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Growth, Yield and Yield Traits of Rice Varieties in Rotation with Clover, Potato, Canola and Cabbage in North of Iran

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Abstract: In order to investigate the effects of second crop cultivation on growth yield and yield components of rice, a field experiment was conducted at Rice Research Institute of Iran-Deputy of Mazandaran during 2005 and 2006. Tarom as a traditional variety and Fajr as a improve variety were used in this research. Clover, Potato, Canola and Cabbage were used as a second crop in rotation with rice. Second crop cultivation had not significant effect on yield and yield components of rice variety but second crop cultivation had significant effect on plant height at 1% probability level. Results indicated that rice varieties had different reaction to second crop cultivation. According to results, Rice-clover-Rice and Rice-fallow-Rice rotations systems for the best performance of rice yield in North of Iran's paddy fields were recommended.

Key words: Rice, clover, potato, canola, cabbage, yield

INTRODUCTION

Crop residue is a vital natural resource for conserving and sustaining soil productivity. It is the primary substrate for replenishment of soil organic matter. Upon mineralization, crop residue supplies essential plant nutrients (Walters *et al*., 1992). Additionally, residue incorporation can improve physical and biological conditions of the soil and prevent soil degradation (Nymborg *et al*., 1995). Annual rice-wheat double crop systems occupy 21 million ha in the Indo-Gangetic plains of south Asia (Bronson *et al*., 1998). The benefits of sequestering soil organic amendments and crop residue and including legumes in crop rotations have been well documented in the temperate regions. Although many green manuring studies have been conducted with rice in Asia (Buresh *et al*., 1993; Yadvinder-Singh *et al*., 1992) few studies have looked at comparative effect of crop residue management with or without fertilizer N and legume green manure on crop yields and sequestering soil organic carbon. On-station data from long-term experiments in China (Byerlee, 1992), Nepal (Regmi, 1994) and India (Nambiar, 1995) indicate that productivity of rice and wheat has been declining. Inadequate or imbalanced nutrient management and decreasing sequestering soil organic are probably the factors in the declining trend in this cropping system. Over the past 20 years production in rice-second crop system has kept pace with increased population but now there are signs of stagration or decline in yield (Duxbury *et al*., 2000; Yadave *et al*., 2000). Several researchers have studied Long-term rice-wheat experiments in south Asia but most studies were restricted to simple yield trend analysis (Nambiar, 1995; Yadave *et al*., 2000; Dawe *et al*., 2000; Duxbury *et al*., 2000). More than one third of the human population rely on rice for their daily sustenance, making it the most important of the world's food crops (Brennane *et al*., 1994). The global rice production needs to be increased by 75% by 2020 to feed the world rice consumer (Donald, 1994). Since arable land is becoming limited improving productivity and increasing cropping intensity by adopting rice cultivation with second crops in potentially irrigated areas will be required to meet the food demand of the regions increasing population (Regmi, 1994). There are many reports about rice-second crop-rice rotation systems in many tropical Asian countries. The analysis of some of these experiments have shown declining rice second crop yields (Cassman *et al*., 1995; Yadave *et al*., 2000; Duxbury *et al*., 2000). When a yield decline is maintained (Dawe *et al*.,

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2000), the major causes suggested as a gradual decline in the supply of soil organic matter content, atmospheric pollution, pest and disease in festations and negative changes in the biochemical and physical composition of soil organic matter (Nambiar, 1995; Yadave *et al*., 2000). Also second crop cultivation maybe had positive effect on rice rotation. For first time second crop cultivation had been used at Iran's paddy field in 1965 (Fallah, 2000). In the first years, foliage cops and oil seed crops were used as a second crop. Ofori and Stern (2001) showed that leguminous crop had positive effect on rice grain yield. Fransis (2002) indicated that canola is not a good crop in rotation with rice because it supply much of soil food material. Different experiments had been showed that potato and clover could be a good crop as a second crop. Different experiments had been showed that Berseem Clover (*Trifolium alexandrium*) had positive effect on rice yield. Rice yield with canola rotation is lower than with potato rotation. Handand and Dhillon (1993) showed the positive effects of *Trifolium alexandrium* as a green manure on rice yield, they reported that rice yield in the plots with green manure was more than in fallow plots. Know about the positive or negative effect of different plants on rice growth is very important.

MATERIALS AND METHODS

Second crop cultivation in paddy field is a way of increasing farmers income. Some second crops like clover, potato, canola and cabbage are usual in north of Iran. For this case this experiment was conducted at the Rice Research Institute of Iran-Deputy of Mazandaran (Amol) located in North of Iran (52°22' N, 36° 28' E, Altitude 28 m) during 2005 and 2006. After rice harvesting. The field was prepared for second crops cultivation. clover, potato, canola and cabbage were selected as a second crop. The soil total N and organic carbon contents were low, the available P and exchangeable K contents are medium (Table 1) cultivation of second crop was done as a experiment in Randomized Completely Block Design with three replications. Standard cultural practices like irrigation and weeding were carried out until each second crop was mature . After harvesting all of second crops the field was prepared for rice varieties cultivation. The plots related to second crop were divided in two sections and rice cultivation was done as a experiment in split plot in basis of Randomized Completely Block Design with three replications. Tarom variety as a traditional variety with yield average of 4 t ha^{-1} and Fajr variety as a improved variety with yield average of 6 t ha^{-1} were selected for this research. 100 kg N ha^{-1}, 50 kg P ha^{-1} and 70 kg K ha^{-1} were used in each plot. Cultural practices like weeding and irrigation were done in appropriate time. Rice varieties were transplanted in 20×20 cm planting space. Six hills (excluding border hills) were randomly selected from each plot prior to harvest for measured rice components. Grain yield was determined from harvest area of 5 m^2 adjusting to 14% moisture content. Harvesting of rice varieties were done at end of August All statistical tests (simple and combined analysis) were done using statistically analysis system (SAS, 1996) and mean value were compared by Duncan Multiple Rang Test (DMRT).

Table 1: Physical and chemical properties of the top soil in the experimental field at Iran Rice Research Institute

Soil parameters	
pH	7.500
Organic carbon (%)	0.730
Total N (%)	0.071
P available (mg kg^{-1})	9.800
K exchangeable (cmol$^+$$kg^{-1}$)	0.240
Textural class	Loam

RESULTS AND DISCUSSION

Results showed that year had significant effect on panicle length, 1000 grains weight, plant height and yield (Table 2). Total tiller influenced significantly by interaction effect of year × second crop at 5% probability level. Results indicated that variety had significant effect on plant height at 0.01 probability level (Table 2). Plant height, total tiller and yield influenced significantly by interaction of variety×year at 0.01 probability level. The most panicle length (27.7) and 1000 grains weight (22.4) were produced in 2005. Also the most plant height (138.6) and yield (4585.4) were obtained in 2006 (Table 3). According to results (Table 4) the most tiller numbers were produced after clover (19) and fallow (19.4) also the least tiller number was obtained after cultivated of canola (16.8). The most panicle length (28.5), total grain (153.4), total tiller (19.7) and yield (4566) were produced in Fajr variety (Table 5). Results showed that in interaction effect of fallow and Fajr variety the most total tiller (21.1) was produced. The most grain yield (5192) interaction effect of variety and year was produced in Fajr variety in year 2006 (Table 8).

Results showed that second crop cultivation in rice rotation had not significant effect on panicle length in each two years (Table 7). Panicle length usually not affected by environmental conditions and it seemed be a genetically characteristic (Hatami, 2002). Tiller number is a important component in grain yield of rice varieties (Islam and Hossain, 2002). Any factor that influenced this component can change rice yield (Hoseini, 2003). In this

Table 2: Mean squares of rice yield and yield components in rotation with second crop

SOV	df	Panicle length	Grain per panicle	Filled grain	1000 grain weight	Plant height	Total tiller	Yield
Year	1	44.1**	470.4ns	1.40ns	114.7**	5330.1**	0.02ns	11369577.0*
Rep×Year	6	1.7	709.1	0.28	0.7	17.2	20.90	1217963.6
Second crop	4	1.9ns	1980.1ns	0.24ns	3.9ns	131.7ns	20.30ns	317051.5ns
Year×second crop	4	5.5ns	740.4ns	0.82ns	1.2ns	44.7ns	18.70*	405310.1ns
E(b)	24	2.5	570.6	0.40	2.7	40.1	7.10	362184.8
Variety	1	195.3ns	43800.1ns	17.30ns	112.8ns	3408.9**	2.40ns	10230936.0ns
Variety×Year	1	5.5ns	955.6ns	0.50ns	9.1ns	165.3**	37.50**	4976552.6**
Variety×second crop	4	7.2ns	1800.1ns	1.10ns	3.8ns	42.5ns	0.86ns	357144.5ns
Second crop×year×variety	4	1.9ns	493.7ns	0.40ns	4.3ns	12.8ns	3.20ns	351049.9ns
Total Error	30	4.3	676.2	0.40	3.9	22.7	4.60	268832.4ns
CV		7.7	20.0	7.00	9.3	3.7	11.90	12.3

*: Significant; **: Highly significant; ns: Non significant

Table 3: Mean comparison of rice yield and yield components in different year

Year	Panicle length (cm)	Grain number	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
2005	27.7a	127.5a	76.6a	22.4a	122.2b	18.1a	3831.0ab
2006	26.4b	132.4a	72.2a	20.0b	138.6a	18.0a	4585.4a

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT

Table 4: Mean comparison of rice yield and yield components in different treatments

Treatments	Panicle length (cm)	Grain number	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
Potato	26.4a	115.8b	69.2a	21.5a	132.1a	17.9ab	4439.0a
Cabbage	27.0a	122.7ab	74.9a	21.5a	130.8a	17.1b	4097.0a
Canola	27.3a	142.2a	72.1a	20.4b	125.4a	16.8b	4101.3a
Clover	27.3a	139.5a	78.9a	24.4a	132.3a	19.0a	4169.4a
fallow	27.0a	129.6ab	76.1a	21.2a	131.4a	19.4a	4135.1a

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT

Table 5: Mean comparison of rice yield components in different varieties

Variety	Panicle length (cm)	Total grain	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
Tarom	25.4b	106.6b	83.4a	22.4a	150.1a	16.4b	3850.8b
Fajr	28.5a	153.4a	68.1b	20.0b	109.8b	19.7a	4566.0a

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT

Table 6: Interaction effect of second crop cultivation and rice variety on yield and yield components of rice varieties

Treatments	Panicle length (cm)	Total grain	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
a1v1	23.9d	95.6e	83.4ab	22.3a	153.6a	16.0de	4105.6abcd
a1v2	29.0a	136.0cd	61.2d	20.7ab	110.6c	19.8abc	4772.4a
a2v1	26.2bc	109.4de	85.1ab	22.9a	151.8a	15.6e	3937.6abcd
a2v2	27.7ab	136.1cd	70.5bcd	20.1ab	109.8c	18.7abc	4256.7abcd
a3v1	25.5cd	102.7e	82.3ab	22.2a	143.2b	15.3e	3595.1d
a3v2	29.0a	181.7a	72.9bcd	18.5b	107.6c	18.2bcd	4607.4ab
a4v1	25.9bc	111.4de	88.6a	22.6a	154.0a	17.7cde	3886.0bcd
a4v2	28.6a	167.6ab	69.8cd	20.3ab	110.6c	20.3ab	4452.7abc
a5v1	25.6cd	113.7de	82.1abc	21.8a	152.7a	17.6cde	3729.5cd
a5v2	28.3a	145.4bc	79.4abcd	20.5ab	110.2c	21.1a	4740.7a

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT, a_1 = Potato, a_2 = Cabbage, a_3 = Canola, a_4 = Clover, a_5 = Fallow, v_1 = Tarom, v_2 = Fajr

Table 7: Interaction effect of second crop cultivation and year on yield and yield components of rice varieties

Year	Second crop	Panicle length (cm)	Total grain	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
2005	a1	28.0a	121.4bc	73.3ab	22.7a	124.1c	19.5ab	4092.7abcde
2005	a2	28.0a	123.5bc	76.6ab	22.5a	125.2c	17.6abcd	3478.2e
2005	a3	27.6ab	129.7abc	73.0ab	22.0abc	116.1d	15.5d	3865.0cde
2005	a4	28.0a	134.4abc	83.4a	22.2a	122.4cd	18.7abc	3727.7de
2005	a5	27.0ab	128.7abc	75.5ab	22.2ab	123.4c	18.9abc	3992.2bcde
2006	a1	24.9c	110.2c	64.9b	20.2cd	140.1ab	16.3cd	4785.2a
2006	a2	26.0bc	122.0bc	73.1ab	20.5bcd	136.3ab	16.7bcd	4716.1a
2006	a3	26.9ab	154.7a	77.9ab	18.7d	134.7b	18.0abcd	4337.5abcd
2006	a4	26.6abc	144.6ab	72.9b	20.4cd	142.2a	19.2abc	4610.0ab
2006	a5	26.9ab	130.4abc	75.9ab	20.1d	139.5ab	19.9a	4478.0abc

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT

Table 8: Interaction effect of variety and year on yield and yield components of rice varieties

Year	Variety	Panicle length (cm)	Total grain	Filled grain (%)	1000 grain weight (g)	Plant height (cm)	Total tiller	Yield (kg ha^{-1})
2005	V1	25.9c	107.6b	84.6a	23.2a	141.5b	17.1b	3723.2b
2005	V2	29.5a	147.5a	72.0b	21.5b	103.0d	19.0a	3939.6b
2006	V1	27.9c	105.5b	82.3a	21.5b	170.7a	15.7c	3978.3b
2006	V2	27.5b	159.2a	67.2c	18.5	117.5c	20.3a	5192.4b

Means with similar letter(s) in each column are not significantly different at the 5% probability level according to DMRT

research, the tiller number of varieties were least after use of canola in paddy field. In this experiment canola had a negative effect on Tarom tiller number more than Fajr tiller number (Table 6). Analysis of some of these experiments have shown declining rice second crop yields (Cassman *et al*., 1995; Yadave *et al*., 2000; Duxbury *et al*., 2000) when a yield decline is maintained (Dawe *et al*., 2000), the major causes suggested as a gradual decline in the supply of soil organic matter content, atmospheric pollution pest and disease in festations and negative changes in the biochemical and physical composition of soil organic matter (Nambiar, 1995; Yadave *et al*., 2000). Fajr variety was seemed more sensitive to pests and diseases than Tarom variety. According to these results, Clover (*Trifolium alexandrinum*) can be a good second crops in rice rotation. Rodelas *et al*. (2004) got almost the similar results. They indicated that faba bean can be good crop in rotation with other crops because of its nitrogen fixation role. Yield of Fajr variety in 2005 is least than 2006 because in 2005 these varieties cultivated late. Tarom variety yield was not decreased, because this variety had a difference with Fajr variety in growth period. For these varieties, Rice-Clover-Rice and Rice-Fallow-Rice rotation systems for the best performance of rice yield in north of Iran's paddy field were recommended.

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