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YIELD AND GROWTH RESPONSE OF RAPESEED (*BRASSICA NAPUS* L.) MUTANTS TO DIFFERENT SEEDING RATES AND SOWING DATES

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Abstract

The effect of various seeding rates and seeding dates on the agronomic performance of four rapeseed genotypes (three advanced mutants and one commercial variety) was studied for two consecutive years. The results showed that seeding rates did not affect plant height but influenced maturity significantly and plots seeded with 4 kg ha^{-1} matured earlier than rest of the plots. Significant differences in mean values of rapeseed genotypes with respect to physiological maturity were also observed and RM-152-2 matured significantly earlier than rest of the entries. The yield data showed that only RM-182 significantly out yielded the check (Pak Cheen) at different seed rates. Also the yield tended to increase with an increase in seed rate up to 10 kg ha^{-1}, above which a slight decrease was noted. The lowest yields were obtained at the lowest seed rate. The interaction between the seed rates and genotypes was significant at $P \leq 0.05$. The results of seeding date experiment revealed that plant height was reduced as sowing was delayed (except 15 October). The genotypes, however, did not differ significantly in plant height when averaged over sowing dates. They also did not differ significantly in days taken to maturity, nevertheless, plots sown early (on 15 September) matured earlier than other plots. It was also observed that delayed sowing beyond 25 October resulted in forced maturity, which adversely affected yield. The interaction of seeding dates and genotypes was significant at $P \leq 0.05$. The yield results revealed that the highest yields were obtained in plots sown on 25 September and 5 October beyond that gradual reduction in yield was noted. The lowest yields were obtained from plots sown on 14 November, the last sowing date. All the mutants produced significantly higher yield than the check. Based on the results of these experiments over two years, it is concluded that seed rates and time of sowing had significant influence on yield and growth of rapeseed. A seed rate of 8 kg ha^{-1} and sowing between 25 September and 15 October is, therefore, recommended for obtaining higher yields of rapeseed genotypes.

Introduction

Pakistan has made significant improvement in the development of Agriculture sector but the acute shortage of edible oil has persisted unabated for the past many years. Edible oil is one of the major commodities of total national imports and number one among the food items. The total domestic requirement of edible oil during 2006-07 stood at 3.107 million tons, out of which 0.857 million tons was locally produced and rest (1.787 million tons) was imported to meet the short fall, which cost the national exchequer huge sum of Rs. 83.874 billion during 2006-2007 (Anon., 2007; Anon., 2008). The national requirement of edible oil is going to increase even further in the coming years due to high population growth rate and increase in per capita consumption. This huge import bill can only be reduced by increasing the domestic oilseed production.

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Rapeseed (*Brassica napus* L., and *Brassica campestris* L.) and mustard (*Brassica juncea* L.) are the important oilseed crops throughout the world which rank third among the oilseed crops after soybean and oil palm in production of vegetable oils, while fifth in the production of oilseed proteins (Anon., 1995; Kauser *et al.,* 2006)). Rapeseed and mustard are also important oilseed crops of Pakistan. The share of these crops in total area and production of all oilseed crops grown in the country (excluding cotton seed, which is primarily grown as a fiber crop) is over 31% and 28% respectively (Anon., 2006). The area and production of canola (*Brassica napus* L.) has increased from 34,000 ha and 43,000 tons in 2000-01 to 145,000 ha and 180,000 tons, respectively during 2006-07, showing an increase of over 300% in both area and production of canola (Anon., 2008).

Canola is relatively a new crop in Pakistan and information regarding its production technology is important for increasing grower's productivity and profitability. Appropriate sowing time and seeding rates are important determinants of yield in canola (Robertson *et al*. 1999). The development of an improved production technology is essential for the adoption of new varieties on commercial scale as new varieties, due to their specific genetic make up, respond differently to increase or decrease in seed rates and delay in sowing time. The present study was, therefore, undertaken to determine effects of different seeding rates and dates on the agronomic performance of newly evolved high yielding rapeseed mutants, so that recommendation for optimum seeding rate and sowing time could be made for achieving higher productivity.

Materials and Methods

Four rapeseed/canola (*Brassica napus* L.) genotypes *viz*., RM-152-2, RM-182, RM-159-2 (advanced mutant lines) and Pak Cheen (local commercial variety as control) were used in this study. Six seed rates from 2 to 12 kg ha^{-1} with a difference of 2 kg between each were tried. In another experiment, same genotypes were sown from 15 September to 14 November on seven seeding dates, with an interval of 10 days between each sowing. Split plot design based on randomized complete blocks with three replications was used for these experiments, wherein seed rates and seeding dates were put in the main plots and genotypes in the subplots, respectively. The subplot size was 5.4 m^2 containing 6 rows, 3 m long and 30 cm apart in both the experiments. Data on plant height were recorded at maturity on 5 randomly selected plants. The data on physiological maturity were recorded from sowing to harvesting of the plots. At maturity four central rows were harvested and data on yield per plot were recorded; this was later converted into yield per hectare. Statistical analysis of data was done according to procedure outlined by Gomez & Gomez (1984).

Results and Discussion

The results of seeding rate experiment (Tables 1-3) showed that seeding rates did not affect plant height significantly as no significant differences were found among the different treatments as well as among genotypes. However, significant differences in mean values of physiological maturity of rapeseed genotypes were observed. RM-152-2 matured significantly earlier than rest of the entries. Different seed rates also had significant influence on physiological maturity and plots seeded with 4 kg ha^{-1} matured earlier than rest of the plots. Pronounced effect of seeding rates on maturity of canola has also been reported by various researches (Anon., 1999; George *et al.*, 1999). The yield of

Table 1. Plant height (cm) of four rapeseed genotypes as affected by six seeding rates.

Seed rates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
S_1	190.7 B	208.6 A	204.1 A	204.3 A	201.9 A
S_2	195.5 B	203.1 B	205.6 A	207.6 A	202.9 A
S_3	202.6 A	207.1 A	201.5 AB	208.5 A	204.9 A
S_4	200.1 AB	207.1 A	202.3 A	205.1 A	203.6 A
S_5	202.5 A	207.9 A	200.4 A	205.2 A	204.0 A
S_6	205.2 A	207.9 A	204.0 A	205.8 A	205.7 A
Mean	199.4 A	206.9 A	202.9 A	206.0 A	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

Table 2. Physiological maturity (days) of four rapeseed genotypes as affected by six seeding rates.

Seed rates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
S_1	171.0 B	175.0 A	173.0 A	173.0 AB	173.0 AB
S_2	171.0 B	172.0 C	173.3 A	172.7 B	172.2 C
S_3	173.0 A	174.0 AB	173.0 A	174.3 A	172.8 BC
S_4	172.0 AB	173.0 BC	173.0 A	172.1 B	172.5 BC
S_5	173.0 A	174.0 AB	174.3 A	173.0 AB	173.5 A
S_6	172.3 AB	174.0 AB	173.7 A	172.3 B	173.0 AB
Mean	172.1 B	173.7 A	173.3 A	172.9 A	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

Table 3. Yield (kg/ha) of four rapeseed genotypes as affected by six seeding rates.

Seed rates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
S_1	1208 E	1233 D	1245 D	1075 D	173.0 AB
S_2	1245 E	1212 D	1258 D	1117 D	172.2 C
S_3	1758 D	1750 C	1758 C	1715 C	172.8 BC
S_4	2050 B	2092 B	2325 A	1942 B	172.5 BC
S_5	2333 A	2375 A	2358 A	2167 A	173.5 A
S_6	1992 C	1975 B	2075 B	1958 B	173.0 AB
Mean	1764.3 AB	1772.8 AB	1836 A	1662.3 B	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

all the genotypes tended to increase with an increase in seed rate and the highest yield was recorded at 10 kg ha^{-1}, thereafter decline in yield was observed. The lowest yields were obtained at the lowest seed rate. Among the genotypes, RM-182 outyielded all the entries across different seed rates and produced 10.5% higher seed yield than the control. The interaction between seed rates and genotypes was significant at 5 % level of significance. Moderate seed rate of 6 kg ha^{-1} was found optimal for crop performance in several studies conducted by Kondra (1977). Other researchers (Christensen & Drabble 1992; George *et al*., 1999; Ashraf & Sarwar, 2002*)* observed that seeding rates used in a number of studies had no effect on yield. Brandt (1992) reported that seeding rates of 8, 12 and 16 kg ha^{-1} resulted in similar yield of yellow mustard, however, crop development was hastened by increased seeding rates. George *et al*., (1999), however, observed that seeding rate did not affect yield but higher seed rate reduced maturity by 2-4 days compared to the low seeding rate, hence seeding rate may play a role in maturity of canola management. Van Deynze *et al*., (1992) reported that 50% flowering and maturity displayed a linear response to varying seeding rate, while increases in seeding rate reduced days to maturity. These results support our finding of higher seed yield and early maturity with increasing seeding rates of rapeseed genotypes.

The results of seeding date experiment (Tables 4-6) revealed that plant height was reduced as sowing was delayed with the exception of D_4 i.e. October 15. The genotypes, however, did not differ significantly in plant height when averaged over sowing dates. The rapeseed genotypes also did not differ significantly in days taken to maturity. The plots sown early (15 September) D_1 matured earlier and maturity of different genotypes delayed proportionately with delayed sowing except D_3. It was also observed that sowing delayed beyond 25 October (D5) resulted in forced maturity, which adversely affected yield. The interaction of seeding dates and genotypes was significant at $p \leq 0.05$. The yield results revealed that significantly highest yield was obtained from plots sown on D_2 and D_3 i.e., on 25 September and 5 October and gradual reduction in yield was noted as sowing was delayed beyond it. The lowest yields were obtained from plots sown on D_7 (14 November). All the mutants yielded significantly higher than the check.

Taylor & Smith (1992) reported that yields of seed and oil declined when sowing was delayed beyond May (the optimum period of canola sowing in Australia). Robertson *et al*., (1999) observed that yield declined with delay in sowing date i.e., the linear regression slope coefficient between sowing date and grain yield was negative and the average relative yield loss per week was -5.1 %. Similarly Ozer (2002), Farre *et al*., (2002), Qasim *et al*., (2003), Mohsen *et al*., (2004), Fathi *et al*., (2005) and Gul & Ahmad (2007) reported that delayed sowing affected growth and yield components which resulted in lower yields, and therefore these results corroborate and support our findings.

Based on the results of these experiments over two years, it was concluded that seed rates and time of sowing had significant influence on yield and growth of rapeseed. A seed rate of 8 kg ha^{-1} and sowing between 25 September and 15 October is, therefore, recommended for obtaining higher yields of rapeseed genotypes.

Table 4. Plant height (cm) of four rapeseed genotypes as affected by seven seeding dates.

Sowing dates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
D_1	217.6 A	214.9 A	214.4 A	202.9 A	212.5 A
D_2	204.5 B	203.7 B	201.0 B	205.8 A	203.8 AB
D_3	182.7 D	183.2 CD	184.0 CD	182.9 C	183.2 AB
D_4	193.9 C	186.8 C	180.9 D	191.5 B	188.3 AB
D_5	173.8 E	181.5 D	187.7 C	181.4 C	181.1 BC
D_6	169.9 E	164.9 E	139.2 E	148.2 D	155.6 CD
D_7	122.3 F	130.7 F	124.8 F	126.9 E	126.1 D
Mean	180.7 A	180.8 A	176.0 A	177.1 A	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

Table 5. Physiological maturity (days) of four rapeseed genotypes as affected by seven seeding dates.

Sowing dates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
D_1	155.0 D	157.7 D	155.3 F	158.0 D	156.5 D
D_2	170.3 B	172.0 B	177.0 BC	177.7 B	174.5 B
D_3	182.3 A	184.0 A	182.7 A	185.7 A	183.7 A
D_4	172.0 B	174.7 B	173.0 C	176.0 B	173.9 B
D_5	172.3 B	173.3 B	172.7 DC	173.3 B	172.8 B
D_6	162.0 C	164.7 C	163.7 E	165.0 C	163.8 C
D_7	160.3 C	165.0 C	163.7 E	165.3 C	163.6 C
Mean	167.8 A	170.4 A	169.7 A	171.6 A	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

Table 6. Yield (kg ha^{-1}) of four rapeseed genotypes as affected by seven seeding dates.

Sowing dates	Genotype				
	RM-152-2	RM-159-2	RM-182	Pak-Cheen	Mean
D_1	1870.7 D	1722.2 D	1796.3 D	1555.6 C	1736.1 D
D_2	3888.9 A	3796.3 A	3555.6 A	3388.9 A	3657.4 A
D_3	3092.9 B	2944.4 B	2963.0 B	2425.9 B	2856.5 B
D_4	2611.1 C	2407.4 C	2333.3 C	2222.2 B	2393.5 C
D_5	1444.4 E	1333.3 E	1342.6 E	1222.2 C	1335.7 E
D_6	1185.9 E	1037.0 E	1259.6 E	750.0 D	1057.9 E
D_7	222.2 F	139.0 F	148.2 F	83.3 E	148.2 F
Mean	2045.0 A	1911.4 A	1914.0 A	1664.0 B	

Means in a column sharing a common letter are not significantly different at 5% level of significance, using DMRT.

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