Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.7, 2015

Effect of Transplanting Dates on Yield and Yield Components of Various Rice Genotypes in Hilly Area Cold Climatic Region of Khyber Pakhtunlhwa-Pakistan

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Abstract
To study the effect of different transplanting dates on yield and yield components of rice genotypes in cold climatic region of hilly areas, two years consecutive experiments were conducted at Agriculture Research Institute (N) Mingora Swat, Pakistan, during summer 2012 and 2013. The experiments were laid out on randomized complete block design (RCBD) with four replications. Seven genotypes(PARC 403, OM5627,IR64,IR8225-9-3-2-3, CIBOGO,GA-5015,and FakhreMalakand) and 5 transplanting dates (D1= 25th May, D2= 9th June, D3= 24th June, D4= 9th July, and D5= 25th July) were used. The optimum 20 x 20 cm row to row and plant to plant distance was kept. On the basis of the result transplanting on either D2 (9th June) or D3(24thJune) gave maximum tiller plant^{-1}, panicle length, paddies panicle^{-1}, 1000 paddy weight and paddy yield in both yeas respectively. Transplanting on D5 decreased panicle length, paddies panicle^{-1}and paddy yield. While D1 and D4 were at par valued in respect of tiller plant^{-1}, Panicle length, 1000 paddy weight, and paddy yield respectively. Among the rice genotypes, FakhreMalakand produced highest tillers plant^{-1}(22.2 and 25.20), panicle length (21.8and 22.08 cm), paddies panicle^{-1}(197.7 and 212.1), 1000 paddy weight (19.2 and 20.11g) and paddy yield (6.49 and 5.55 t ha^{-1}) in both years while the genotype IR8225-9-3-2-3 was statistically at parin with Genotype Fakhremalakand in respect of paddy yield in year 2013. Other genotypes were statistically at par value in this order. On the basis of the above results, among the tested genotypes FakhreMalakand is recommended for transplanting on either June 9thor 24thin the agro-ecological conditions of hilly areas cold climatic regions of Khyber Pakhtunkhwa swat Pakistan.
Keywords: Rice (Oryza sativa L.), genotypes, transplanting dates,panicle,paddy, paddy yield, yield

INTRODUCTION

Rice (*Oryza sativa* L*)* is an important*kharif* crop of Pakistan ranking second to wheat as a staple food. Rice has gradually moved to occupy a predominant position in the agricultural economy of Pakistan. Pakistan is the world's 4thlargest producer of rice, after China, India and Indonesia. In Asia, it is the main itemof the diet of 3.5 billion people. Therefore, increase inpopulation will require 70 percent more rice in 2025than is consumed today (Kim and Krishnan, 2002).Traditionally, rice cultivation has been concentrated in the Khyber Pakhtunkhwa, central Punjab and the north western districts of Sindh. In Khyber Pakhtunkhwa rice cultivation stands next to wheat and maize and is characterized by being grown under two different agro climatic conditions, i.e., the plains and the upper mountainous valleys. Most of the cultivated area (81%) out of the total of 64719 ha is situated in the cooler, high altitude areas of Malakand and Hazara divisions and adjacent tribal areas of Khyber Pakhtunkhwa(NWFP agriculture statistics 2007-2008).The average rice yield in the country and particularly in Khyber Pakhtunkhwa is far behind what can be obtained from the potential of the crop. It may be attributed to many reasons.However, it is possible to double the average yield by adopting scientific crop production technologies. In Khyber Pakhtunkhwa 81% of the rice acreage lies in the high altitude, cold and mountainous areas, where cold damage to rice crop has been a problem to growers (NWFP agriculture statistics 2007-2008). The peculiar cooler climatic conditions encompass Malakand division, Hazara divisions; and high altitude of attached tribal areas and include categorical low air and water temperatures (Bashir *et al*., 2010). Water temperature remains 18^{o}C during the main growing season. Owing to this reason, the direct use of modern high yielding and fine basmati rice varieties has not been successful. Major impediments in higher rice yields are existing low temperature and sub-optimal cultural practices. Leaf yellowing, stunting in seedling and early vegetative stage, delayed heading and sterility in the reproductive stage are common consequences of cold stress. These conditions dictate the development of cold tolerant rice with appropriate production technologies for these cooler hilly areas(Bashir *et al*., 2010).Rice in Malakand division (34.5' to 36.0'N) is grown from an elevation of 800 to 1800 m above sea level. The lowest minimum air temperature varies from 8.5^{o}C to 18.5^{o}C during the rice growing season (May to October) with also large amount of precipitation in these months (Bashir *et al* ., 2010). Irrigation water is from the melting snow over the mountains in the river swat. The temperature of water in the river is below 15^{o}C in the rice season and the temperature of irrigation water depends on the distance from the main channel which rarely increases up to 18^{o}C in the rice fields. Therefore in the cold climate areas of the province cold damage to rice has been a problem to rice growers. Low air and water temperature are causing damage to the rice crop. Thus the modern high yielding rice varieties and the fine basmati types are not directly successful in the areas. Most coarse varieties (FakhreMalakand, JP5, Swat-1 and others) are grown in the cold climates, while basmati type (basmati 385 and others) are also cultivated in areas where the temperature is not so severe. The objective of the present study was to find out the most suitable time of transplanting of some rice genotypes in cold climatic regionof upper swat.

MATERIALS AND METHOD

To study the effect of different transplanting dates on yield and yield components of rice genotypes, two years consecutive study was conducted at the Agricultural Research Institute, (N) Mingora (Swat) Pakistan during*kharif* seasons 2012 and 2013. The design of the experiment was used randomized complete block design (RCBD) with four replications. During the experiments seven number of genotypes (PARC 403 (G1), OM5627 (G2),IR64 (G3),IR8225-9-3-2-3 (G4), CIBOGO (G5),GA-5015 (G6) and FakhreMalakand (G7) and 5 transplanting dates (D1= 25th May, D2= 9th June, D3= 24th June, D4= 9th July, and D5= 25th July) were used.The first date of sowing of all these genotypes was 25th April 2012.Dry bed method was used for nursery rising.Each genotype was sown in six rows in dry bed nursery.The germination percentage was above 90%.The nursery reached its optimum size up to 30 days and was ready for transplantation.

These genotypes were tested to find out the optimum dates for transplanting.

The field was well prepared and puddle. First transplantation was done on 25th May in both years. The fields were divided in uniform size of 3 meter in width and 10 meter in length. The optimum 20x20 cm row to row and plant to plant distance was kept.All the genotypes were transplanted in six rows with four replications. Each row was consisting of 15 plants. The field area of each genotype in each replication was 3.60 m^2. All the recommended agronomic practices were followed. The nursery of the second date was sown on 10th May in both years. The aforementioned nursery was transplanted on 9th June 2012 in 1st year and also in 2nd year of study by getting its optimum size. The standard row to row and plant to plant distance of 20x20 cm was maintained in all thefour replications. Datawere recorded on number of tillers plant^{-1}, panicle length (cm), numbers of paddy panicle^{-1}, 1000 paddy weight, paddy yield (t ha^{-1}). Number of tillers were recorded at physiological maturity in five randomly selected hill and then averaged. After harvesting, number of paddy panicle^{-1} was recorded by counting paddy in five randomly selected panicles in each subplot and then averaged.After threshing, thousand paddieswere selected randomly to record thousand paddy-weights with the help of electronicbalance form the produce of each subplot.Paddy yield was recorded with the help of electronic balance after threshing. Paddy yield thus obtained was then converted intotons ha^{-1}.

Data collected were analyzed statistically according to the procedure relevant to RCB design. Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Number of tillers plant^{-1}

Data regarding number of tillers plant^{-1} are presented in Table1. Analysis of the data showed that transplanting dates and genotypes significantly affected tillers plant^{-1}. The interaction of transplanting dates and genotypes (GxD) for tiller plant^{-1} was non-significant. Mean value of the dates showed that in both years(2012 and 2013) higher number of tiller plant^{-1} produced by genotypes transplanted on D2 and D3 having at par valued 20.33 tiller plant^{-1} in year 2012and 23.43 and 23.12 tillers plant^{-1} in year 2013 while the other transplanting dates were at par valuein both years having 18.19 tillers on D4 in 1st year whereas 21.19 tillers were produced on 2nd year followed by D5 17.66 (1st year) and 20.66 tiller plant^{-1} (2nd year) and D1 17.71tiller plant^{-1} in 1styear and 20.71 tillers in 2nd year study (2013). Rafi *et al*(2013) found that higher number of tillers plant^{-1} was recorded at 25th June. Among the genotypes “FakhreMalakand” produced maximum tillers plant^{-1}during both years (22.20 1st year and 25.20 2nd year tillers plant^{-1}) followed bygenotypes having at par value (G6=18.93, G5=18.80, G1=18.4, G2=18.26 and G3=18.26 number of tiller plant^{-1} in year 2012) except genotype “IR8225-9-3-2-3” which produced minimum tillers plant^{-1}(17.06tillers) whereas in next year (G6 = 21.93, G5= 21.8, G1= 21.4, G2= 21.26 and G4 = 21.06 in year 2013). The reason could be that too early and too late transplanting could not fulfill the required temperature and photoperiod for rice crop. Late transplant are sever to cold and effect plant growth and yield(Bashir *et al*., 2010).

Table 1: ***Number of tillers plant^{-1} of rice genotypes as affected by different transplanting dates***

Number of tillers plant^{-1}		
Transplanting Dates	Year 2012	Year 2013
25th May	**17.71b**	20.71b
9th June	**20.33a**	23.43a
24th June	**20.33a**	23.12a
9th July	18.19b	21.19b
25th July	17.66b	20.66b
LSD $_{(0.05)}$	**0.90**	**0.88**
Genotypes		
PARC 403	**18.40b**	21.40b
OM5627	18.26b	21.26b
IR64	18.26b	20.06c
IR8225-9-3-2-3	17.06c	21.06b
CIBOGO	18.80b	21.8b
GA-5015	18.93b	21.93b
FakhreMalakand	22.02a	25.20a
LSD $_{(0.05)}$	**1.07**	**1.12**
Interaction (D X G)	**ns**	**ns**

Means in the same category followed by different letters are significantly different at P ≤0.05 level.
ns = non-significant

Panicle length (cm)

Data regarding panicle length are presented in Table 2. Statistical analysis of the data showed that transplanting dates, genotypes and interaction between dates and genotypes (GxD) significantly affected panicle length. Table 2 showed that in year 2012 maximum at par valued panicle length was recorded on D3 and D2 produced 22.03 and 22.02 cm panicle length while in year 2013 the same dates of transplanting showed the same result having22.56 and 22.40 cm panicle length. Minimum Panicle length in both years was recorded on D5 having 19.76 cm and 17.62 cm panicle length in year 2012 and 2013. D1 and D4 produced at par valued panicle length in both years "19.46 and 19.20 cm in year 2012" whereas 19.12 and 19.63 cm in year 2013. Rafi *et al* (2013) reported that panicle length decreased with delayed transplanting. Reduction in panicle length might be due to climatic factor (temperature, photoperiod, optimum time of sowing etc) which leads the plants to early reproductive stage. Among genotypes "FakhreMalakandranked first in maximum panicle length producing during both years. The genotype Fakhr-e- Malakand produced 21.83 cm long panicle in year 2012 while 22.08cm long in year 2013 followed by genotype "IR8225-9-3-2-3" produced panicle length of 20.38 and 20.5 cm in both years. Minimum panicle length was recorded in genotypes "PARC403 and GA-5015" produced 19.55 and 19.7 cm panicle length in 1st year however 19.45 cm and 19.58 cm in 2nd year. These findings of the results are associated with those of Bashir *et al*., (2010). Who reported that panicle length was varied in all cultivars transplanted on different dates. Interaction revealed that minimum panicle length produced by genotype "PARC403" transplanted on D1 and D5 respectively in. Whereas maximum panicle length produced by genotype FakhreMalakand transplanted on D3 and D2.Differences in panicle length could be attributed to the genetic potential of thegenotypes and may have an environmental effect. It might be due to temperature stress because rice is sensitive to cold temperature which damagesthe crop growth.

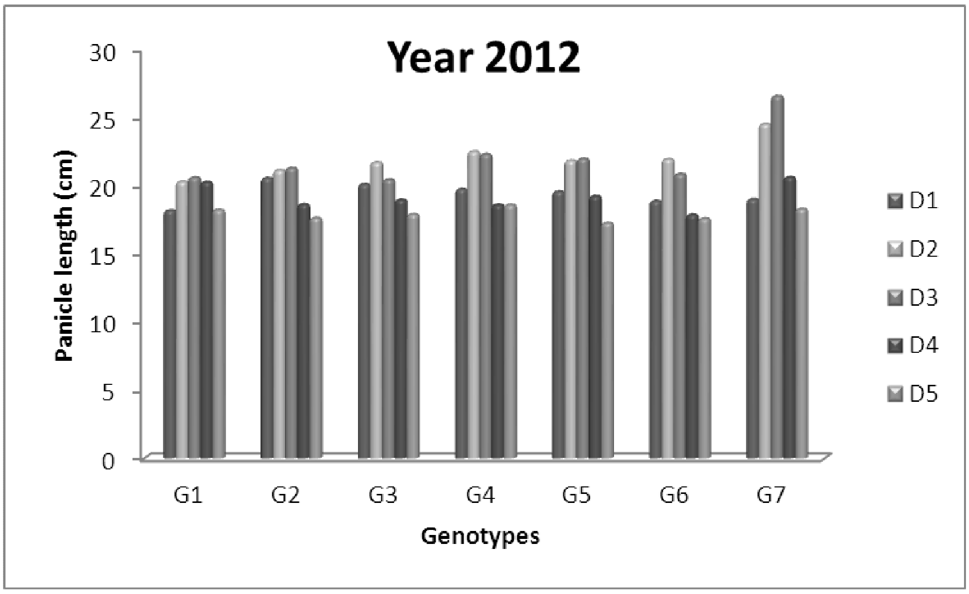

Fig: 1. Panicle length for the year 2012 of various rice genotypes as affected by different transplanting dates

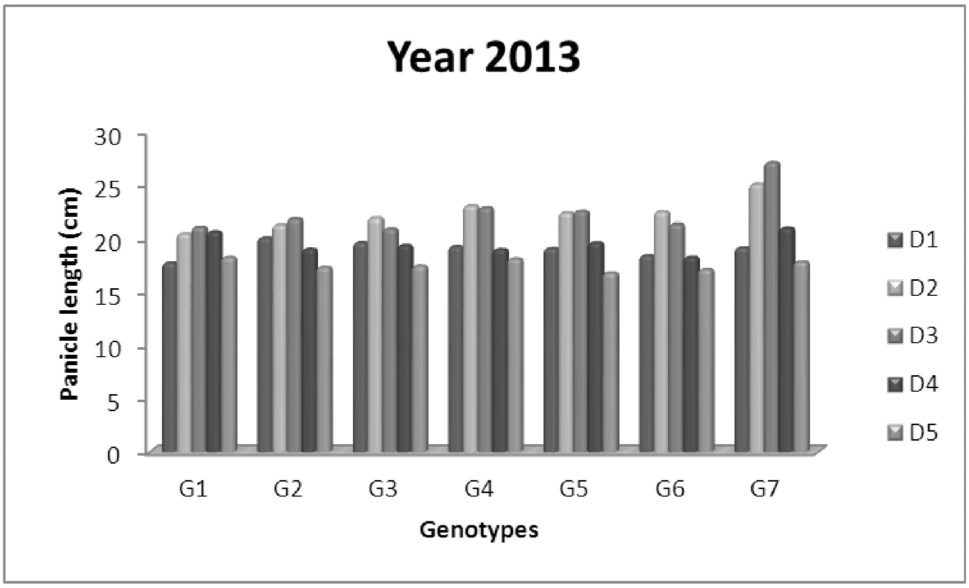

Fig: 2. Panicle length for theyear 2013 of various rice genotypes as affected by different transplanting dates

Table 2: ***Panicle length (cm)of rice genotypes as affected by different transplanting dates***

Panicle length (cm)		
Transplanting Dates	Year 2012	Year 2013
25th May	**19.46b**	19.12b
9th June	**22.02a**	22.40a
24th June	**22.03a**	22.56a
9th July	19.20b	19.63b
25th July	18.76c	17.62c
LSD $_{(0.05)}$	0.59	**0.63**
Genotypes		
PARC 403	**19.55c**	19.70c
OM5627	19.88bc	19.97bc
IR64	19.85bc	19.91bc
IR8225-9-3-2-3	20.38b	20.50b
CIBOGO	20.00bc	20.12bc
GA-5015	19.45c	19.58c
FakhreMalakand	21.83a	22.08a
LSD $_{(0.05)}$	0.70	**0.75**
Interaction (D X G)	1.57	**1.68**

Means in the same category followed by different letters are significantly different at P ≤0.05 level.
ns = non-significant

Paddy panicle^{-1}

Perusal of the data indicated that transplanting dates and genotypessignificantly affected number of paddy panicle^{-1}while interaction between dates and genotypes (GxD) was non-significant. Significant difference was recorded in paddy panicle^{-1} in both years in the substance of transplanting dates. Maximum at par paddy panicle^{-1} produced by D3 (193 paddies panicle^{-1}) followed by D2 and D1 produced 191 and 190 paddies in year 2012 whereas the standing state of stuffs was different in next year. In Next year (2013) maximum paddies panicle was recorded on D3 (202 paddies) followed by D4 (201paddies) while on the rest transplanting dates paddies panicle $^{-1}$ was found at par valued. Minimum paddies panicle^{-1} was recorded in D5 produced 176 and 185 paddies panicle^{-1} in both years.Bashir *et al* (2010) reported that number of paddy per panicle significantly affected by different transplanting dates.This might be due to temperature stress because rice is sensitive to cold temperature which damages the crop growth and seed filling duration. Among rice genotypes significant difference was found in respect of paddies panicle^{-1}. Maximum paddies produced by genotype FakhreMalakand (197.73 paddies) followed by at par value of the other sowed genotypes (PARC 403, OM5627,IR64,IR8225-9-3-2-3, CIBOGO and GA-5015), which produced 184.93, 184.47, 185.53, 181.73, and 183 paddies panicle^{-1} in 1st year (2012).In next year (2013) genotype PARC 403 contest with genotype FakhreMalakand in esteem of paddies panicle^{-1} produced 190 paddies panicle^{-1}. FakhreMalakand produced highest Paddies panicle^{-1}(212) while the other genotypesproduced at par valued paddies panicle^{-1}. These results are in line with those of Hussain*et al.* (2005). Who reported that maximum number of paddies panicle^{-1} was produced by line transplanted method and cultivar IRRI 6. This might be due genetic superiority, adaptation with climate, well adopted root system and well adopted leaf structure and canopy having optimum light absorption,nutrients uptake and synthesis of more carbohydrates.

Table 3: ***Paddies panicle^{-1} of rice genotypes as affected by different transplanting dates***

Number of paddies panicle^{-1}		
Transplanting Dates	Year 2012	Year 2013
25th May	**189.86a**	189.0b
9th June	**190.95a**	185.0b
24th June	**192.95a**	202.0a
9th July	181.05b	201.5a
25th July	176.14c	184.5b
LSD $_{(0.05)}$	3.76	**0.57**
Genotypes		
PARC 403	**184.93b**	187.9c
OM5627	184.47b	195.3b
IR64	185.53b	187.5c
IR8225-9-3-2-3	185.93b	187.2c
CIBOGO	181.73b	188.1c
GA-5015	183.00b	188.1c
FakhreMalakand	197.73a	212.1a
LSD $_{(0.05)}$	4.45	**0.67**
Interaction (D X G)	ns	**ns**

Means in the same category followed by different letters are significantly different at P ≤0.05 level.
ns = non-significant

Thousand paddy weight (g)

Analysis of the data showed that transplanting dates and rice genotypes significantly affected 1000 paddy weight in both years. Interaction between dates and genotypes (GxD) had non-significant effect on 1000 paddy weight Table 4. Maximum 1000 paddy weight was recorded in both years on D3 and D2 produced 18.16g and 18.15 g in 1st year (2012) whereas 19.06 and 19.05 gram in next year (2013) respectively. In both years (2012 and 2013) at par valued 1000 paddy weight was recorded on D1, D4 and D5.This indicated that the environmental conditions like temperature, photoperiod and humidity was most favorable for grain development during 9th June and 24th June as compared to other transplanting dates. The findings of the result are with conformity of Yawinder*et al.* (2006), Biswas and Salokhe (2001), Lu and Cai (2000) andMajid*et al.* (1989). They reported that early transplanting (15 June) hadthe highest 1000-grain weight and decreased when plantation of rice was delayed. The findings of these results are supported by Shah and Bhurer, (2005) and Mahmood*et al.,* (1995).They reported that 1000-grainweight decreased gradually with the delayed in planting time. Among rice genotypes maximum 1000 paddy weight was recorded in FakhreMalakand (19.21 and 20.11g) in years 2012 and 2013,followed by OM5627 produced 1000 paddy weight of 17.53 and 18.43g in both years respectively. While in both years study minimum at par value of 1000 paddy weight was recorded in the other sowed genotypes. Interaction revealed that minimum1000 paddy weight produced by genotype PARC403on D5. Whereas Maximum 1000 paddy weight produced by genotype FakhreMalakand (20.31g) on D3 followed by same genotype on D2. This might be due genotype superiority,appropriate temperature for growth and development, nutrients absorption, proper root system of the genotype and proper time of transplanting which leads to provide optimum duration for seed filling.

Table 4: ***Thousand paddies weight (g) of rice genotypes as affected by different transplanting dates***

Thousand paddies weight (g)		
Transplanting Dates	Year 2012	Year 2013
25th May	**16.90b**	**17.80b**
9th June	**18.15a**	**19.05a**
24th June	**18.16a**	**19.06a**
9th July	16.50b	17.40b
25th July	16.45b	17.35b
LSD $_{(0.05)}$	**0.56**	**0.57**
Genotypes		
PARC 403	**16.79c**	**17.69c**
OM5627	17.53b	18.43b
IR64	16.75c	17.65c
IR8225-9-3-2-3	16.72c	17.62c
CIBOGO	16.81c	17.71c
GA-5015	16.81c	17.71c
FakhreMalakand	19.21a	20.11a
LSD $_{(0.05)}$	**0.67**	**0.65**
Interaction (D x G)	**ns**	**ns**

Means in the same category followed by different letters are significantly different at P ≤0.05 level.
ns = non-significant

Paddy yield (t ha^{-1})

Analysis of the data showed that dates and rice genotypes significantly affected paddy yield whereas interaction between dates and genotypes (DxG) nonsignificantly affected paddy yield. Promising paddy yield was gave by D2 and D3 produced (5.65 and 5.53 t ha^{-1}) paddy yield followed by D4 and D1 gave 4.77 and 4.69 t ha^{-1} paddy yield in year 2012, While minimum paddy yield was recorded on D5 (4.12 t ha^{-1}). In year 2013 the yield data was quite different from the 1st year. Maximum paddy yield was noted on D3 (5.67 t ha^{-1}) followed by at par value D2 and D4 (5.39 and 5.24 t ha^{-1}). D4 and D1 were statistically at par with each other in respect of paddy yield (5.24 and 4.76 t ha^{-1}). Minimum paddy yield was observed on D5 (4.49 t ha^{-1}). This results might be due genotype superiority, appropriate temperature for growth and development, nutrients absorption, proper root system of the genotype and proper time of transplanting which leads to provide optimum duration for seed filling. Hwang *et al*., (1998).reported that paddy yieldsdeteriorated as planting date was delayed.These results are also in line with the findings of Shah and Bhurer (2005) who reported that June 15 seeding recorded significantly the highest paddy yield and decreased with the delay in planting time. These results are supported by Khakwani*et al.*, (2006). Who reported that highest paddy yields (4530, 4030 and 4530 kg ha^{-1}) were obtained in early transplanting.Significant differences were found among genotypes in both years. In year 2012 promising paddy yield produced by genotype FakhreMalakand 6.49 t ha^{-1} followed by at par value of the other sowed genotypes. In year 2013 maximum paddy yield was noted in genotype IR8225-9-3-2-3 (5.75 t ha^{-1}) having at par value with genotype FakhreMalakand (5.55 t ha^{-1}). Minimum paddy yield was recorded in genotype GA 5015 (4.83 t ha^{-1}). The reason could be that this might be due genotype genetic superiority, appropriate temperature for growth and development, nutrients absorption, proper root system of the genotype and proper time of transplanting which leads to provide optimum duration for seed filling.

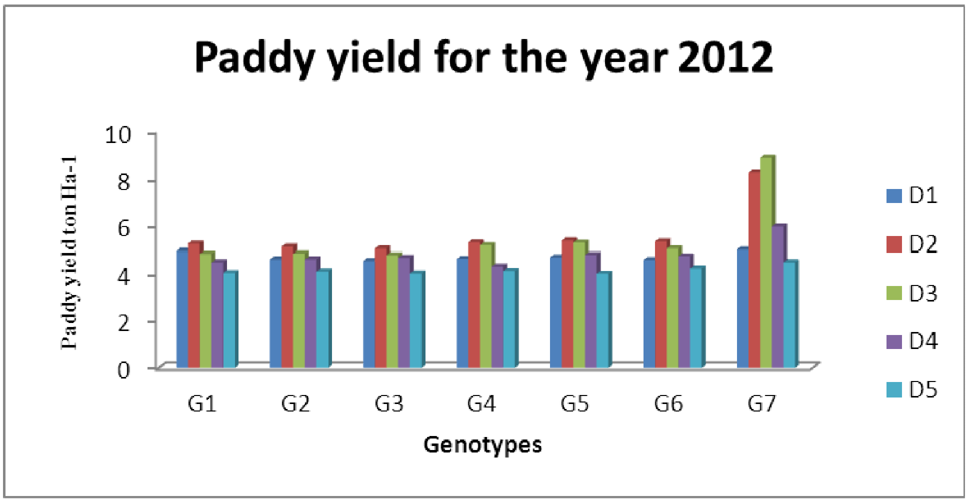

Fig: 3. Paddy yield for the year 2012 of various rice genotypes as affected by different transplanting date

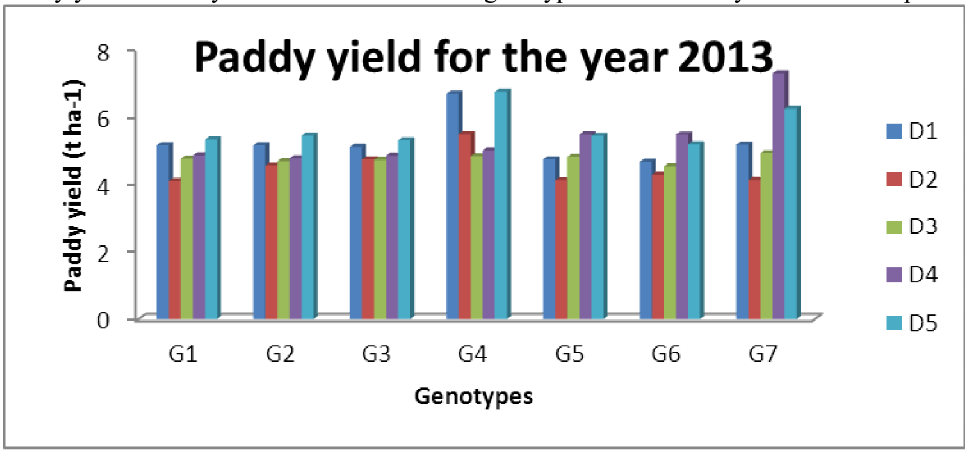

Fig: 4. Paddy yield for the year 2013 of various rice genotypes as affected by different transplanting dates

Table 5: ***Paddy yield (t ha^{-1}) of rice genotypes as affected by different transplanting dates***

Paddy yield (t ha^{-1})		
Transplanting Dates	Year 2012	Year 2013
25th May	**4.69b**	4.76bc
9th June	**5.65a**	5.39a
24th June	**5.53a**	5.67a
9th July	4.77b	5.24ab
25th July	4.12c	4.49c
LSD $_{(0.05)}$	**0.32**	**0.59**
Genotypes		
PARC 403	**4.69b**	4.84c
OM5627	4.63b	4.92bc
IR64	4.59b	4.95bc
IR8225-9-3-2-3	4.68b	5.75a
CIBOGO	4.81b	4.92bc
GA-5015	4.76b	4.83c
FakhreMalakand	6.49a	5.55ab
LSD $_{(0.05)}$	**0.37**	**0.70**
Interaction (D X G)	**ns**	**ns**

Means in the same category followed by different letters are significantly different at $P \leq 0.05$ level.
ns = non-significant

CONCLUSION AND RECOMMENDATIONS

It was concluded from the research that among the rice genotypes FakhreMalakand gave significantly higher tiller plant^{-1}, panicle length, paddies panicle^{-1} , 1000 paddy weight and paddy yield followed by statistically at par value of the IR8225-9-3-2-3and other sowed genotypes. Similarly, highest 1000 paddy weight, paddy panicle^{-1} and paddy yield were produced when transplanting was carried out on either 9th or 24th June as compared with 25th May, 9th July and 25th July. Therefore, on the basis of highest paddy yield, among the tested rice genotypes FakhreMalakand is recommended for transplanting on either June 9th or 24th in the agro-ecological condition of cold climatic hilly regions of Khyber Pakhtunkhwa swat Pakistan.

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