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Economics of Residues Incorporation and Phosphorus Application for Direct Seeded Rice and Wheat under Saline Soil

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Abstract

Two-year long field study was conducted using a permanent layout to investigate the economics of crop residues incorporation (2 t·ha^{-1}) and P application (0, 40, 80 and 120 kg P_2O_5 ha^{-1}) to directly sowing of rice and wheat crops gown under naturally salt-affected calcareous soil (EC_e = 4.59 dS m^{-1}; pH_s = 8.38; SAR = 6.57 (mmol$_c$ L^{-1})$^{1/2}$; $CaCO_3$ = 3.21%; Extractable P = 4.07 mg·kg^{-1}; sandy clay loam) at farmers field in district Hafizabad during the year 2012-13. Split plot design (crop residues in main plots and P application in sub plots) was followed with three replications. Agronomic data on growth and yield were collected at the time of each crop maturity. Maximum growth and yield of both the crops were harvested from the plots where P_2O_5 was applied @ 80 kg·ha^{-1} along with crop residues incorporation. On an average of two years, maximum paddy (3.26 t·ha^{-1}) and wheat grain (3.56 t·ha^{-1}) yield were produced with P application @ 80 kg P_2O_5 ha^{-1} along with crop residues incorporation. Although, the yield harvested with this treatment (80 kg P_2O_5 ha^{-1} + crop residues) performed statistically equal to 120 kg P_2O_5 ha^{-1} without crop residues incorporation during both the years, however, on an average of two years, grain yield of directly sowing rice and subsequent wheat was significantly superior (22% and 24% respectively) than that of higher P rate (120 kg·ha^{-1}) without crop residues. Overall, continuous two-year crop residues incorporation further increased (17%) paddy yields during the follow up year of crop harvest. Economic analyses of both the crops were carried out to choose the best treatment with adequate economic benefits as compared to those without crop residue incorporation. Maximum net benefit of Rs =

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108,680/- for direct seeded rice and Rs = 99,362/- for wheat grown with 80 kg P_2O_5 ha^{-1} application under crop residues incorporation was determined. Among P application treatments without crop residues incorporation, the maximum net benefit (Rs = 75,874/- and Rs = 65,725/-) and highest residual values (49,809 and 39,160) for direct seeded rice and wheat respectively, were obtained with extended P application rate (120 kg P_2O_5 ha^{-1}) which was not again as much as that of 80 kg P_2O_5 ha^{-1} application with crop residues incorporation.

Keywords

Crop Residues Incorporation, P Application, Direct Seeded Rice and Wheat, Saline Soil, Economic Analysis

1. Introduction

With world population now more than seven billion is a timely moment for such an assessment to boost up the grain production for fulfilling the mounting demands. Population growth and economic burden are exerting the pressure on arable lands. Intensive cropping are exhausting nutrients from soil equilibrium gradually which is among the major constraints to get optimum yields. The specter of possible changes in traditional agriculture could be a step forward to release these pressures. It is the time to consider how we can move "towards sustainability" towards a vision of natural resources management that supports current population's demands otherwise leaving the future generations on an equitable soil degradation owing to gradual nutrient depletion. Soil is critical component of the resource base upon which a successful agriculture depends. To move towards sustainability, agriculture and natural resource management interests must recognize that they are equal partners in the effort. The challenges are to adapt and extend our knowledge about soil health to develop economically productive, culturally appropriate and environmentally sound systems. A flexible ongoing process is necessary to set research priorities to support inherently dynamic agricultural techniques.

In Pakistani, totals extents off salt-affected areas is 6.3 mha, of which 1.89 mha is saline, 1.89 mha is permeable saline-sodic, 1.02 mha is impermeable saline-sodic while sodic-soils is only 0.028 mha. Provinces wised distributions off saline's patches outs of 1.89 mha, 0.94 mha is in the Punjab, 0.5 mha in Sindh and 0.45 mha is in Khyber Pakhtun Khawa [1]. Soil salinity and P fixation reduce activity of soil microorganisms. Nutrient mining due to intensive cropping and practice of imbalance fertilizers applications is the main examples of soil resources degradation. A significant reduction in the yield of rice and wheat owing to these reasons is 68% and 64%, respectively, causing a loss estimate from 0.3 to 1.0 billion dollar per annum [2]. The interrelated apprehensions of rising population definitely impose economic pressures; intensified land use and environmental degradation at local and regional levels are serious issues to concern. Combinations of biological and societal resources are required to make successful agricultural production managements and its sustainability will necessitate the changes in philosophy and operating procedures for improving productivity. A major limitation in the rice-wheat cropping system is the short time between rice harvesting and wheat cultivation and any delay in planting adversely affects crop yields. As the result of improved farm machinery convenience, a large area under rice and wheat crops are being harvested with combined harvester which leaves behind a massive loose straw whose removal or exploitation in a short time period is not so easy. Rice is grown on 2.58 mha with annual straw production of about 4 million tons [3]. The situation compels farmers to burn them for preparation their lands for timely sowing of subsequent crops [4] [5]. Circumstances after the harvest of wheat crop are also the same. Crop residues are rich source of plant nutrients that farmers demolish through burning which not only causes nutrient losses but also pollutes the environment. In addition to these restrictions, P fixation in our soils due to calcareousness and high pH are other constraints considerably reducing crop yields and under saline conditions, its availability is further declined. The growing crop plants under such environment demand relatively higher nutrition to reach the potential yields. Since the prices of P fertilizers are becoming out of the reach of resource poor farmers day by day as a result they don't be anxious about nourishing their growing crop plants with balanced fertilization [6]. The left over residues could be recycled if its burning is discouraged. Generally, a large portion of nutrients taken up by the plants remains in the straw which can be utilized for the growth of subsequent crops through their incorporation [7]. In many studies, recycling of crop residues is reported to increase the nutrient status of the soils and hence crop productivity [8]-[10].

Traditionally transplanting of rice is a very hard and difficult process of cultivation which requires expensive labour and extensive machinery tools for puddling as well. Consequently, directly sowing of rice is an option which saves all these expenses and complexities. Keeping all these points in view, two year field study using a permanent layout was conducted under naturally saline soil to investigate the economics of crop residue incorporation as well as P application and their impact on direct seeded rice paddy and wheat grain yields.

2. Materials and Methods

A two year study using a permanent layout was conducted under marginal saline soil of rice-wheat cropping system at farmers field in Wachhoki Kalan, Kankah Dogran-Hafizabad Road, district Hafizabad (EC_e = 4.59 $dS \cdot m^{-1}$; pH_s = 8.38; SAR = 6.57 $(mmol_c \cdot L^{-1})^{1/2}$; $CaCO_3$ = 3.21%; Extractable P = 4.07 $mg \cdot kg^{-1}$; Sandy clay loam) during 2012-13. The experiment was laid out according to split plot design with three replications. Planting methods *i.e.*, direct seeding with and without crop residue (wheat) incorporation @ 2 $t \cdot ha^{-1}$ were kept in main plots and various P doses (0, 40, 80 and 120 kg P_2O_5 ha^{-1}) were applied in sub plots.

Recommended basal dose of N @ 100 $kg \cdot ha^{-1}$ (half at sowing time and remaining half at tillering stage) and K @ 50 $kg \cdot ha^{-1}$ as SOP were applied to all the plots at the time of sowing. Soaked seed (for 24 h) of rice cv. Supper-2000 @ 40 $kg \cdot ha^{-1}$ was broad-casted uniformly. The same inputs were applied to intermediate wheat crop. Effective weedicides were used to control weeds and the crop was grown to upto maturity. All agronomic requirements and plant protection measures were met throughout the growth period whenever required. At maturity, each crop was harvested and direct seeded rice paddy and wheat grain yields were recorded.

The economic analysis of crop residues incorporation and four P application rates to direct seeded rice and wheat crops was computed by using the method as described earlier [11].

3. Results and Discussion

3.1. Growth and Yield of Direct Seeded Rice and Wheat Crops

On an average of two years data, maximum paddy (3.26 $t \cdot ha^{-1}$) and wheat grain (3.56 $t \cdot ha^{-1}$) yields were produced with P application @ 80 kg P_2O_5 ha^{-1} alongwith crop residues incorporation (**Table 1**) which was comparable with higher P rate (120 $kg \cdot ha^{-1}$) under no crop residues incorporation. The paddy and wheat grain yields produced by this treatment showed 22% and 24%, respectively additional yield over control (0 kg P ha^{-1} + crop residues). Under crop residues incorporation, further increase in P application (120 kg P_2O_5 ha^{-1}) caused 6% paddy yield reduction as compared to the P application @ 80 kg P_2O_5 ha^{-1}. Crop residue incorporation positively contributed in grain yield of direct seeded rice and subsequent wheat particularly during second year. This was most probably due to complete decomposition and mineralization of added crop residues that enriched the soil with mineral nutrients in addition to improvement in soil physical condition by ameliorating toxic effects of

Table 1. Average direct seeded rice and wheat yields ($kg \cdot ha^{-1}$) 2011-12.

Direct Seeded Rice Yield	T1	T2	T3	T4
+CR (Grain)	2685	2870	3262	3080
+CR (Straw)	6853	6953	7447	7170
−CR (Grain)	1724	2171	2715	3062
−CR (Straw)	4491	5627	6194	6356
Wheat Yield				
+CR (Grain)	2652	3194	3560	3259
+CR (Straw)	5836	6285	6576	6358
−CR (Grain)	1591	2054	2877	3320
−CR (Straw)	3577	4433	5263	5832

T1 = 0 kg P_2O_5 ha^{-1}; T2 = 40 kg P_2O_5 ha^{-1}; T3 = 80 kg P_2O_5 ha^{-1}; T4 = 120 kg P_2O_5 ha^{-1}; +CR = With Crop Residue; −CR = Without Crop Residue.

saline ions. Moreover, water and P retention capacity might have also been improved due to added crop residues that retained comparatively excess moisture and P availability for a longer time. Besides, production of acid farming substances by microbial activities and partial pressure of CO_2 released during crop residues decomposition decreased soil pH and enhanced P availability and other necessary plant nutrients which encouraged healthy plant growth and hence yields. Similar points of view have also been documented by [12] [13]. Further, adequate P fertilization promoted vigorous plant growth that ultimately improved number of grains per panicle resulting in increased yields of direct seeded rice and succeeding wheat crop [14] [15]. The increase in yield due to crop residues incorporation as well as P application has also been well documented by [16]-[20].

3.2. Partial/Budget Analysis of Direct Seeded Rice and Wheat Crops

Partial budget analysis for P application rates (**Table 2** and **Table 3**) showed that all P application rates under crop residues incorporation gave higher benefit than that of without crop residues incorporation. However maximum net benefit for direct seeded rice and wheat crops was calculated from P application @ 80 kg P_2O_5 ha^{-1} with crop residues incorporation under saline soil. This treatment for direct seeded rice and wheat again performed to be superior than that of elevated P application rate (120 kg P_2O_5 ha^{-1}) without crop residues incorporation. Whereas, minimum net benefit was obtained from the plots receiving 40 kg P_2O_5 ha^{-1} without crop residues incorporation. Correspondingly, P application @ 80 kg P_2O_5 ha^{-1} with crop residues incorporation also demonstrated the highest Cost Benefit Ratio (CBR) for direct seeded rice and wheat.

Table 2. Partial budget analysis for direct seeded rice grown with and without CR under saline soil.

Average Yield (kg·ha^{-1}) 2012-13	T1	T2	T3	T4
+CR				
Paddy	2685	2870	3262	3080
Straw	6853	6953	7447	7170
TCV	**26,625**	**27,105**	**27,585**	**28,065**
10% less Paddy Yield	268.5	287.0	326.2	308.0
10% less Straw Yield	685.3	695.3	744.7	717.0
Adjusted Grain Yield	2417	2583	2936	2772
Adjusted Straw Yield	3427	6258	6702	6453
Income (Grain)	84,578	90,405	102,753	97,020
Income (Straw)	17,133	31,288.5	33,511.5	32,265
Gross Income (Paddy + Straw)	**101,710**	**121,694**	**136,265**	**129,285**
Net Benefit (Rs ha^{-1})	**75,085**	**94,589**	**108,680**	**101,220**
−CR				
Paddy	1724	2171	2715	3062
Straw	4491	5627	6194	6356
TVC	**24,625**	**25,105**	**25,585**	**26,065**
10% less Paddy Yield	172.4	217.1	271.5	306.2
10% less Straw Yield	449.1	562.7	619.4	635.6
Adjusted Paddy Yield	1552	1954	2444	2756
Adjusted Straw Yield	4042	5064	5575	5720
Income (Paddy)	54,306	68,387	85,523	96,453
Income (Straw)	20,210	25,322	27,873	28,602
Gross Income (Paddy + Straw)	**74,516**	**93,708**	**113,396**	**125,055**
Net Benefit (Rs ha^{-1})	**49,891**	**68,603**	**87,811**	**98,990**

DSR = Direct Seeded Rice; CR = Crop Residue; T1 = 0 kg P_2O_5 ha^{-1}; T2 = 40 kg P_2O_5 ha^{-1}; T3 = 80 kg P_2O_5 ha^{-1}; T4 = 120 kg P_2O_5 ha^{-1}; +CR = With Crop Residue; −CR = Without Crop Residue.

Table 3. Partial budget analysis for wheat grown with and without CR under saline soil.

Average Yield ($kg \cdot ha^{-1}$) 2012-13	T1	T2	T3	T4
+CR				
Grains	2652	3194	3560	3259
Straw	5836	6285	6576	6358
TCV	**27,125**	**27,605**	**28,085**	**28,565**
10% less Grain Yield	265.2	319.4	356.0	325.9
10% less Straw Yield	583.6	628.5	657.6	635.8
Adjusted Grain Yield	2387	2875	3204	2933
Adjusted Straw Yield	5252	5657	5918	5722
Income (Grain)	59,670	71,865	80,100	73,328
Income (Straw)	42,019	45,252	47,347	45,778
Gross Income (Grain + Straw)	**101,689**	**117,117**	**127,447**	**119,105**
Net Benefit (Rs ha^{-1})	**74,564**	**89,512**	**99,362**	**90,540**
−CR				
Grains	1591	2054	2877	3320
Straw	3577	4433	5263	5832
TVC	**25,125**	**25,605**	**26,085**	**26,565**
10% less Paddy Yield	159.1	205.4	287.7	332.0
10% less Straw Yield	357.7	443.3	526.3	583.2
Adjusted Grain Yield	1432	1849	2589	2988
Adjusted Straw Yield	3219	3990	4737	5249
Income (Grain)	35,798	46,215	64,733	74,700
Income (Straw)	25,754	31,918	37,894	41,990
Gross Income (Grain + Straw)	**61,552**	**78,133**	**102,626**	**116,690**
Net Benefit (Rs ha^{-1})	**36,427**	**52,528**	**76,541**	**90,125**

+CR = With Crop Residue; −CR = Without Crop Residue; T1 = 0 kg P_2O_5 ha^{-1}; T2 = 40 kg P_2O_5 ha^{-1}; T3 = 80 kg P_2O_5 ha^{-1}; T4 = 120 kg P_2O_5 ha^{-1}.

3.3. Cost Benefit Ratio (CBR), Net Benefit (NB) and Marginal Rate of Return (MRR)

The data in Table 4 and Table 5 indicates that maximum CBR (4.9) for direct seeded rice was calculated with 80 kg P_2O_5 ha^{-1} under crop residues incorporation and it was 4.8 with higher rate of P_2O_5 (120 $kg \cdot ha^{-1}$ without crop residues incorporation). Similarly, the highest CBR of 4.5 for wheat was calculated with 80 kg P_2O_5 ha^{-1} under crop residues incorporation and it was 4.4 with higher rate of P_2O_5 (120 $kg \cdot ha^{-1}$ without crop residues incorporation). Generally, all P application rates along with crop residues incorporation showed much higher NB and highest residual value being the maximum NB with 80 kg P_2O_5 ha^{-1} application to direct seeded rice (Rs = 108,680/-) and wheat (Rs = 99,362/-) crops. Among P application treatments without crop residues incorporation, the maximum NB (Rs = 98,990/- and Rs = 90,125/-) and highest residual values (72,925 and 63,560) for direct seeded rice and wheat respectively, were obtained with higher P application rate (120 kg P_2O_5 ha^{-1}) which were not again as much as that of 80 kg P_2O_5 ha^{-1} application with crop residues incorporation. Similarly Table 6 showed that highest MRR (4063) for direct seeded rice was computed with 40 kg P_2O_5 ha^{-1} under crop residues incorporation and while it was 3950 with 80 kg P_2O_5 ha^{-1} without crop residues incorporation). Whereas Table 7 indicated, the highest MRR (3114) for wheat was calculated with 40 kg P_2O_5 ha^{-1} under crop residues incorporation and it was (4179) with 80 kg P_2O_5 ha^{-1} without crop residues incorporation).

On the basis of this investigation, it is concluded that crop residues incorporation is the best choice rather it's

Table 4. Cost Benefit Ratio (CBR) for direct seeded rice grown under saline soil.

Treatments	Gross Income (Paddy + Straw)	TCV	NB	CBR
+CR				
T1 (0 kg P_2O_5 ha^{-1})	101,710	26,625	75,085	3.8
T2 (40 kg P_2O_5 ha^{-1})	121,694	27,105	94,589	4.5
T3 (80 kg P_2O_5 ha^{-1})	136,265	27,585	108,680	4.9
T4 (120 kg P_2O_5 ha^{-1})	129,285	28,065	101,220	4.6
−CR				
T1 (0 kg P_2O_5 ha^{-1})	74,516	24,625	49,891	3.0
T2 (40 kg P_2O_5 ha^{-1})	93,708	25,105	68,603	3.7
T3 (80 kg P_2O_5 ha^{-1})	113,396	25,585	87,811	4.4
T4 (120 kg P_2O_5 ha^{-1})	125,055	26,065	98,990	4.8

TCV = Total Cost that Vary; NB = Net Benefit; CBR = Cost Benefit Ratio; +CR = With Crop Residue; −CR = Without Crop Residue.

Table 5. Cost Benefit Ratio (CBR) for wheat grown under saline soil.

Treatments	Gross Income (Grain + Straw)	TCV	NB	CBR
+CR				
T1 (0 kg P_2O_5 ha^{-1})	101,689	27,125	74,564	3.7
T2 (40 kg P_2O_5 ha^{-1})	117,117	27,605	89,512	4.2
T3 (80 kg P_2O_5 ha^{-1})	127,447	28,085	99,362	4.5
T4 (120 kg P_2O_5 ha^{-1})	119,105	28,565	90,540	4.2
−CR				
T1 (0 kg P_2O_5 ha^{-1})	61,552	25,125	36,427	2.4
T2 (40 kg P_2O_5 ha^{-1})	78,133	25,605	52,528	3.1
T3 (80 kg P_2O_5 ha^{-1})	102,626	26,085	76,541	3.9
T4 (120 kg P_2O_5 ha^{-1})	116,690	26,565	90,125	4.4

TCV = Total Cost that Vary; NB = Net Benefit; CBR = Cost Benefit Ratio; +CR = With Crop Residue; −CR = Without Crop Residue.

Table 6. Marginal Rate of Return (MRR) for direct seeded rice grown under saline soil.

Treatments	TCV	MC	NB	MNB	MRR
+CR					
T1 (0 kg P_2O_5 ha^{-1})	26,625	–	75,085	–	–
T2 (40 kg P_2O_5 ha^{-1})	27,105	480	94,589	19,504	4063
T3 (80 kg P_2O_5 ha^{-1})	27,585	960	108,680	33,595	3499
T4 (120 kg P_2O_5 ha^{-1})	28,065	1440	101,220	26,135	1815
−CR					
T1 (0 kg P_2O_5 ha^{-1})	24,625	–	49,891	–	–
T2 (40 kg P_2O_5 ha^{-1})	25,105	480	68,603	18,712	3898
T3 (80 kg P_2O_5 ha^{-1})	25,585	960	87,811	37,920	3950
T4 (120 kg P_2O_5 ha^{-1})	26,065	1440	98,990	49,099	3410

TCV = Total Cost that Vary; MC = Marginal Cost; NB = Net Benefit; MNB = Marginal Net Benefit; MRR = Marginal Rate of Return; +CR = With Crop Residue; −CR = Without Crop Residue.

burning to improve direct seeded rice and wheat yields with 80 kg P_2O_5 ha^{-1} application under slightly saline soil.

3.4. Residual Analysis for Direct Seeded Rice and Wheat Crops

Residual analysis is done to verify the results of marginal analysis. The results of residual analysis (**Table 8** and **Table 9**) demonstrate that the highest residual values of direct seeded rice and wheat were observed with (80 kg P_2O_5 ha^{-1} and crop residues incorporation) followed by 120 kg P_2O_5 ha^{-1} without crop residues incorporation. The improvement in their economics is definitely attributed to continuous P application and crop residues incorporation that might have altered the soil physical conditions due to which P availability and its utilization was enhanced. Consequently, the nutrient utilization efficiency positively happened to be a factor for healthy growth and yield of direct seeded rice and wheat crops under adverse soil condition. This could be supported by the findings of [20]-[24], who had documented similar points of view regarding better correlation between nutrients and plant growth under improved soil physical conditions. The similar trend in economic analysis results of mungbean cultivars and P application rates have been reported by [25]. Performance of green gram and response functions as influenced by different levels of nitrogen and phosphorous was computed by [26]. Similarly the results of [27] showed that application of inorganic fertilizers and organic manures enhanced nutrients availability and improved economical production of mungbean. On the basis of all economic analyses of research work data

Table 7. Marginal Rate of Return (MRR) for wheat grown under saline soil.

Treatments	TCV	MC	NB	MNB	MRR
		+CR			
T1 (0 kg P_2O_5 ha^{-1})	27,125	–	74,564	–	–
T2 (40 kg P_2O_5 ha^{-1})	27,605	480	89,512	14,948	3114
T3 (80 kg P_2O_5 ha^{-1})	28,085	960	99,362	24,798	2583
T4 (120 kg P_2O_5 ha^{-1})	28,565	1440	90,540	15,976	1109
		−CR			
T1 (0 kg P_2O_5 ha^{-1})	25,125	–	36,427	–	–
T2 (40 kg P_2O_5 ha^{-1})	25,605	480	52,528	16,101	3354
T3 (80 kg P_2O_5 ha^{-1})	26,085	960	76,541	40,114	4179
T4 (120 kg P_2O_5 ha^{-1})	26,565	1440	90,125	53,698	3729

TCV = Total Cost that Vary; MC = Marginal Cost; NB = Net Benefit; MNB = Marginal Net Benefit; MRR = Marginal Rate of Return; +CR = With Crop Residue; −CR = Without Crop Residue.

Table 8. Analysis using Residual for direct seeded rice grown under saline soil.

Treatments	1 TCV	2 NB	3 Returned Required by Farmer (100%*1) Rs ha^{-1}	4 = [2 - 3] Residual (Rs ha^{-1})
		+CR		
T1 (0 kg P_2O_5 ha^{-1})	26,625	75,085	26,625	48,460
T2 (40 kg P_2O_5 ha^{-1})	27,105	94,589	27,105	67,484
T3 (80 kg P_2O_5 ha^{-1})	27,585	108,680	27,585	81,095
T4 (120 kg P_2O_5 ha^{-1})	28,065	101,220	28,065	73,155
		−CR		
T1 (0 kg P_2O_5 ha^{-1})	24,625	49,891	24,625	25,266
T2 (40 kg P_2O_5 ha^{-1})	25,105	68,603	25,105	43,498
T3 (80 kg P_2O_5 ha^{-1})	25,585	87,811	25,585	62,226
T4 (120 kg P_2O_5 ha^{-1})	26,065	98,990	26,065	72,925

TCV = Total Cost that Vary; NB = Net Benefit; +CR = With Crop Residue; −CR = Without Crop Residue.

Table 9. Analysis using Residual for wheat grown under saline soil.

Treatments	1 TCV	2 NB	3 Returned Required by Farmer (100%*1) Rs ha^{-1}	4 = [2 - 3] Residual (Rs ha^{-1})
		+CR		
T1 (0 kg P_2O_5 ha^{-1})	27,125	74,564	27,125	47,439
T2 (40 kg P_2O_5 ha^{-1})	27,605	89,512	27,605	61,907
T3 (80 kg P_2O_5 ha^{-1})	28,085	99,362	28,085	71,277
T4 (120 kg P_2O_5 ha^{-1})	28,565	90,540	28,565	61,975
		−CR		
T1 (0 kg P_2O_5 ha^{-1})	25,125	36,427	25,125	11,302
T2 (40 kg P_2O_5 ha^{-1})	25,605	52,528	25,605	26,923
T3 (80 kg P_2O_5 ha^{-1})	26,085	76,541	26,085	50,456
T4 (120 kg P_2O_5 ha^{-1})	26,565	90,125	26,565	63,560

TCV = Total Cost that Vary; NB = Net Benefit; +CR = With Crop Residue; −CR = Without Crop Residue.

(2011-2012), the incorporation of crop residues and 80 kg P_2O_5 ha^{-1} could be recommended to farmers to get maximum return by growing direct seeded rice and wheat on marginally salt-affected soils. The findings could also be supported by the results of [28].

4. Conclusion

Our results indicated that P application @ 80 kg P_2O_5 ha^{-1} along with crop residues incorporation (2 ton·ha^{-1}) was found to be superior to rest of the treatments in term of producing maximum grain yield of both direct seeded rice and wheat crop grown under marginally saline soil.

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