EFFECT OF PLANTING DATES ON BACTERIAL LEAF BLIGHT INCIDENCE AND YIELD PERFORMANCE OF RICE CULTIVARS IN DIFFERENT LOCATION OF KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

This paper presents studies on effect of planting dates on Bacterial leaf blight of rice during 2007 and 2008 at Swat and Mansehra Districts. Interaction of sowing dates x varieties indicated that both Fakhre Malakand and Basmati-385, showed a similar trend of high BLB in both years. Dilrosh-97 and Swat-1 resulted in increased BLB till 15th June and any further delay did not change disease incidence. Tillers plant^{-1} was reduced for all varieties at Mingora i.e. Dilrosh-97, Fakhre Malakand, JP-5 and Basmati-385 showed decreased tillers plant^{-1} when sowing was delayed at both locations and years. Sites, sowing dates and varieties, significantly influenced 1000 grain weight (g) at all locations. Mean value for this trait was greater at Bafa along with a Maximum grains panicle^{-1} during both years. Variety Fakhre Malakand produced heavier grains than all other varieties. Sowing dates x verities interaction indicated that 1000 grain weight was enhanced till 15th June in each variety tested but further delay in sowing resulted in decline in 1000 grain weight of all varieties at both location and years. Long panicles (cm) were observed at Bafa as compared to Mingora. Panicle length was drastically decreased when sowing was delayed for almost all tested varieties except JP-5 and Swat-1 during both years. Site, sowing dates and varieties significantly affected the grain yield. Mean values for rice verities showed that high grain yield was achieved for Fakhre Malakand, whereas, both Swat-1 and JP-5 resulted in lowest grain yield during both years and locations. In case of sowing dates, higher grain yield was recorded when planting was done on 15th June.

***Keywords: Xanthomonas oryzae* pv *oryzae*, Rice (*Oryza sativa*), Bacterial Leaf Blight, Management, Sowing Dates**

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INTRODUCTION

Xanthomonas oryzae pv. *oryzae (Xoo)* the causal agent of bacterial blight (BB) of rice, is one of the most economically important pathogens of rice worldwide (Mew, 1987). It is found in most irrigated, rainfed and tropical rice growing areas, including all Asian countries, West Africa, Australia, South America and the Caribbean (Mew *et al*., 1982, Mew 1987). Bacterial blight appears on leaves of young plants, as pale-green to grey-green water-soak streaks near the leaf tip and margins. These lesions coalesce and become yellowish-white with wavy edges. Eventually, the whole leaf may become whitish or grayish and then dies. Leaf sheaths and culms of highly susceptible cultivars may also be attacked. Systemic infection, known as kresek (Reddy, 1984), results in desiccation of leaves and death, particularly of young transplanted plants. In older plants, the leaves become yellow and then die. Blight of rice affect filling of the grains and emergence of panicles, about 28-30% yield reduction was observed in susceptible cultivars (Shahjahan *et al*., 1991). The disease may weaken the seedling and in older plants the loss of grain may be 4-29% (Bedi & Gill, 1960). There is a report of loss in rice crop due to blight up to 59-90% (Ghose *et al*., 1970). Bacterial leaf blight has the potential to become a destructive bacterial disease of rice in Pakistan and can cause huge losses mainly because of the lack of information regarding the pathogen and its effective measure of control (Waheed *et al*., 2009). In Pakistan, BB can reduce the yield up to 20 to 30% (Ou, 1985). The disease reduces grain yield to varying levels depending on the stage of the crop, degree of cultivar susceptibility and a great extent to the conduciveness of the environment in which it occurs (Akhtar *et al*., 2011).

It has been observed that regardless of providing similar agronomic conditions variation at a particular location and within locations can be observed. However, some of this could be managed thorough reducing experimental errors. The source of such variations may be due to genotype of the cultivar, existence of different pathogen

races, crop husbandry practices and suppressive or conducive environmental conditions. The optimal growing season of popular cultivars has been determined by testing their growth and yields at different sowing dates.

There are several reports that indicate that delaying sowing has altered qualitative as well as quantitative traits of a crop. In present studies two years data of Bafa, Mansehra and Mingora, Swat, expressed similar trends in terms of agronomic traits as well as BB severity percentage while major objective of the study was to investigate the effect of planting dates on BB incidence and yield performance of selected rice cultivars in different location of Khyber Pakhtunkhwa (KP). Our data indicate that sites and varieties significantly affected incidence of bacterial leaf blight and effects on certain plant parameters tillers plant^{-1}, grains panicle^{-1}, 1000 grains weight, panicle length (cm) and grain yield at Swat and Mansehra Districts.

MATERIALS AND METHODS

Effect of planting dates on BB incidence and Yield components in Rice

A two year multi-location study was conducted at Agricultural Research Institute Mingora (North) and Agricultural Research Station, Bafa Mansehra during 2007 and 2008. During each year, five rice cultivars including, Swat-1, Basmati-385, Dilrosh-97, Fakhr-e-Malakand and JP-5 were tested at three transplanting dates viz., June 5, June 15 and June 25 in four replicates in a split plot design. The row length was maintained at 2.5 meters with 20 cm plant – plant and 30 cm row – row distance. Planting dates were kept in main plots while cultivars served as sub plots. For each transplanting date, thirty day old seedlings of each variety were used. Fertilizer at the rate of 120:60:40 kg/ha NPK to the field in two split doses. 60:60:40 kg/ha NPK was applied at the time of transplanting and 60:0:0 kg/ha NPK after one month of transplanting. Data on BB severity were recorded twenty days after flowering (Booting). Data on yield and yield parameters were recorded at maturity. Disease severity was recorded according to the scale of Chaudhry (1996).

RESULTS AND DISCUSSION

Effect of planting dates on Bacterial leaf blight incidence in Rice

Data pertaining to bacterial leaf blight for the year 2007 and 2008 are shown in tables 3 and 4, respectively. Perusal of the data indicates that bacterial leaf blight was significantly affected by sowing dates and varieties, whereas the effect of sites was found non-significant during both years. All interactions were found non-significant except sowing dates x varieties during both years. Higher bacterial leaf blight was recorded for F. Malakand (17.92%) followed by basmati-385 (13.33%), whereas the lower incidence of bacterial leaf blight (7.05%) was observed in swat-1, although it was statistically similar to JP-5 and Dilrosh-97 during 2007 (Table 4.24). During 2008, a similar trend was observed and F. Malakand was found extremely prone to bacterial leaf blight (21.88), followed by Basmati-385 while the least amount blight was observed on Swat-1 (9.38%), which was at par with JP-5 and Dilrosh-97. Interaction between sowing dates x varieties indicated that rice varieties i.e. Dilrosh-97, and Swat-1 resulted in increase bacterial leaf blight till 15th June but further delay did not significantly increase.

Effect of planting dates on Rice Biomass

Tillers plant^{-1}

Two years data regarding tillers plant^{-1} are presented in Tables 1 and 2, for 2007 and 2008, respectively. Statistical analysis of the data revealed that there was an interactive effect of sites and varieties on tillers plant^{-1} during 2007. Conversely, sites during 2008 did not have a significant effect for tillers m^{-2}. On the other hand the effect of sowing dates was not significant on tillers plant^{-1} during both years. Interactions among sowing dates x varieties and sites x varieties were found significant during 2007 for tillers plant^{-1}. However, in 2008, interaction between sites and varieties was found non-significant. Interaction among sowing dates x sites, sites x sowing dates x varieties were not significant for tillers plant^{-1} in both years. Means indicated that higher number of tillers plant^{-1} were recorded in rice variety Dilrosh-97; although, it was at par with F. Malakand and Basmati-385, whereas a lower number of tillers plant^{-1} was recorded in JP-5, which was statistically similar to Swat-1 during both years. In case of sites, number of tillers plant^{-1} was higher at Bafa as compared to Mingora during both years. Sites and varieties interaction showed that tillers plant^{-1} were decreased for all varieties at Mingora as compared to Bafa and the maximum number of tillers plant^{-1} (29) were found for Dilrosh-97 at Bafa while lower number of tillers plant^{-1} (18) was recorded for the same variety at Mingora during 2007. Interaction between sowing dates x varieties indicated that rice varieties i.e. Dilrosh-97, F.Malakand, JP-5, and Basmati-385 showed decreased tillers plant^{-1} when sowing was delayed and higher number of tillers plant^{-1} was recorded at 25th June, whereas it was higher at 15th June during both years for the other two varieties.

Table 1. ***Tillers plant^{-1} affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2005.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	33.25	26.25	25.25	23.25	25.50	26.70
Bafa	**JUNE, 15**	27.00	26.25	22.25	22.50	27.50	25.10
	JUNE, 25	27.50	26.75	22.75	23.50	25.50	25.20
	JUNE, 05	18.12	19.65	22.70	17.70	22.38	20.11
Mingora	**JUNE, 15**	18.38	19.70	18.20	20.45	19.98	19.34
	JUNE, 25	16.13	19.68	14.40	16.62	16.85	16.74
		Site x Varieties					
Bafa		29.25	26.42	23.42	23.08	26.17	25.67
Mingora		17.54	19.67	18.43	18.26	19.73	18.73
		Sowing Dates x Varieties					
JUNE, 05		25.69	22.95	23.97	20.47	23.94	23.40
JUNE, 15		22.69	22.97	20.22	21.47	23.74	22.22
JUNE, 25		21.81	23.21	18.57	20.06	21.17	20.97
Means		23.40 a	23.05 a	20.92 b	20.67 b	22.95 a	

LSD (P≤0.05) for Sites = 1.43 (1.43), LSD (P≤0.05) for Sowing = 2.50 (2.50), LSD (P≤0.05) for Varieties = 1.531.53, LSD (P≤0.05) for S x SD= 3.06, LSD (P≤0.05) for S x V= 2.3, LSD (P≤0.05) for SD x V = 3.33, LSD (P≤0.05) for S x SD x V= 4.43

Table 2. ***Tillers plant^{-1} affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	27.25	20.25	19.25	17.25	19.50	20.70
Bafa	**JUNE, 15**	21.00	20.25	16.25	16.50	21.50	19.10
	JUNE, 25	21.50	20.75	16.75	17.50	19.50	19.20
	JUNE, 05	16.79	18.31	21.36	16.36	21.04	18.77
Mingora	**JUNE, 15**	17.04	18.36	16.86	19.11	18.64	18.00
	JUNE, 25	14.79	18.34	13.06	15.29	15.51	15.40
		Site x Varieties					
Bafa		23.25	20.42	17.42	17.08	20.17	19.67
Mingora		16.20	18.34	17.09	16.92	18.39	17.39
		Sowing Dates x Varieties					
JUNE, 05		22.02	19.28	20.31	16.81	20.27	19.74
JUNE, 15		19.02	19.31	16.56	17.81	20.07	18.55
JUNE, 25		18.14	19.54	14.91	16.39	17.51	17.30
Means		19.73 a	19.38 a	17.26 b	17.00 b	19.28 a	

LSD (P≤0.05) for Sites = 1.43, LSD (P≤0.05) for Sowing = 2.50, LSD (P≤0.05) for Varieties = 1.53, LSD (P≤0.05) for S x SD= 3.06, LSD (P≤0.05) for S x V= 2.3, LSD (P≤0.05) for SD x V = 3.33, LSD (P≤0.05) for S x SD x V= 4.43
Means followed by different letters in categories are significantly different at 5% level of probability

Table 3. ***Bacterial Leaf Blight (%) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2007.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	5.0	17.5	17.5	7.5	16.3	12.8
Bafa	**JUNE, 15**	10.0	17.5	6.3	8.8	11.3	10.8
	JUNE, 25	6.3	17.5	5.0	5.0	11.3	9.0
	JUNE, 05	6.3	18.8	16.3	7.5	17.5	13.3
Mingora	**JUNE, 15**	12.5	17.5	6.3	8.8	11.3	11.3
	JUNE, 25	5.0	21.3	6.3	5.0	13.8	10.3
			Site x Varieties				
Bafa			17.5	9.6	7.1	12.9	10.8
Mingora			19.2	9.6	7.1	14.2	11.6
			Sowing Dates x Varieties				
JUNE, 05			18.1	16.9	7.5	16.9	13.0 a
JUNE, 15			17.5	6.3	8.8	11.3	11.0 ab
JUNE, 25			19.4	5.6	5.0	12.5	9.6 b
Means			18.3 a	9.6 c	7.1 c	13.5 b	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for Sites = 3.45, LSD (P≤0.05) for Sowing = 2.92, LSD (P≤0.05) for Varieties = 3.08, LSD (P≤0.05) for S x SD= 4.42, LSD (P≤0.05) for S x V= 4.88, LSD (P≤0.05) for SD x V = 5.47, LSD (P≤0.05) for S x SD x V= 7.93,

Grains panicle^{-1}

Data regarding grains panicle^{-1} during the year 2007 and 2008 are shown in Tables 5 and 6, respectively. During each year, sites and varieties significantly affected grains panicle^{-1}. The effect of sowing dates was however non-significant. None of the interactions was significant except interaction between sowing dates and varieties. Higher grains panicle^{-1} was recorded at Bafa as compared to Mingora. In case of varieties, higher number of grains panicle^{-1} was found in rice variety JP-5, followed by Basmati-385, which were statistically at par. Lower grains panicle^{-1} were counted in Dilrosh-97; which was at par with Swat-1. Interaction between sowing dates and varieties showed that grains panicle^{-1} decreased with delay in sowing for variety Dilrosh-97, whereas rice varieties Basmati-385 and Swat-1 produced maximum number of grains panicle^{-1} by 25th June. Higher number of grains panicle^{-1} in F. Malakand was recorded on 15th June, whereas in case of JP-5 higher number of grains panicle^{-1} was recorded on 5th June.

Table 4. ***Bacterial Leaf Blight (%) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	10.00	22.50	22.50	12.50	21.25	17.75
Bafa	**JUNE, 15**	15.00	22.50	11.25	13.75	16.25	15.75
	JUNE, 25	11.25	22.50	10.00	10.00	16.25	14.00
	JUNE, 05	10.00	25.00	15.00	5.00	25.00	16.00
Mingora	**JUNE, 15**	12.00	17.50	7.50	10.00	12.50	12.00
	JUNE, 25	5.00	21.25	7.50	5.00	13.75	10.50
		Site x Varieties					
Bafa		12.08	22.50	14.58	12.08	17.92	15.83
Mingora		9.17	21.25	10.00	6.67	17.08	12.83
		Sowing Dates x Varieties					
JUNE, 05		10.00	23.75	18.75	8.75	23.12	16.88 a
JUNE, 15		13.75	20.00	9.38	11.88	14.38	13.88 b
JUNE, 25		8.12	21.88	8.75	7.50	15.00	12.25 b
Means		10.62 c	21.88 a	12.29 c	9.38 c	17.50 b	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for Sites = 3.14, LSD (P≤0.05) for Sowing dates = 2.65, LSD (P≤0.05) for Varieties = 2.91, LSD (P≤0.05) for S x SD= 4.02, LSD (P≤0.05) for S x V= 4.54, LSD (P≤0.05) for SD x V = 5.12, LSD (P≤0.05) for S x SD x V= 7.41

1000 grain weight

Data regarding thousand grain weights (g) are presented in Tables 7 and 8, for both the years. Sites, sowing dates and varieties, significantly influenced 1000 grain weight during 2007. All interactions were non-significant except interaction between sowing dates and varieties. Mean values indicated that greater 1000-grain weight was produced at Bafa as compared to Mingora. Comparing different rice varieties, it was observed that heavier grains were recorded in rice variety F. Malakand followed by Dilrosh-97, whereas lighter grains were recorded for Swat-1. Interaction between sowing dates and varieties showed that 1000 grain weight was enhanced till 15th June in each variety but further delay in sowing resulted in decline in 1000 grain weight for all rice varieties, although the increase was higher in both F. Malakand and Dilrosh-97. For the year 2008, on the other hand the effect of varieties was significant whereas sowing dates and sites did not considerably alter 1000 grain weight of rice. None of the interactions was found significant for 1000 grain weight during 2008. Comparing different rice varieties during 2008, revealed that greater 1000-grain weight was recorded for F.Malakand, which was at par with Dilrosh-97, and basmati-385, whereas minimum 1000-grain weight was observed in Swat-1, while it was statistically similar to JP-5.

Panicle length

Perusal of the data exhibited that sites had a significant effect on panicle length, whereas the effect of sowing dates and varieties was nonsignificant during 2007. None of the interactions was found significant except interaction between sowing dates and varieties for panicle length. By comparing both sites, it was obvious that longer panicles were observed at Bafa as compared to Mingora (Tables 9 and 10). Interaction between sowing dates and varieties showed that panicle length decreased when sowing was delayed for rice varieties Dilrosh-97, F.Malakand and Basmati-385, whereas JP-5 and Swat-1 resulted in a higher panicle length when sowing was delayed during both years.

Grain Yield

Tables 11 and 12 shows grain yield (tones ha^{-1}) during 2007 and 2008, respectively. Sites, sowing dates and varieties significantly affected grain yield. Interactions among sowing dates x varieties, sites x varieties, sites x sowing dates and sites x sowing dates x varieties were found significant during both the years. Means values for

rice varieties showed that higher grain yield was achieved for varities F. Malakand followed by Dilrosh-97, whereas both Swat-1 and JP-5 resulted in the lowest grain yield during both years. Greater grain yield was observed at Bafa as compared to Mingora for both years. In case of sowing dates, higher grain yield was produced when planting was done on 15th June, while lower grain yield was recorded for early sowing (5th June).

Table 5. ***Grains panicle^{-1} affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2007***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	186.0	195.2	233.8	188.2	219.5	204.6
Bafa	**JUNE, 15**	184.0	209.0	221.2	179.2	215.5	201.8
	JUNE, 25	181.0	194.5	227.2	204.2	225.2	206.5
	JUNE, 05	169.3	178.5	217.0	171.5	202.8	187.8
Mingora	**JUNE, 15**	167.3	192.2	204.5	162.5	198.8	185.1
	JUNE, 25	164.2	177.7	210.5	187.5	208.5	189.7
		Site x Varieties					
Bafa		183.7	199.6	227.4	190.6	220.1	204.3
Mingora		166.9	182.8	210.7	173.8	203.3	187.5
		Sowing Dates x Varieties					
JUNE, 05		177.6	186.9	225.4	179.9	211.1	196.2
JUNE, 15		175.6	200.6	212.9	170.9	207.1	193.4
JUNE, 25		172.6	186.1	218.9	195.9	216.9	198.1
Means		175.3 c	191.2 b	219.0 a	182.2 c	211.7 a	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 11.90, LSD (P≤0.05) for sowing dates = 12.80, LSD (P≤0.05) for varieties = 7.45, LSD (P≤0.05) for S x SD= 17.53, LSD (P≤0.05) for S x V= 14.10, LSD (P≤0.05) for SD x V = 16.66, LSD (P≤0.05) for S x SD x V= 23.42

Table 6. ***Grains panicle^{-1} affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	171.5	180.8	219.2	173.8	205.0	190.1
Bafa	**JUNE, 15**	169.5	194.5	206.8	164.8	201.0	187.3
	JUNE, 25	166.5	180.0	212.8	189.8	210.7	191.9
	JUNE, 05	147.0	156.2	194.8	149.2	180.5	165.6
Mingora	**JUNE, 15**	145.0	170.0	182.2	140.2	176.5	162.8
	JUNE, 25	142.0	155.5	188.2	165.2	186.2	167.4
		Site x Varieties					
Bafa		169.2	185.1	212.9	176.1	205.6	189.8
Mingora		144.7	160.6	188.4	151.6	181.1	165.3
		Sowing Dates x Varieties					
JUNE, 05		159.2	168.5	207.0	161.5	192.8	177.8
JUNE, 15		157.3	182.2	194.5	152.5	188.8	175.1
JUNE, 25		154.3	167.8	200.5	177.5	198.5	179.7
Means		156.9 c	172.8 b	200.7 a	163.8 c	193.3 a	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 19.04, LSD (P≤0.05) for sowing dates = 12.80, LSD (P≤0.05) for varieties = 7.45, LSD (P≤0.05) for S x SD= 22.08, LSD (P≤0.05) for S x V= 20.02, LSD (P≤0.05) for SD x V = 16.66, LSD (P≤0.05) for S x SD x V= 26.7

Interaction between Sites x varieties indicated that the least grain yield was obtained for all varieties at Mingora as compared to Bafa. Greater grain yield was recorded for Dilrosh-97 at Bafa but lower for swat-1 at Mingora during both years. Interaction between sowing dates and varieties exhibited that Dilrosh-97, F. Malakand and JP-5 varieties yielded better when sowing was delayed from 5 June to 15th June but further delay in sowing resulted in lower grain yield, whereas delay in sowing upto 25th June for Swat-1 and Basmati-385 resulted in increased grain yield during both years. Sites x sowing dates interaction showed that grain yield was enhanced with delay in sowing from first to third sowing at Bafa, but at Mingora, the increase was noted up to 15th June and further delay upto 25th June resulted in reduced grain yield. Interaction between sites x sowing dates x varieties revealed that grain yield increased with delay in sowing till 15th June for each of varities Swat-1, Basmati-385 and F.Malakand at Bafa, whereas delay in sowing resulted in decline in grain yield for JP-5 at Bafa. Delay in planting up to 15th June for Dilrosh-97 gave better grain yield at Bafa. At Mingora, all rice varieties planted on 15th June resulted in higher grain yield.

Bacterial leaf blight is one of the most significant stresses in Rice. Manipulating planting dates along with pyramiding disease resistance in high yielding rice cultivars can potentially minimize losses to bacterial blight. Furthermore, a comprehensive study on yield potential of commercially grown rice cultivars with and without

disease pressure on a larger scale is required to fully elucidate the interaction among rice cultivars, planting dates and the role of Xoo in yield losses.

Table 7. 1000 grains weight (g) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2007

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	17.34	18.54	15.59	15.06	16.39	16.58
Bafa	**JUNE, 15**	18.36	19.79	16.31	15.59	17.27	17.46
	JUNE, 25	17.39	18.61	15.63	15.07	16.44	16.63
	JUNE, 05	14.39	15.59	12.64	12.11	13.69	13.68
Mingora	**JUNE, 15**	15.66	17.09	13.61	12.89	14.58	14.77
	JUNE, 25	14.69	15.91	12.93	12.37	13.74	13.93
		Site x Varieties					
Bafa		17.70	18.98	15.84	15.24	16.70	16.89
Mingora		14.92	16.19	13.06	12.46	14.00	14.13
		Sowing Dates x Varieties					
JUNE, 05		15.86	17.06	14.11	13.59	15.04	15.13 b
JUNE, 15		17.01	18.44	14.96	14.24	15.93	16.12 a
JUNE, 25		16.04	17.26	14.28	13.72	15.09	15.28 b
Means		16.31 b	17.59 a	14.45 d	13.85 e	15.35 c	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 1.30, LSD (P≤0.05) for sowing dates = 0.38, LSD (P≤0.05) for varieties = 0.06, LSD (P≤0.05) for S x SD= 1.31, LSD (P≤0.05) for S x V= 1.36, LSD (P≤0.05) for SD x V = 0.39, LSD (P≤0.05) for S x SD x V= 1.31

Table 8. ***1000 grains weight (g) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	17.15	18.34	15.39	14.87	16.19	16.93
Bafa	**JUNE, 15**	18.17	19.59	16.12	15.39	17.08	17.27
	JUNE, 25	17.20	18.41	15.44	14.87	16.25	16.43
	JUNE, 05	17.63	18.88	13.87	14.12	17.65	16.43
Mingora	**JUNE, 15**	17.15	16.45	15.95	15.20	16.45	16.24
	JUNE, 25	16.95	13.70	17.70	16.95	15.95	16.25
		Site x Varieties					**Means**
Bafa		17.50	18.78	15.65	15.04	16.51	16.70
Mingora		17.24	16.34	15.84	15.43	16.68	16.31
		Sowing Dates x Varieties					**Means**
JUNE, 05		17.39	18.61	14.63	14.50	16.92	16.41
JUNE, 15		17.66	18.02	16.03	15.30	16.76	16.75
JUNE, 25		17.07	16.06	16.57	15.91	16.10	16.34
Varieties		17.37 a	17.56 a	15.75 bc	15.23 c	16.59 ab	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 2.19, LSD (P≤0.05) for sowing dates = 1.26, LSD (P≤0.05) for varieties = 1.14, LSD (P≤0.05) for S x SD= 2.43, LSD (P≤0.05) for S x V= 2.45, LSD (P≤0.05) for SD x V = 2.12, LSD (P≤0.05) for S x SD x V= 3.38

Table 9. ***Panicle Length (cm) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2007.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	27.00	28.00	23.00	23.25	27.25	25.70
Bafa	**JUNE, 15**	26.75	26.25	25.75	25.00	26.25	26.00
	JUNE, 25	26.75	23.50	27.50	26.75	25.75	26.05
	JUNE, 05	23.73	24.73	19.73	19.98	23.50	22.33
Mingora	**JUNE, 15**	23.00	22.30	21.80	21.05	22.30	22.09
	JUNE, 25	22.80	19.55	23.55	22.80	21.80	22.10
		Site x Varieties					
Bafa		26.83	25.92	25.42	25.00	26.42	25.92
Mingora		23.18	22.19	21.69	21.28	22.53	22.17
		Sowing Dates x Varieties					
JUNE, 05		25.36	26.36	21.36	21.61	25.38	24.02
JUNE, 15		24.88	24.28	23.78	23.03	24.28	24.05
JUNE, 25		24.78	21.53	25.53	24.78	23.78	24.08
Means		25.00	24.05	23.55	23.14	24.48	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 2.70, LSD (P≤0.05) for sowing dates = 1.74, LSD (P≤0.05) for varieties = 1.62, LSD (P≤0.05) for S x SD= 3.08, LSD (P≤0.05) for S x V= 3.14, LSD (P≤0.05) for SD x V = 2.98, LSD (P≤0.05) for S x SD x V= 4.58

Table 10. ***Panicle length (cm) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	26.25	26.50	23.00	23.25	27.25	25.25
Bafa	**JUNE, 15**	26.25	26.00	25.75	25.00	26.25	25.85
	JUNE, 25	26.25	23.00	27.50	26.75	25.50	25.80
	JUNE, 05	23.73	24.73	19.73	19.98	23.50	22.33
Mingora	**JUNE, 15**	23.00	22.30	21.80	21.05	22.30	22.09
	JUNE, 25	22.80	19.55	23.55	22.80	21.80	22.10
		Site x Varieties					
Bafa		26.25	25.17	25.42	25.00	26.33	25.63
Mingora		23.18	22.19	21.69	21.28	22.53	22.17
		Sowing Dates x Varieties					
JUNE, 05		24.99	25.61	21.36	21.61	25.38	23.79
JUNE, 15		24.63	24.15	23.78	23.03	24.28	23.97
JUNE, 25		24.53	21.28	25.53	24.78	23.65	23.95
Means		24.71	23.68	23.55	23.14	24.43	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 2.61, LSD (P≤0.05) for sowing dates = 1.72, LSD (P≤0.05) for varieties = 1.57, LSD (P≤0.05) for S x SD= 3.01, LSD (P≤0.05) for S x V= 3.04, LSD (P≤0.05) for SD x V = 2.89, LSD (P≤0.05) for S x SD x V= 4.44

Two years data of Bafa, Mansehra and Mingora, Swat, expressed similar trends in terms of agronomic traits as well as BB severity percentage. Cultivars attain maximum benefits of prolonged photoperiodic exposure when planted earlier.

Both, locations are situated in semi-temperate zones of KP where winter starts earlier than plains and as such rice cultivars sensitivity to low temperature is a problem. Maximum number of grains panicle^{-1} in Bafa than at Mingora may be due the favorable climatic condition for growth and thus ultimately gave more number of grains panicle^{-1}.

Table 11. ***Grain yield (tones ha^{-1}) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2007.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	7.89	7.33	6.93	5.38	4.27	6.36
Bafa	**JUNE, 15**	9.14	7.19	5.66	6.57	5.66	6.85
	JUNE, 25	5.95	8.08	5.38	9.83	8.30	7.51
	JUNE, 05	3.42	6.54	3.17	2.54	4.96	4.13
Mingora	**JUNE, 15**	7.42	10.75	6.17	4.29	7.08	7.14
	JUNE, 25	5.71	6.79	5.63	3.83	5.25	5.44
		Site x Varieties					
Bafa		7.66	7.53	5.99	7.26	6.08	6.90
Mingora		5.51	8.03	4.99	3.56	5.76	5.57
		Sowing Dates x Varieties					
JUNE, 05		5.65	6.94	5.05	3.96	4.61	5.24 c
JUNE, 15		8.28	8.97	5.92	5.43	6.37	6.99 a
JUNE, 25		5.83	7.43	5.50	6.83	6.78	6.47 b
Means		6.59 b	7.78 a	5.49 d	5.41 d	5.92 c	

Means followed by different letters in categories are significantly different at 5% level of probability
LSD (P≤0.05) for sites = 0.35, LSD (P≤0.05) for sowing dates = 0.28, LSD (P≤0.05) for varieties = 0.33, LSD (P≤0.05) for S x SD= 0.44, LSD (P≤0.05) for S x V= 0.51, LSD (P≤0.05) for SD x V = 0.57, LSD (P≤0.05) for S x SD x V= 0.82

The reason for higher number of grains panicle^{-1} in JP-5 and Basmati-385 may be due their difference in genetic potential from other varieties since grains panicle^{-1} is a genetic character.

In both the years 2007 and 2008 results regarding grain yield proved 15th June as best sowing date. The increase in grain yield on 15th June might be associated with lower bacterial leaf light incidence as compared to 5th June during both the years and sites. Similarly, greater grain yield at Bafa than at Mingora may be ascribed to the favorable climate at the former than the latter for all the rice varieties during both years. Differences in grain yield of various rice cultivars may be due to their genetic make up and potential under suitable climate of both regions. The second seeding crop (15th June) benefited from improved sunshine and suitable temperature that ultimately gave higher grain yield in both years for all varieties except Swat-1 and Basmati-385, which resulted in greater grain yield with delay in seeding upto 25th June at both sites. From the present research it can be

concluded that early sowing proved better across locations in terms of agronomic traits as well as reduced disease and could be an option for disease management.

Table 12. ***Grain yield (tones ha^{-1}) affected by sowing dates and varieties of rice at Mansehra (Bafa) and Mingora during 2008.***

Sites	Sowing dates	Rice Varieties					S x SD
		Dilrosh-97	F. Malakand	JP-5	Swat-1	Bas-385	
	JUNE, 05	7.63	7.10	6.63	5.06	4.04	6.09
Bafa	**JUNE, 15**	8.85	6.93	5.45	6.36	5.45	6.61
	JUNE, 25	5.74	7.87	5.17	9.62	8.09	7.30
	JUNE, 05	3.29	6.41	3.04	2.41	4.83	4.00
Mingora	**JUNE, 15**	7.29	10.62	6.04	4.16	6.95	7.01
	JUNE, 25	5.58	6.66	5.50	3.70	5.12	5.31
		Site x Varieties					
Bafa		7.41	7.30	5.75	7.02	5.86	6.67
Mingora		5.38	7.90	4.86	3.43	5.63	5.44
		Sowing Dates x Varieties					
JUNE, 05		5.46	6.75	4.83	3.74	4.44	5.04 c
JUNE, 15		8.07	8.78	5.75	5.26	6.20	6.81 a
JUNE, 25		5.66	7.26	5.33	6.66	6.61	6.30 b
Means		6.40 b	7.60 a	5.30 d	5.22 d	5.75 c	

Means followed by different letters in categories are significantly different at 5% level of probability.
LSD (P≤0.05) for sites = 0.40, LSD (P≤0.05) for sowing dates = 0.29, LSD (P≤0.05) for varieties = 0.33, LSD (P≤0.05) for S x SD= 0.48, LSD (P≤0.05) for S x V= 0.53, LSD (P≤0.05) for SD x V = 0.57, LSD (P≤0.05) for S x SD x V= 0.84

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