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Effect of Residue Management on Yield and Economics of Pearlmillet Based Cropping Systems under Rainfed Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was aimed to investigate the effects of residue management on yield and economics of pearlmillet based cropping systems in rainfed condition at Indian Agricultural research Institute, New Delhi. Field experiments were conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 using the pearlmillet variety 'Pusa Composite 443. The application of residue as mulch resulted in 16.94 and 8.97% increase in CEY over conventional tillage and residue as standing retention, respectively. Highest net returns of Rs. 56537/ha was obtained with Pearlmillet-chickpea cropping systems followed by Rs. 42429/ha with pearlmillet-barley. Pearlmillet-chickpea cropping systems was observed more productive, remunerative and resource efficient cropping systems in rainfed conditions.

Keywords: Crop management; pearlmillet; yield; agriculture.

1. INTRODUCTION

Rainfed agriculture play vital role to maintain food security worldwide as it accounts for about 80% of the total agricultural land and contributes 58% to the world's staple foods. In India, rainfed agriculture covers nearly 52% of total net cropped area and produced nearly 44% of the total food grain production of the country. Therefore, rainfed agriculture has the potential to meet the rising food grain requirements. But owing to several constraints such as low rainfall

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and its uneven distribution, high temperature, water scarcity, frequent drought, land degradation, poor physico-chemical properties of the soil and poor socio-economic status of the farmers, rainfed agriculture remains at high risk which forces the farmer to adopt subsistence farming. Foodgrain yields vary from 1 to 2 t ha^{-1} in the rainfed regions compared to at-tainable yields of more than 4 t ha^{-1} [1]. In addition, annual mean temperature have increased at the rate of 0.42°C, while southern and western India have shown a rising trend of 1.06 and 0.36°C, respectively in last 100 years [2]. As per National Action Plan on Climate Change, North Eastern India, Gujarat and Kerala witnessed 6-8% reduction in rainfall due to severe climate change during the last 100 years. Heavy rains and cloud bursts will also increase [3]. Snow covered areas will also decrease. Very high temperature heat waves and tropical hurricanes are also among the impacts of climate change in different regional areas [4]. Furthermore, unless people change their farming behaviour, there is a possibility of 10 to 40% loss in crop production by 2080-2100 due to global warming. Under such situation, achieving the sustainable crop production is one of the major challenges in rainfed areas. This challenge can be addressed by identifying, promoting, and realizing widespread and durable adoption of technologies for sustainable agricultural and there is a need to focus more on the development of such resource conservation technologies that are able to overcome from various constraints and maintain stability in crop production. Hence, a shift towards more sustainable production systems in the form of conservation agriculture (minimal soil disturbance, coverage of soil surface with residue and crop rotation) can play vital role to stabilize crop production under rainfed conditions [5]. Rainfed agriculture is practiced under a wide variety of soil type, agro-climatic and rainfall conditions. Crops in these regions are prone to the monsoon breaks, variability in rainfall amount, diversity in crop management practice and variability of the soil type [6].

Pearlmillet is one of the important drought hardy cereal crops grown in marginal lands of rainfed areas. Pearlmillet is cultivated on about 30 million ha in more than 30 countries of five continents viz., Asia, Africa, North America, South America and Australia [7]. It is also a good source of good quality fodder. In addition to fodder, it is also can be used to cover soil surface for many purposes such as improving soil fertility and soil temperature, conserving soil moisture in the soil profile and increasing water stable aggregates [8]. Many low water requiring crops like chickpea, lentil, barley etc. can be succeeded to pearlmillet during *rabi* season with the adoption of suitable moisture conservation practices. In order to minimize the risk of crop failure and maximize crop production per unit area, use of suitable cropping systems and crop residue management is of prime importance under rainfed conditions. Keeping this in view, an attempt has been made to study the effect of residue management on the resource use efficiency and productivity of pearlmillet based cropping systems in rainfed areas.

2. MATERIALS AND METHODS

Field experiments were conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 at Indian Agricultural research Institute, New Delhi. The soil of the experimental site was sandy loam with pH 7.9, low in organic carbon (0.38%), available nitrogen (141.6 kg/ha) and medium in available P (14.2 kg/ha), and potassium (168 kg/ha). The treatment comprised of three residue management (Conventional tillage, residue as standing retention in zero tillage and residue as mulch in zero tillage) in *rabi* crops and 3 cropping systems (pearlmillet-chickpea, pearlmillet-barley and pearlmillet-lentil) were studied in a split plot design with 3 replications. Experimental crops received total rainfall of 579 mm and 991 mm during the whole cropping period of 20017-18 and 20018-19, respectively. The pearlmillet variety 'Pusa Composite 443' was sown using the seed rate of 5 kg/ha at 45X10 cm spacing at the onset of monsoon under zero tillage on July 8 and 10 during 2017 and 2018, respectively. The crop was harvested in the last week of September during both the years and pearl millet residue @ 3 ton/ha was applied in succeeding crops (chickpea, lentil and barley). Chickpea (Pusa 3022), Lentil (Pusa Shivalik) and barley (RD 2715) were succeeded to pearlmillet during *rabi* season. All the crops were sown in the last week of October during both the years. Chickpea, lentil and barley were sown at row to row spacing of 45, 30 and 25 cm, respectively. Chickpea and lentil were harvested in the second fortnight of March, whereas barley was harvested in the first week of April during both the years. Recommended cultural practices for all the crops were adopted as per the crop need. Standard procedures were practiced in collection and analysis of all data.

Table 1. Effect of residue management and cropping systems on the system productivity, economics and resource use efficiency

Treatments	CEY Yield (kg/ha)	Net returns (Rs/ha)	Bulk density (Mg/m^3)	Water use efficiency (CEY kg/ha/mm)	Agronomic efficiency (kg yield increase/kg nutrient applied)		
					N	P	K
Residue							
Conventional tillage	1777	30465	1.54	2.90	17.77	14.75	22.12
Residue as standing retention in zero tillage	1907	45357	1.52	3.11	19.07	15.90	23.83
Residue as mulch in zero tillage	2078	51917	1.52	3.398	20.78	17.32	25.97
CD (P=0.05)	117.6	-	NS	-	-	-	-
Cropping systems							
Pearlmillet-chickpea	2260	56537	1.52	3.69	28.25	18.83	28.25
Pearlmillet-lentil	1616	29526	1.53	2.64	20.20	13.47	20.2
Pearlmillet-barley	1883	42423	1.53	3.07	13.45	15.70	23.53
CD (P=0.05)	181.4	-	NS	-	-	-	-

3. RESULTS

Among the residue management treatments, crop residue used as mulch recorded the maximum chickpea-equivalent yield (CEY) of 2078 kg/ha and found significantly superior over conventional tillage and residue as standing retention in zero tillage (Table 1). The application of residue as mulch resulted in 16.94 and 8.97% increase in CEY over conventional tillage and residue as standing retention, respectively. The increase in CEY was owing to improvement of water and nutrient use efficiency, and decrease of bulk density. Bhardwaj et al. [9] also reported that crop residue in addition to being an important source of nutrients for crop production also improves physico-chemical properties and biological functions of the soil, if managed properly. However, highest net returns, water and nutrient use efficiency were also observed with residue applied as mulch. The lowest CEY, net returns, water and nutrient use efficiency, and highest bulk density were recorded with conventional tillage.

Pearlmillet-chickpea cropping systems recorded significantly higher CEY over pearlmillet-lentil and pearlmillet-barley cropping systems. Pearlmillet-chickpea recorded 2260 kg/ha CEY compared to 1616 kg/ha with pearlmillet-lentil and 1883 kg/ha with pearlmillet-barley cropping systems. The increase of CEY with pearlmillet–chickpea cropping systems was owing to higher productivity and selling price of chickpea. Highest net returns of Rs. 56537/ha was obtained with Pearlmillet-chickpea cropping systems followed by Rs. 42429/ha with pearlmillet-barley. The magnitude of increase of net returns with Pearlmillet-chickpea cropping systems was 24.96 and 47.77% over pearlmillet-barley and pearlmillet-lentil, respectively. The highest water and nutrient use efficiency were also recorded with pearlmillet-chickpea cropping systems.

4. CONCLUSION

Thus, it can be concluded that use of crop residue in zero tillage is beneficial for improving water and nutrient use efficiency and physico-chemical properties of the soil as compared to conventional tillage. Application of crop residue as mulch found more effective to obtain higher yield, net returns and better physico-chemical properties of the soil compared to residue as standing retention and conventional tillage. Pearlmillet-chickpea cropping systems was observed more productive, remunerative and resource efficient cropping systems in rainfed conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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