Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 1290-1298

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 1290-1298**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.611.154

Resource Conservation Agricultural Practices, Rhizosphere and Diseases of Wheat under Wheat-Rice Cropping System

Anju Rani[1], D.P. Singh[2*], R.K. Sharma[2] and R.S. Chhokar[2]

[1]Department of Bioscience and Biotechnology, Banasthali University, Rajasthan, India
[2]ICAR-Indian Institute of Wheat and Barley Research, Karnal 132 001, India
Corresponding author

Keywords

Resource Conservation Agricultural Practices (RCAPs), Rice-Wheat, Cropping system, Rhizosphere, Diseases.

Article Info

Accepted:
12 September 2017
Available Online:
10 November 2017

A B S T R A C T

The effect of Resource Conservation Agricultural Practices (RCAPs) on rhizospheric microbes of wheat under rice-wheat cropping system was observed in various residue management options *i.e.* burning, removal, incorporation or soil surface retention of both or either of rice and wheat crop residues in the main plots and Nitrogen doses (100,150 and 200 kg/ha) in the sub plots. Differences in populations of bacteria, actinomycetes and fungi were observed amongst various treatments. These crop residue and nitrogen management options may have bio-control properties against soil borne diseases. Likewise root architecture also changed due to the RCAPs thus affecting the vigor of plants. The dehydrogenase activity also differed in treatments of RCAPs. Amongst different RCAPs, retention of crop residue at the soil surface, after harvest of both wheat and rice crops, was the best option for soil and plant health. The work conducted on effect of RCAPs on wheat diseases was not conclusive keeping in view results of different reports.

Introduction

Rice (*Oryza sativa* L.)-wheat (*Triticum aestivum*) is the most important two crops a year intensive wheat based cropping system of Asia. It accounts for one third of the irrigated rice and half of the irrigated wheat in South Asia. Available estimates show that 12 million hectares (m ha) of this cropping system exist in four countries of South Asia *i.e.* 9.4 m ha in India, 1.5 m ha in Pakistan, 0.6 m ha in Bangladesh, and 0.5 m ha in Nepal and about 9 m ha in China. In this cropping system, rice is grown during rainy season (June to November) and wheat during the winter season (November to April). This is an intensive cropping system and its productivity varies from 5 to 10 metric tons of grains per hectare per year (Singh *et al.,* 2014). However, concerns are expressed about the sustainability of the system keeping in view the different types of ecological systems required for growing rice and wheat and its impact on soil properties and health (André and Lagerlof, 1983). It has been estimated that system is covering more than 23.5 million ha in different countries (Bimb *et al.*, 1994). In Punjab and Haryana states of India, almost 95-98% of the rice-wheat cropping area is practiced under irrigated conditions, with over 90% of water requirement sourced from groundwater (Ambast *et al.*, 2006). This has contributed to a fall in water table levels in central Punjab (the main area for rice-wheat cropping) by more than 33 cm per year from 1979-1994 in 46% of the area. The conventional method of puddling rice is also damaging the physico-chemical conditions of the soil. During puddling the soil for growing rice, a thick hardpan can develop, which restricts root growth of crops grown in rotation with rice. The constant flooding of the soil also leads to greater losses of soil and Nitrogen fertilizer. The practice of burning the rice stubble has a substantial negative effect on the environment. More than 90% of the 17 Mt of rice stubble in Punjab are burnt each year, resulting in thick smoke blanket over the region, since the burn-off occurs over a short period. The air pollution caused by this burn-off has serious adverse health effects on humans and animals. It has also been blamed for causing road accidents and the closing of airports due to poor visibility. Furthermore, the burning results in the loss of nutrients as well as the important organic source which can help improve the soil physico-chemical properties by improvement in the organic carbon status of the soil leading to long term sustainability.

Much of this work has been focused on developing Resource Conservation Agricultural Practices (RCAPs) helping to produce cereals at a lower cost while attempting to improve soil health through reduced tillage and stubble retention at the soil surface. Several kinds of these RCAPs are being adopted according to the farmers' needs and situations. In zero tillage, wheat seeds are drilled into unploughed fields which retain the anchored crop residues from the rice crop. In reduced tillage, the seeds are either drilled or sown by broadcasting involving 3-5 tractor passes using harrow, cultivator and plank. The other option is drilling of broadcast sowing using rotary-till drill leading to saving on tillage costs. The RCAPs are also more sustainable as they use less energy and are more environmental friendly. In spite of above advantages, information on the effect of RCAPs on soil health, micro-flora and diseases of wheat is very scanty. Conservation Agriculture is a set of practices that leave crop residues on the soil surface which increases water infiltration, conserve soil moisture, moderates soil temperature and reduces water erosion by cutting off the rain drop impact which seals the surface and enhances the surface runoff. The increasing popularity of this technique has led to the need for research into their effects on soil health. The conventional mode of agriculture through intensive agricultural practices was successful in achieving goals of production, but simultaneously led to the degradation of natural resources (Sturz *et al.*, 1997). Conservation Agriculture (CA) is an approach for designing and sustainable management of resource-conserving agricultural systems (Cartwright *et al.*, 1996; Pankhurst, 1997). It is currently practiced on more than 156 mha worldwide in 55 countries and about 1.5 mha in India (FAO, 2017) while till 1992 it was being practiced on about 80 million ha worldwide in more than 50 countries and the area (Rothrock, 1992).

Soil health studies were carried out at IIWBR, Karnal and CCS HAU Rice Research Station, Kaul in Haryana, North India. The studies were conducted by Anju Rani (2012) at IIWBR Karnal, India in wheat crop to evaluate the effect of conservation agriculture (CA) on soil health, and soil micro biota profiles under rice wheat cropping system. The size and composition of microbial populations was used to assess the changes in the soil biota which happened in response to CA. Soil microflora is important for sustainable agriculture as its activity contributes to increasing agricultural production. Disease susceptibility of crops may be reduced considerably by better understanding the interactions between pathogens and crop residue and then modifying local environmental conditions, crop rotations, tillage practices, and antagonistic microflora accordingly. These are often good indicators of the biological status of soil. High levels of soil borne pathogens often indicate poor soil health because of the increased threat of root diseases. Different cropping systems and tillage practices can also influence soil health for crop growth as they will influence the number of detrimental as well as beneficial organisms in the rhizosphere. Conservation agriculture maintains organic soil cover by retaining residues on soil surface from growing crops by growing catch crops. Its function is to protect the soil physically from sun, rain drop impact and wind and it is also a food to soil biota. The soil micro-organisms and soil fauna also take over the tillage function and soil nutrient balancing. Mechanical tillage disturbs this process by killing soil biota by direct exposure to sunlight. Therefore, zero or minimum tillage and direct seeding are important elements of CA. A diversified crop rotation is also important to avoid occurrence of disease and pest problems.

Materials and Methods

The studies were conducted on micro biota profiles in the soil, root architecture and dehydrogenate activity. The main-plot treatments were i) Removal of rice and wheat crop residues, ii) Incorporation of rice and wheat crop residues, iii) Incorporation of rice residue and removal wheat residue, iv) Burning of rice and wheat crop residues, v) Burning of rice and removal wheat residues, vi) Retention of rice and wheat residues and vii) Retention of only rice and removal wheat residues. The sub-plot treatments were Nitrogen applications @ 100, 150, and 200 kg/ha. The experiment was in progress from since Kharif 2004. The sampling of wheat plants was done during 2011-12 crop season using standard procedure. The rhizosphere soil was assessed for microbiological population and activity within 1 hour of sampling. Soil sample (1 g) was added to 9 ml sterile water in the test tube and then diluted up to 10^{-6}. Out of it, 0.1 ml of each dilution (10^{-1}, 10^{-3}, 10^{-5} and 10^{-6}) were spread on nutrient agar, potato dextrose agar, *Pseudomonas* agar base + 1 % (v/v) glycerol (Bridge *et al.*, 1999).

The agar plates were incubated at 28 ^{o}C up to 7 days. Morphologically different microbial colonies were selected after 48 and 96 h of incubation, assessed broadly and cultured on respective media for further studies. The number of cultivable bacteria in the original 1 gram of soil by averaging the results from each countable plate was counted according to procedure of Florida International University (1996). The bacterial isolates were identified by IMTECH (Chandigarh).

Biological oxidation of soil organic compounds is generally a dehydrogenation process carried out by specific dehydrogenases involved in the oxidative energy transfer of microbial cells. This activity is a measure of microbial metabolism and thus of the oxidative microbial activity in the soil. The technique involves the incubation of soil with 2, 3, 5 tri phenyl tetrazolium chloride (TTC) either in the presence or absence of added electron donating substrate. Microbial dehydrogenase activity during this incubation results in reduction of water soluble colourless TTC to water insoluble red 2, 3, 5 triphenyl tetrazolium formazen which was extracted from soil and determined calorimetrically for quantification.

The root samples were taken from different plots and were thoroughly washed with distilled water until the adhering soil is completely removed. The root samples were then surface dried and analyzed by scanning and using Win RHIZO 2012A software for different root parameters like total length, surface area, root volume etc.

Results and Discussion

Microbial population

The predominant fungal species found in the wheat rhizosphere under rice-wheat cropping system and conservation agriculture were *Aspergillus terrus*, *Aspergillus heteromorphus*, *Fusarium* spp. *Penicillium* spp. *Alternaria triticina* and *Bipolaris sorokiniana*. Bacterial counts were more than fungal and actinomycetes counts. The predominant actinomycetes spp. were *Streptomycetes* spp. which possess bio-control properties (Table 1).

Amongst different treatments, total colony forming units (CFU) were highest in plots where retention of residues of both rice and wheat crops was followed. Differences were also found in terms of kind of microbial populations amongst different RCAPs treatments. Significantly higher counts of CFU were found in treatments provided with N150 kg/ha (Table 1).

Effect on root architect

The root parameters (Analyzed region width, height, area and diseased root area differed in different treatments of RCAPs. The effect of N doses was not significant. Better root architect was recorded in plots having wheat and rice crop residue retention. The burning of crop residues had negative effect on root health (Table 2). Root architecture show different surface area, root volume, healthy condition of root. These results show higher surface area is responsible for higher number of micro biota in soil, more lengths of root help plant in water logging conditions (Table 2).

Dehydrogenase activity

The dehydogenase activity of soil biomass was low in different RCAPs treatments as compared to the plots where rice residue was burnt and wheat residue was removed (Table 3).

The results of these studies indicated beneficial effect of RCAPs on soil microbes, their activities and root architecture which may in turn help the rice-wheat cropping system to sustain effectively over long period without deteriorating soil health and making the system sustainable.

Agar medium for Actinomyces		**Nutrient Agar**	
Ingredients	*g/l*	*Ingredients*	*g/l*
Ingredients	g/l	Peptic digest of animal tissue	5.0
Sodium caseinate	2.0	Beef extract	1.5
L Asparagine	0.1	Yeast extract	1.5
Sodium propionate	4.0	Sodium chloride	5.0
Dipotassium phosphate	0.5	Agar	15.0
Magnesium sulphate	0.1	pH	7.4
Ferrous sulphate	0.001	***Pseudomonas* isolation Agar base**	
Agar	15.0	Peptone	20.0
pH	8.1	Agar	13.6
Potato Dextrose Agar (PDA)		Potassium sulphate	10.0
Infusion of potatoes	200.0	Magnesium chloride	1.4
Dextrose	20.0	Irgasan(triclosan)	0.025
Agar	15.0		

Table.1 Effect of different resource conservation agricultural practices on microbial profiles in wheat

MAIN TREATMENTS	**Total colony counts/Petri plate (9 cm diameter)**					
	CFU/ Plate (total)	***Streptomycetes* spp.**	**Bacterial colony color**			***Aspergillus heteromorphus***
		Chalky white colony*	Dark yellow*	Orange	Cream	Black colony
Removal of both rice and wheat crop residue	52.1	1.7	14.8	8.0	25.3	2.0
Incorporation of both rice and wheat crop residue	34.0	2.2	14.0	1.3	16.4	0.0
Incorporation of rice residue and Removal wheat residue	32.1	1.4	10.4	1.7	18.4	0.0
Burning of both rice and wheat residues	44.2	8.5	6.5	3.6	25.4	0.0
Burning of rice residue and removal wheat residue	38.3	1.4	11.0	2.8	23.0	0.0
Retention of rice residue and wheat residues	54.1	1.3	13.4	1.5	37.4	0.0
Retention of rice residue and removal of wheat residue	25.9	1.3	2.0	1.5	20.3	0.0
MEAN	40.1	2.5	10.3	2.9	23.8	0.3
CD (5%)	3.3	1.2	2.5	1.1	2.1	0.3
SUB TREATMENTS						
N 100 kg/ha	39.0	4.2	5.9	2.2	26.0	0.5
N 150 kg/ha	50.3	1.7	16.6	3.2	28.4	0.3
N 200 kg/ha	31.0	2.0	8.4	3.5	16.9	0.0
MEAN	40.1	2.6	10.3	3.0	23.8	0.3
CD (5%)	2.2	0.8	1.7	0.7	1.4	0.2

*Identification at IMTECH Chandigarh pending

Table.2 Effect of different resource conservation agricultural practices on root architect in wheat

Main treatments	**Root Parameters**			
	Analyzed region width (cm)	**Analyzed region height (cm)**	**Analyzed region area (cm2)**	**Root volume diseased (cm3)**
Removal of both rice and wheat crop residues	8.6	12.7	109.5	1.4
Incorporation of rice and wheat crop residues	9.3	12.1	112.8	2.7
Incorporation of rice residue and removal wheat residue	9.5	12.0	113.7	2.5
Burning of both rice residue and wheat residue	9.9	12.6	123.6	3.0
Burning of rice residue and removal wheat residue	9.3	11.7	109.1	1.8
Retention of both rice and wheat residues	11.0	11.5	126.6	2.1
Retention of rice residue and removal wheat residue	8.9	10.3	91.9	2.0
MEAN	9.5	11.8	112.5	2.2
CD (5%)	0.8	0.8	11.0	0.6
Sub treatments				
N 100 kg/ha	9.8	11.4	111.9	2.3
N 150 kg/ha	9.1	11.9	109.3	2.1
N 200 kg/ha	9.6	12.2	116.2	2.3
MEAN	9.5	11.8	112.5	2.2
CD (5%)	0.5	0.5	7.2	0.4

Table.3 Effect of different resource conservation agricultural practices on dehydrogenase activity in wheat

Main treatments	Dehydrogenase activity		
	Concentration ppm/ (4g)	Reading/g	Reading/dry weight
Removal of both rice and wheat crop residues	178.9	44.7	50.9
Incorporation of both rice and wheat crop residues	222.5	55.6	62.8
Incorporation of rice residue and removal wheat residue	118.3	29.6	33.7
Burning of both rice and wheat residue	252.6	63.2	71.4
Burning of rice residue and removal wheat residue	305.5	76.4	87.0
Retention of both rice and wheat residues	209.4	52.4	58.8
Retention of rice residue and removal wheat residue	124.7	31.1	34.9
MEAN	201.7	50.4	57.1
CD (5%)	12.6	3.1	3.5
Sub treatments			
N 100 kg/ha	225.5	56.3	63.5
N 150 kg/ha	191.2	47.8	54.3
N 200 kg/ha	188.3	47.0	53.4
MEAN	201.7	50.4	57.1
CD (5%)	8.2	2.0	2.3

Due to tillage practices, physical and chemical properties of the soil, root growth, nutrient uptake and microbial population is altered and it indirectly affects the viability and activity of the plant pathogens as well as host response to these. The changes also occur in soil temperature, moisture, aeration, compaction, porosity, plant nutrients, pH and organic matter of soils due to tillage practices. Several diseases are more damaging in high than low-residue seedbeds, and in crops planted during early autumn to reduce soil erosion during winter, especially un-irrigated winter wheat in rotation with summer fallow in low rainfall zones of 250-400 mm rain fall (Smiley, 1996).

Conservation agriculture may reduce pests and diseases by integrating crop rotation, which breaks the cycles that perpetuate crop diseases such as wheat rust and pest infestations (ICARDA, 2016). Fusisaka *et al.*, (1994) reported higher losses by grassy weeds due to rice-wheat cultivation.

Subsequent plant residue decomposition may result in phyto-toxin release and the stimulation of toxin producing microorganisms. It predisposed the plants to pathogens (Sturz *et al.*, 1997).

Relatively high soil microbial activity can lead to competition effect that may ameliorate pathogen activity and survival. Microbial antagonism in root zone can lead to the formation of disease suppressive soil. The losses in yield due to foliar and root pathogens Septoria blotch, glume blotch, Rhizoctonia root rot, seed and root rot, powdery mildew, crown rot have been reported higher under conservation agriculture. The incidence of spot blotch, and Fusarium common root rot is partially or completely controlled by reduced tillage. The others however reported contrasting findings (Ram Singh *et al.*, 2005).

References

Ambast S. K., Tyagi, N. K.; and Raul S. K. 2006. Management of declining groundwater in the Trans Indo-Gangetic Plain (India): some options. *Agricultural Water Management*, 82, 279-296.

André, O., and Lagerlof, J. 1983. Soil fauna (microarthropods, enchytraeids, nematodes) in Swedish agricultural cropping systems. *Acta Agricultarae Scandinavica*, 33, 33-52.

Anju Rani. 2012. Effect of Resource Conservation Agriculture Practices on Rhizosphere of Wheat Under Wheat–Rice Cropping System. Project report submitted for partial fulfillment of M.Sc. degree at Department of Bioscience & Biotechnology, Banasthali University, Rajasthan, India. p 20.

Belmar, S. B., Jones, R. K., and Starr, J. L. 1987. Influence of crop rotation on inoculum density of *Rhizoctonia solani* and sheath blight indices in rice. *Phytopathology*, 77, 1138-143.

Bimb, H. P., and Dubin, J. H. 1994. Studies of soil borne diseases and foliar blight of wheat at the National Wheat Research Experiment Station, Bhairahawa, Nepal. Wheat Special Report, 36. CIMMYT, Wheat Programme.

Bridge, J., *et al.*, 1999. Technical protocols for crop disease assessment, plant and soil sampling, isolation and extraction of fungi and nematodes. DFID Rice-Wheat Soil Health Project, CABI Bioscience, UK Centre, Egham, Surrey, TW20 9TY, United Kingdom, p 20.

Cartwright, R. D., *et al.*, 1996. Conservation tillage and sheath blight of rice in Arkansas. Ark. Expt. Sta. Res. Ser. 456, 83-88.

FAO. 2017., AG: Conservation Agriculture. CA Adoption Worldwide.

AQUASTAT.

Florida International University., 1996. Isolation of Soil Bacteria: Viable Isolation and Pure Culture Cornell University: Enrichment and Isolation "Lab Manual for Soil Microbiology"; David Zuberer, Ph.D.

Fujisaka, S., Harrington, L., and Hobbs, P.1994. Rice-wheat in South Asia: systems and long-term priorities established through diagnostic research. Agr. Syst., 46, (2), 169-187.

ICARDA, 2016. Conservation agriculture: opportunities for intensified farming and environmental conservation in dry areas. (Source: http://reliefweb.int/report/world/conservation-agriculture-opportunities-intensified-farming-and-environmental).

Pankhurst, C. E. 1997. Biodiversity of Soil Organisms as Indicators of Soil Health. In: *Biological Indicators of Soil Health*, Pankhurst, C. E. *et al.*, eds. CAB International. Pp. 297-324.

Ram Singh, *et al.*, 2005. Long-Term Response of Plant Pathogens and Nematodes to Zero-Tillage Technology in Rice-Wheat Cropping System. Technical Bulletin 7, Regional Research Station, Kaul, Department of Nematology and Directorate of Extension Education, CCS Haryana Agricultural University, Hisar, India. (Source: http://www. hau.ernet.in/hisar_admin/newspdf/1421384428plantprokaul.pdf).

Rothrock, C. S. 1992. Tillage systems and plant diseases. *Soil Sci.* 154, 308-315.

Singh, D. K., *et al.*, 2014. Evaluation of agronomic management practices on farmers' fields under rice-wheat cropping system in Northern India. Int. J. Agron. (Source: http://dx.doi.org/10.1155/2014/740656).

Smiley. R. W. 1996. Diseases of wheat and barley in conservation cropping systems of the semiarid Pacific Northwest. *Am. J. Alternative Agric.* 11 (2-3), 95-103.

Sturz, A.V.; *et al.*, 1997. A review of plant disease-pathogen interactions and microbial antagonism under conservation tillage in temperate, humid agriculture. *Soil Tillage Res.* 41, 169-189.

How to cite this article:

Anju Rani, D.P. Singh, R.K. Sharma and Chhokar, R.S. 2017. Resource Conservation Agricultural Practices, Rhizosphere and Diseases of Wheat under Wheat-Rice Cropping System. *Int.J.Curr.Microbiol.App.Sci.* 6(11): 1290-1298.
doi: https://doi.org/10.20546/ijcmas.2017.611.154