
- Irrigation scheduling
- Fertigation scheduling
- Training and capacity building

Today millions of happy farmers across the globe are enjoying inclusive growth and shared value by our pioneering and sustainable solutions.

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