Quality and yield of Indian mustard genotypes as influenced by different fertility levels

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ABSTRACT

An essential requirement for biotechnological interventions for improving oil quality in mustard species is to examine oil content and types of fatty acids in germplasm. A field experiment was, therefore, conducted at Research Farm of CCS, Haryana Agricutural University, Hisar, India during *Rabi(winter)* season of 2008-09. The treatment consisted of four genotypes (RL-1359, TAC-437, Kranti and NRCDR-601) of Indian mustard *(Brassica juncea*) in the main plots and four fertility levels i.e. 75, 100, 125 and 150% of the recommended dose of fertilizer (N+P) in the sub-plots were tested in split plot design with three replications. Mustard genotype TAC-437 produced the maximum seed yield and it was superior to all other entries, which did not differ significantly among themselves. Seed yield increased only up to recommended dose of fertilizer and the increase was non-significant thereafter. Genotype TAC-437, which had the maximum seed yield, was found to be inferior in oil content than other genotypes. Genotypes NRCDR-601 had maximum oil content and it was at par with RL-1359 and Kranti but superior to TAC-437. Application of fertilizer to mustard crop had adverse effect on oil content. The decrease in oil content with the increase in fertilizer was maximum in RL-1359. Different genotypes had no marked changes in fatty acid composition. However, erucic acid was found to be minimum in genotype TAC-437 (~45%) and maximum in NRDCR-601 (~55%), whereas, oleic acid was minimum in NRDCR-601 and maximum in TAC-437. The study of erucic acid levels is important to identifying genes responsible for erucic acid synthesis so as to develop low erucic acid lines . The modification of these genes responsible for fatty acid synthesis may help in tailoring the low erucic genotypes crop

Key words: Mustard – Fertility – Genotypes - Fatty Acid

INTRODUCTION

India is one of the largest oilseeds producing country that covers one fifth of the entire area under this group of crops and also yields one-fifth of the total oilseed production in the world. In India, oilseeds are the second largest agricultural commodity after cereals, which occupy about 13.5% of the gross cropped area in the country, and account for 5% of gross national product and 10% of the value of all agricultural products (Rai et al*.,* 2002). Among oilseeds, rapeseed-mustard occupies a prestigious position and ranks second after groundnut in area and production, contributing 23% of the total oilseed production. It is estimated that 58 million tons of oilseeds will be required by the year 2020, wherein the share of rapeseed-mustard will be around 24.2 million tons (Bartarial et al., 2001). Indian mustard is the most important winter season (*rabi*) oilseed crop, which thrives best in light to heavy loam soil in areas having 25-40 cm of rainfall.

Mustard is nutritionally very rich and its oil content varies from 37-49%. The seed and oil are used as a condiment in the preparation of pickles, flavouring curries and vegetables as well as for cooking and frying purposes. Its oil is used in many industrial products, cake as cattle feed and manure and green leaves for vegetable and green fodder. Though the productivity of rapeseed-mustard Haryana state of India is quite good (1369 kg/ha) (Anonymous, 2001-02), yet it is for below the productivity of developed countries such as Germany (3364 kg/ha), France (3269 kg/ha), and Poland (2346 kg/ha) (Damodaram and Hedge 2000).This calls for new genotypes of mustard with perfect plant type and proper nutritional support particularly nitrogen, phosphorus and sulphur. Quality of the oil is mainly dependent upon genotype but inter-relationship between genotypes and fertilizers needs to be evaluated. Therefore, the present investigation was undertaken to study the impact of India mustard genotypes and fertility levels on yield and quality.

MATERIALS AND METHODS

To study the impact of genotypes and fertilization on yield and quality of India mustard, a field experiment was conducted at Research Farm of CCS, Haryana Agricultural University, Hisar India during *rabi* (winter) season of 2008-9. The soil of the experimental field was sandy loam in texture, low in organic carbon (0.24%), low in available N (127 kg/ha), medium in $P_2\ 0_5$ (12.2 kg/ha), and high in K_20 (472 kg/ha) and S (21 ppm) with slightly alkaline in reaction (ph 8.2). The experiment consisted of four genotypes of Indian mustard (RL-1359, TAC-437, Kranti and NRCDR-601 in main plots and four fertilizer levels i.e. 75, 100, 125 and 150% of the recommended dose of N and P (80kg N and 30kg $P_2\ 0_5$ /ha) in sub-plots was laid out in split plot design with three replications. The gross plot size was 6.0mx5.0m. Various genotypes were sown on October 30, 2008 with hand plough at a row to row distance of 30 cm. Thinning was done after about two weeks of sowing to maintain plant to plant spacing of 15 cm. Nitrogen was applied through urea in two splits (half as basal and half at flowering) and phosphorus at seeding through single super phosphate. The crop received only one post sowing irrigation at flowering. All other recommended package of practices were followed for rising the crop. The crop was harvested on March 23, 2009. Yield and yield attributes, oil content and fatty acid composition were recorded to draw some valuable conclusions.

RESULTS

Effect of genotypes

Among four genotypes, TAC-437 produced maximum seed yield (3237 kg/ha) and it was superior to all other genotypes (RL-1359, Kranti and NRCDR-601) which did not differ significantly (Table-1).The seed yield of RL-1359, Kranti and NRCDR-601 was 2934, 2820 and 2918 kg/ha, respectively. The seed yield in different genotypes was mainly governed by seed yield per plant. The 1000-seed weight was the maximum in RL-1359 (5.15g) whereas it was at par in other genotypes. Main shoot height was minimum (58.2%) in RL-1359 and it was maximum in TAC-437 (62.6cm). NRCDR-601 produced maximum number of pods per main shoot (46.9) followed by Kranti (43.7) and it was significantly less in RL-1359 (40.8) and TAC-437 (40.9). Siliqua length (4.1cm) being similar in TAC-437 and Kranti was significantly more than RL-1359 and NRCDR-601. The number of seeds/pod was statistically similar between TAC-437 (14.3) and Kranti (14.6) and these were superior to both RL-1359 and NRCDR-601. Oil yield was significantly more in TAC-437 (1224 kg/ha) and its trend was identical to seed yield in different genotypes (Table-1). However, oil content was minimum (37.9%) and significantly less in TAC-437 compared to other genotypes, which were statistically at par.

Effect of fertility levels

The seed and oil yields increased significantly up to 100% of recommended fertilizer (N+P) and the increase was non-significant thereafter (Table-1). The increase in seed and oil yield due to 100% over 75% of recommend fertilization was 6.6 and 9.1%, respectively. Yield /plant (19.85) and number of pod per main shoot (41.3) were minimum at 75% of recommended fertilization, whereas it was at par at other fertility levels. The number of seeds/pod was also less at 75% of recommended fertilizer which increased significantly at 125 and 150% recommended fertilization. The test weight, main shoot height and siliqua length were not influenced by different fertility levels. Oil content decreased significantly with each increment of fertilizer application beyond 75% of recommended dose (Table-1). The decrease in oil content at 150% recommended fertilization was 5.7% compared to 75% of recommend fertilization.

There was decrease in oil content in each genotype with the increase in fertilizer application beyond 75%of the recommended dose (Table-2) and the decrease was more pronounced in RL-1359, (3.4%) followed by NRCDR-601 (2.5%)TAC-437 (2.3%) and Kranti (1.1%). Palmitic acid (2.39-2.57%), Oleic acid (11.33-12.73%), linoleic acid (16.90-18.31%), linolenic acid (11.89-13.31%) and eicosenoic acid (10.21-11.40%) at different fertility levels were comparatively higher and erucic acid (44.06-45.03%) was less in TAC-437 than all other genotypes. Erucic acid (55.32-57.78%) was more in NRCDR-601 closely followed by Kranti and

RL-1359. However, there was no definite trend in fatty acid composition with different fertilizer levels. Fatty acid composition appeared a function of genotypes and not much of fertilization.

Table 1. Yield attributes, seed and oil yield of India mustard as influenced by various genotypes and fertility levels.

Treatment	Test wt. (g)	Yield /plant (g)	Main shoot ht.(cm)	Main shoot pods (No.)	Siliqua length (cm)	Seeds /pod (No.)	Oil content (%)	Seed yield (kg/ha)	Oil yield (kg/ha)
Genotype:									
RL-1359	5.15	21.8	58.2	40.8	3.8	13.0	39.4	2934	1153
TAC-437	4.02	26.0	62.6	40.9	4.1	14.3	37.9	3237	1224
Kranti	3.96	21.9	62.5	43.7	4.1	14.6	39.6	2820	1116
NRCDR-601	4.04	24.3	60.9	46.9	3.7	13.9	40.0	2918	1167
CD 5%	0.09	1.1	2.4	1.9	0.2	0.6	0.81	180	47
Fertility level *									
75%	4.22	19.8	59.4	41.3	3.8	13.5	40.4	2748	1110
100%	4.33	24.3	60.6	43.3	3.8	13.8	39.5	2998	1184
125%	4.33	24.8	61.9	43.4	4.0	14.2	38.8	3065	1186
150%	4.29	25.4	62.4	44.4	4.0	14.4	38.1	3099	1180
CD 5%	NS	1.1	NS	1.9	NS	0.6	0.52	114	47

* % recommended dose (80kg N+30kg $P_2\ 0_5$ /ha)

Table 2, Oil content and fatty acid composition in Indian mustard as affected by various genotypes and fertility levels.

Entries	Fertility level *	Oil (%)	Fatty acid (%)					
			Palmitic	Oleic	Linoleic	Linolenic	Eicosenoic	Erucic
RL-1359	75%	41.23	2.05	10.23	16.70	11.39	05.46	54.75
	100%	40.17	1.67	10.66	16.12	09.51	07.84	54.77
	125%	38.23	1.57	10.09	15.52	10.69	08.95	53.15
	150%	37.80	1.80	09.43	16.32	10.81	06.95	54.69
TAC-437	75%	39.03	2.39	11.33	16.90	13.31	10.21	45.83
	100%	38.40	2.45	12.24	16.74	12.26	11.28	45.03
	125%	37.27	2.57	11.86	18.31	11.89	11.08	44.26
	150%	36.77	2.40	12.73	17.27	12.11	11.40	44.06
Kranti	75%	40.03	1.64	10.42	12.76	10.47	10.50	54.18
	100%	39.87	1.82	10.10	13.13	11.99	08.28	54.66
	125%	39.67	2.11	11.90	15.16	11.19	06.69	52.32
	150%	38.97	1.77	10.69	14.57	12.27	07.93	52.72
NRCDR-601	75%	41.47	2.12	09.81	14.18	11.85	06.68	55.32
	100%	39.77	1.53	08.41	12.62	11.17	08.26	5778
	125%	39.90	1.76	08.63	14.88	10.56	07.60	56.54
	150%	39.00	2.09	09.45	15.16	10.87	06.75	55.68

* Recommended dose (80kg N+30kg P205/ha)

Interaction effect of genotypes and fertility levels in terms of oil content (Table 3) clearly indicates that there was significant decrease in oil content in RL-1359 and TAC-437 beyond 100% , NRCDR-601 beyond 75% and it was not influenced statistically in Kranti even upto150% of recommended fertilizer. At each of same fertility levels (75, 125 and 150%) of recommended, the oil content did not differ significantly but it was statistically lower in TAC-437 even at 100% of recommend fertilization.

Table-3: Interaction of Indian mustard genotypes and fertility levels in terms oil content.

Genotypes	**Fertility level(% Recommended)**				
	75%	RF	125%	150%	Mean
RL-1359	41.23	40.17	38.23	37.80	39.36
TAC-437	39.03	38.4	37.27	36.77	37.87
Kranti	40.03	39.87	39.67	38.97	39.63
NRCDR-601	41.47	39.77	39.90	39.00	40.03
Mean	40.44	39.55	38.77	38.13	

CD at 5%: Genotype: 0. 81 , Fertilizer level: 0.52
Fertility level at same level of genotype: 1.10
Genotype at same level of fertility: 1.20

DISCUSSION

Seed yield is probably the most difficult trait to predict accurately. Numerous attempts have been made to identify the most important yield component. Positive relationship have frequently been cited between the seed yield and the number of siliqua per plant and main raceme, as well as the number of seeds per siliqua and seed weight per siliqua. In the present investigation, the seed yield in different genotypes was a function of seed yield per plant which was governed by 1000 seed weight, pods on main shoot and seed numbers per pod. Among four genotypes TAC-437 produced maximum seed yield because of better yield attributes. These findings are in conformity with Phogat et al. (1997) and Bisht (2004). Oil yield is mainly a function of seed yield which is generally influenced by genetic structure of different genotypes. Oil yield was significantly higher in TAC -437 though the oil content was lower. Singh et al. (2003) and Bisht (2004) have also reported similar results. Among various fatty acids oleic and linoleic are essential and have to be provided through diet whereas, linolenic, eicosenoic and erucic acids are undesirable from edible point of view. It is suggested that these three fatty acids should be reduced if not eliminated completely in view of their nutritional quality. Lower amounts of linolenic acid will improve the stability of oil. Mustard is valued for both high and low erucic acid. Lower proportions of erucic acid will make the oil more palatable, nutritive and less vulnerable to metabolic disorders (Rutkowski,1971),whole higher erucic acid may be useful toward industrial end-use. Fatty acid composition appeared a function of genotypes. Bisht et al. (2007) and Banga, et al. (2007) have also reported different fatty acid composition in various genotypes of Indian mustard.

Positive response of different genotypes in term of seed and oil yield was realized significantly only up to 100% of recommended fertilizer, whereas the oil content decreased significantly with each increment of fertilizer doses. Similar results have been reported elsewhere (Trivedi and Sharma,1997; Bisht, 2004) Fatty acid composition was not much influenced by fertilization indicating that plant breeding and biotechnological approaches are only the emerging alternative and agronomic manipulation in terms of fertilization has limited scope in modifying fatty acid profile of oilseed *Brassicas* to the desired level.

CONCLUSION

Among four genotypes, TAC-437 produced maximum seed and oil yield and lowest erucic acid. Oil content was reduced with increasing level of fertilization beyond 100% of recommend. Fatty acid composition appeared to be influenced mainly by genotypes and not by fertilization.

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