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Climate Resilient Management Practices in Rice and Rice based Cropping Systems

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A B S T R A C T

As Indian agriculture is highly dependent on specific climate conditions, the research on the impacts of climate change on Agriculture in general and rice production in specific is a high priority in India. There is an urgent need to focus on climate resilient input management Practices for improving use efficiency and sustaining the rice and rice based cropping system across the country. The issues of Changing climate a combination of water and nutrient management practices were tested aimed at water and nitrogen saving. In order to Climate Resilient Management Practices in rice and rice based cropping systems towards enhancement of grain yield, two field experiments were conducted during *Kharif* 2013 and *Rabi* 2013-14 at Perunthalaivar Kamaraj Krishi Vigyen Kendra (PKKVK), Puducherry State experimental farm in a randomized block design with three replication. The treatments were consisted T1: split application of Nitrogen (50% basal+ 25% active tillering + 25% at flowering) in puddle soil; T2: Use of bio-fertilizer (*Azotobacter* and *Azolla*, to meet 50% of N requirement); T3: Crop residue retention (at least 30%) in cropping system to maintain organic carbon); T4: Non-puddled rice establishment to reduce water requirement; T5: Combination of T1+T2; T6: Combination of T1+T2+T3; T7: Combination of T2+T3+T4; and T8: Conventional method of rice cropping that were tested. The findings of two seasons, use of split application of Nitrogen (50% basal+ 25% active tillering + 25% at flowering) in puddle soil and use of bio-fertilizer (*Azotobacter* and *Azolla*, to meet 50% of N requirement) with addition of Crop residue retention (at least 30%) in cropping system to maintain organic carbon (T6) was performed excellent by registering higher yield attributes and grain yield of 6050 and 6820 kg ha^{-1} during Kharif 2013 and *Rabi* 2013-14 respectively. It's may be due to use of split application of inorganic fertilizers, biofertilizers and crop residue.

Keywords

Rice, Biofertilizers, Crop residues, Use of inorganic

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Introduction

Agriculture plays an important role in the social and economic life of people in India, and will continue to do so in the foreseeable future. Today agriculture accounts for about 14 percent of the Gross Domestic Product (GDP) and 11 percent of exports (Sharma, 2007; Ministry of Agriculture, 2013). It faces many challenges. Some of the sectoral challenges since the last decade or so are: a slowdown in growth, increased exposure to world commodity price volatility, degradation of the natural resource base, rapid and widespread decline in the groundwater table, land fragmentation, lack of extension services, and the indebtedness of farmers. Further, non-sectoral challenges that are stressors for agriculture are: population growth, expanding urbanization, demographic transition with increasing incomes, improving life styles and changes in food habits, globalization, and the demand for bio-fuels. Added to the latter is the increasing absorption of agricultural land into Special Economic Zones and townships, large industrial and irrigation-cumpower projects, and mining. Currently almost 46 percent of India's geographical area is under agriculture. A large percentage of this land falls in rain-fed regions generating 55 percent of the country's agricultural output, providing food to 40 percent of the nation's population (Planning Commission, 2012). More than 80 percent of the farmers are smallholder producers, with very poor capacity and resources to deal with the vagaries of weather and changes in climate. For the farmer, climate is the seasonal temperature and rainfall pattern expected in their area, based on experience over decades. Weather, on the other hand, is the actual temperature, rainfall, and other climatic conditions experienced from day to day, for which they need adaptation or coping strategies to deal with these variations. With approximately 60 percent of Indian agriculture being rain fed and dependent on the vagaries of the monsoons, the climate will be a major determinant of agricultural production. Temperature, rainfall, and seasonal weather variations will thus aggravate the existing agricultural challenges. The Intergovernmental Panel on Climate Change (IPCC) report of 2007 predicts an increase in rainfall over the Indian subcontinent by 6–8 percent (Ministry of Environment and Forests, 2009). Goswami *et al.,* (2006) predict substantial increase in hazards related to heavy rainfall over Central India in the future. Overall in India, some physical impacts of climate change will be seen as: (1) increase in the average surface temperature by 2°C–4°C; (2) changes in rainfall (distribution and frequency) during both monsoon and non-monsoon months; (3) decrease by more than 15, in the number of rainy days; (5) increase in the intensity of rain by 1–4 mm/day; and (6) increase in the frequency and intensity of cyclonic storms. It is predicted that for every two-degree rise in temperature, the GDP (Gross Domestic Product) will drop by five percent. Climate assessments of the agriculture sector, however, focus on the impacts of crop yields, while little emphasis is given to the interconnected sub-systems of the agriculture production systems as a whole (Ranuzzi and Srivastava, 2012). Today groundwater is the major source of water utilized for irrigation, accounting for about 65 percent, while 15 percent of India's food is produced by mining non-renewable groundwater (Brown, 2009). Hence the rapidly declining groundwater because of over-extraction is a major cause of concern. Current trends estimate that 60 percent of India's groundwater sources will be in a critical state of degradation within the next twenty years (World Bank, 2010). According to the IPCC, in the changing climate scenario, the demand for irrigation in arid and semi-arid 7 regions of Asia is estimated to increase by at least 10 percent for an increase in temperature by 1°C (Bates *et al.,* 2008). Small-holder producers across the world have always faced the vagaries of nature. However, their capacity to cope with the speed and intensity of current climate events is of concern (IFAD, 2011). With over 60 percent of Indian agriculture being rain-fed and more than 80 percent farmers being small-holder producers, the need for a climate-resilient approach to agriculture is critical. Therefore adaptation measures must not only build the response capacity of small-holder producers, but it is crucial to also maintain the resilience of the ecosystem from which they derive a living.

As Indian agriculture is highly dependent on specific climate conditions, the research on the impacts of climate change on Agriculture in general and rice production in specific is a high priority in India. There is an urgent need to focus on climate resilient input management Practices for improving use efficiency and sustaining the rice and rice based cropping system across the country. The issues of Changing climate a combination of water and nutrient management practices were tested aimed at water and nitrogen saving. In this context. This paper presents an approach to climate-resilient agriculture that will help increase the response capacity of farmers and the resilience of the respective ecosystem.

Materials and Methods

The Union Territory of Puducherry comprises of four regions namely Puducherry, Karaikal, Mahe and Yanam which are not geographically contiguous. Puducherry is located in the East Coast, about 162 kilometers south of Chennai. Pondicherry is situated on the Coromandal coast between 110 46’ and 120 30’ North, The climate of the union territory is hot, humid and tropical with moderate rainfall. Summer lasts from April to early June, when maximum temperatures frequently hit the 41 °C mark. The average maximum temperature is 36 °C. Minimum temperatures are in the order of 28 - 32 °C. This is followed by a period of high humidity and occasional thundershowers from June till September. The North East Manson sets in during the middle of October. Puducherry gets the bulk of its annual rainfall during the period from October to December. The annual average rainfall is 1240 mm. Winters are mild, with a maximum of 30 °C and minimum often dipping to around 18 - 20 °C. The region has got good subsoil water potential. Main source of irrigation is through tube wells. Among the entire major crops paddy is predominantly grown throughout the year in three seasons i.e., Sornavari (May-August), Samba (August-January) and Navarai (January-April). In this region about 45% of the cultivable area is under triple crop sequence owing to assured ground water availability.

The issues of Changing climate a combination of water and nutrient management practices were tested aimed at water and nitrogen saving. In order to Climate Resilient Management Practices in rice and rice based cropping systems towards enhancement of grain yield, two field experiments were conducted during Kharif 2013 and Rabi 2013-14 at Perunthalaivar Kamaraj Krishi Vigyen Kendra (PKKVK), Puducherry State experimental farm in a randomized block design with three replication. The treatments were consisted T1: split application of Nitrogen (50% basal+ 25% active tillering + 25% at flowering) in puddle soil; T2: Use of bio-fertilizer (Azotobactor and Azolla, to meet 50% of N requirement); T3: Crop residue retention (at least 30%) in cropping system to maintain organic carbon); T4: Non-puddled rice establishment to reduce water requirement; T5: Combination of T1+T2; T6: Combination of T1+T2+T3; T7: Combination of T2+T3+T4; and T8: Conventional method of rice cropping that were tested. The rice variety is ADT 49 during Kharif 2013. The soil type was clay loam in texture and Acidic in reaction (pH 7.07), acidic having electrical conductivity (EC) of 0.49 dSm^{-1} and available N,P,K content were 481.6 kg ha^{-1}, 50.22kg ha^{-1} and 154 kg ha^{-1} in Kharif 2013 with field duration of 145 days during The rice variety TPS 5 during Rabi 2013-14. The soil type was clay loam in texture and Acidic in reaction (pH 6.56), acidic having electrical conductivity (EC) of 0.27 dSm^{-1} and available N,P,K content were 212.8 kg ha^{-1}, 33.47 kg ha-with field duration of 105 days, was used in the trial. The treatments were Randomized Block Design with treatments formed by with following Objectives, to assess the effect of component of management technology on mitigating the impact of predicted climate change on soil, water and crop in rice production system and to evaluate the management practices combination on rice yield, water requirement and nitrogen saving under predicated climate change.

Table.1a Treatments

T1	Split application of Nitrogen (50% basal + 25% Active tillering + 25% at Flowering) In puddle soil.
T2	Use of bio- fertilizer (use any one or more no. Of bio- fertilizer like Azetobactor and Azolla as per suitability /availability for the rice equivalent to 50% of N requirement
T3	Crop residue retention (At least 30% Crop residue retention) in cropping system (both crops) to maintain organic carbon)
T4	Non – puddled rice establishment through any method (direct seeding of rice, unpuddled manual transplanting) to reduce water requirement
T5	Combination of T1 + T2
T6	Combination of T1 + T2 + T3
T7	Combination of T1 + T2 + T3 + T4
T8	Conventional Method of rice cropping in as per the recommendation of respective area followed by next crop.

Results and Discussion

The findings of two seasons, use of split application of Nitrogen (50% basal+ 25% Active tillering + 25% at flowering) in puddle soil and use of bio-fertilizer (Azotobacter and Azolla, to meet 50% of N requirement) with addition of crop residue retention (at least 30%) in cropping system to maintain organic carbon (T6) was performed excellent by registering higher yield attributes and grain yield of 6050 and 6820 kg ha^{-1} during Kharif 2013 and Rabi 2013-14 respectively (Table 1 and 2). It's may be due to increase the fertilizers use efficiency of split application of inorganic fertilizers. The use of biofertilizers to increase the microbial activity in the soil. The use of crop residue to increase the organic carbon content and retention of water in the soil. This observation was confirmed by the earlier findings of Swaminathan (2010), Uphoff (2012) and Sinha and Swaminathan (1991).

Table.1b Climate resilient management practices in rice and rice based cropping systems towards enhancement of grain yield during Kharif 2013

Treatments	Panicle No./m^2	Panicle weight (g)	Grain yield (t/ha)
T1-Split application of Nitrogen (50% basal + 25% Active tillering + 25% at Flowering) In puddle soil.	406	3.69	5.15
T2-Use of bio- fertilizer (use any one or more no. Of bio-bertilizer like Azetobactor and Azolla as per suitability /availability for the rice equivalent to 50% of N requirement	384	3.62	5.03
T3-Crop residue retention (At least 30% Crop residue retention) in cropping system (both crops) to maintain organic carbon)	354	3.46	4.69
T4-Non – puddled rice establishment through any method (direct seeding of rice, unpuddled manual transplanting) to reduce water requirement	338	3.43	4.59
T5-Combination of T1 + T2	436	4.10	5.89
T6-Combination of T1 + T2 + T3	447	4.34	6.05
T7-Combination of T1 + T2 + T3 + T4	409	3.93	5.72
T81-Conventional Method of rice cropping in as per the recommendation of respective area followed by next crop.	406	3.70	5.07
C.D (0.05)	**17.82**	**0.17**	**0.26**
C.V (%)	**2.56**	**2.6**	**2.78**

Table.2 Climate resilient management practices in rice and rice based cropping systems towards enhancement of grain yield during Rabi 2013-14

Treatments	Panicle No./m2	Panicle weight (g)	Grain Yield (t/ha)
T1-Split application of Nitrogen (50% basal + 25% Active tillering + 25% at Flowering) In puddle soil.	5.43	466	4.87
T2-Use of bio- fertilizer (use any one or more no. Of bio-bertilizer like Azetobactor and Azolla as per suitability /availability for the rice equivalent to 50% of N requirement	5.03	436	4.51
T3-Crop residue retention (At least 30% Crop residue retention) in cropping system (both crops) to maintain organic carbon)	4.97	422	4.33
T4-Non – puddled rice establishment through any method (direct seeding of rice, unpuddled manual transplanting) to reduce water requirement	4.85	410	4.01
T5-Combination of T1 + T2	6.17	490	5.55
T6-Combination of T1 + T2 + T3	6.82	505	5.70
T7-Combination of T1 + T2 + T3 + T4	5.78	483	5.17
T81-Conventional Method of rice cropping in as per the recommendation of respective area followed by next crop.	5.25	449	4.60
C.D (0.05)	0.64	24.63	0.43
C.V (%)	6.62	3.07	5.03

Figure.1 Climate resilient management practices in rice and rice based cropping systems towards enhancement of grain yield during Kharif 2013 & Rabi 2013-14

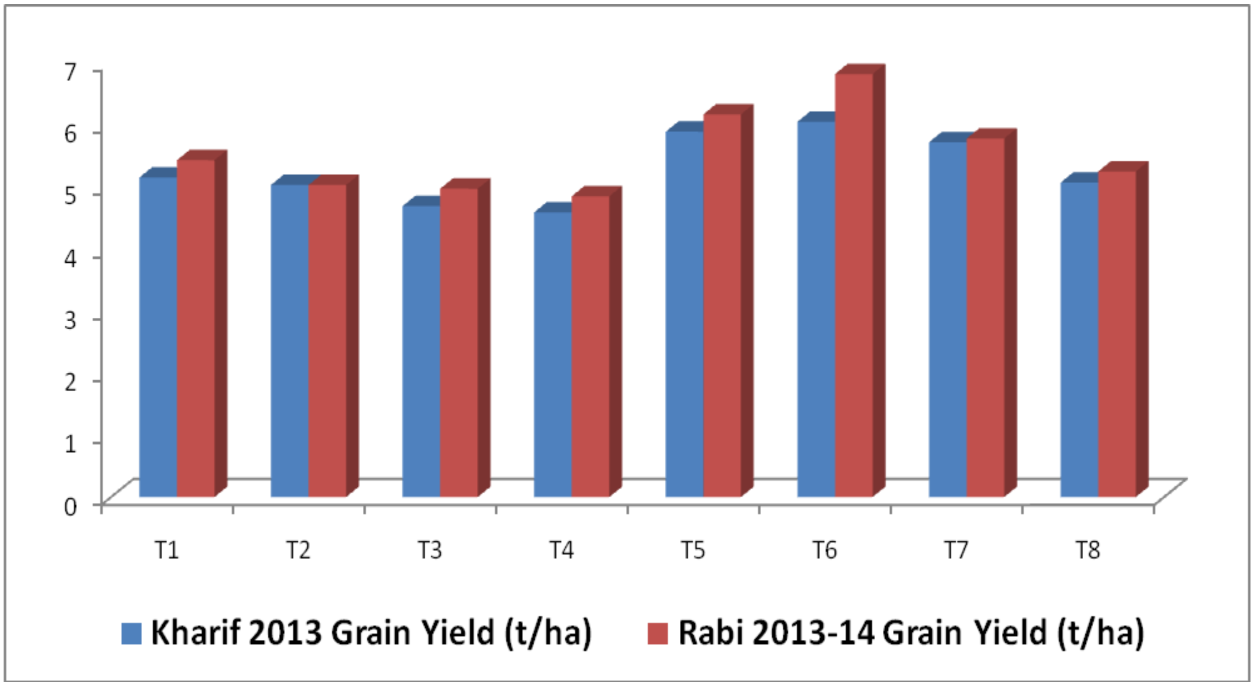


Figure.2 Climate resilient management practices in rice and rice based cropping systems towards enhancement of panicle No./m2during Kharif 2013 & Rabi 2013-14

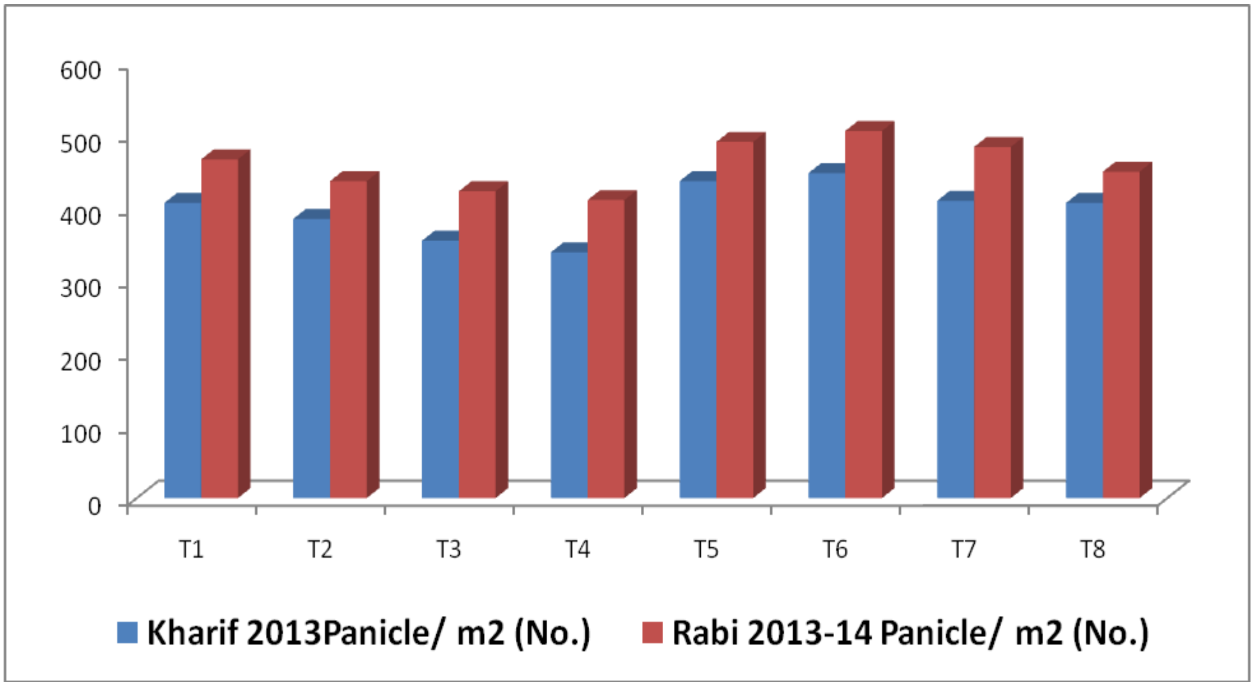
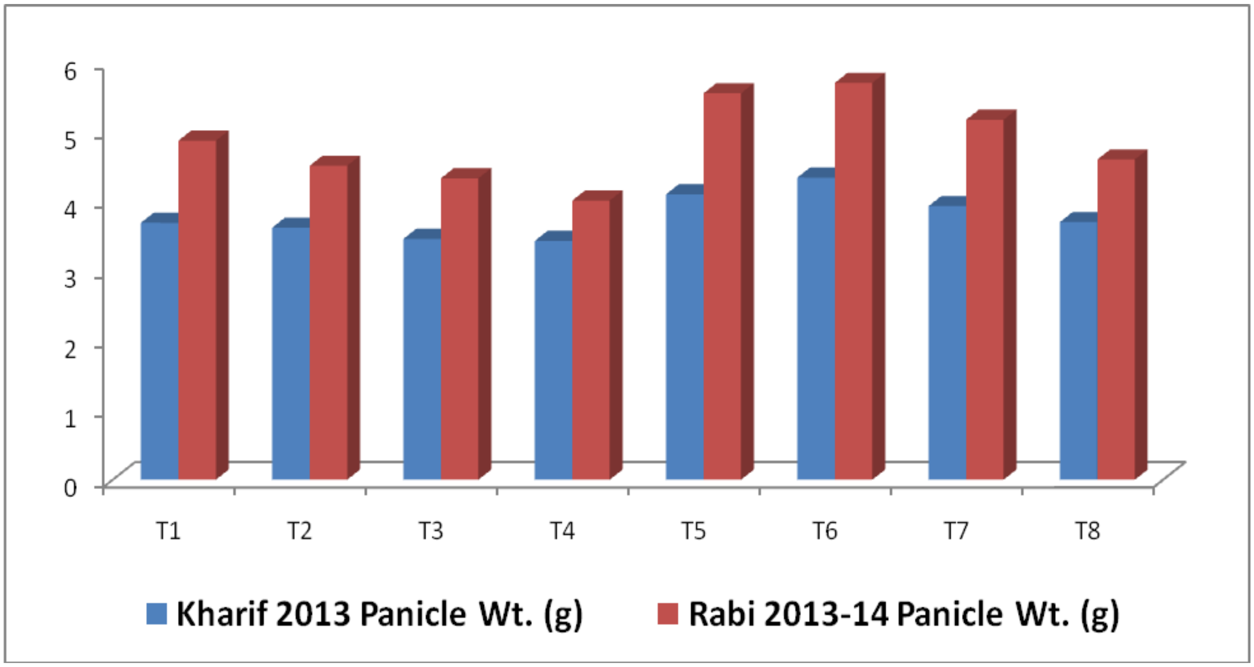


Figure.3 Climate resilient management practices in rice and rice based cropping systems towards enhancement of panicle weight during Kharif 2013 & 2013-14



In this study it was concluded that The findings of two seasons, use of split application of Nitrogen (50% basal+ 25% active tillering + 25% at flowering) in puddle soil and use of bio-fertilizer (*Azotobactor* and *Azolla*, to meet 50% of N requirement) with addition of Crop residue retention (at least 30%) in cropping system to maintain organic carbon (T6) was performed excellent by registering higher yield attributes and grain yield of 6050 and 6820 kg ha^{-1} during Kharif 2013 and *Rabi* 2013-14 respectively (Figure 1, 2 and 3). It's may be due to use of split application of inorganic fertilizers, biofertilizers and crop residue.

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