Appraisal of Rapeseed Genotypes for Yield Traits and Oil Quality under Swat Valley Condition

Fayaz Ahmad[1], Alia[1], Amjad Khan and Mohammad Naeem
Oilseed Section Agricultural research Institute Mingora Swat

Abstract

Eight rapeseed genotypes were evaluated for agronomic parameters, yield, oil quantity and quality. Significant differences were observed for all the parameters except oil and protein percentage. The genotype PI-26369 outperformed the rest of genotypes in yield potential (3118 kg ha^{-1}), followed by PI-26337 (2422 kg ha^{-1}). For yield contributing characters like 1000 seed weight, Seed pod^{-1} and pods plant^{-1}, genotype PI-26369 again showed good results that are, 4gm, 20 and 343 pods plant^{-1}, respectively. The genotype H-19 showed low glucosinolate (54.9 µmol/g), genotype PI-26369 have lowest amount of erucic acid (21.8 µmol/g) and higher amounts of oleic acid (48.09 %). Due to its high yield and oil quality, the genotype PI-26369 is recommended for general cultivation in the area and further use in breeding programmes for Brassica Juncea.

Keywords: rapeseed, Oil quality, genotypes, Swat.

INTRODUCTION

Rapeseed (Brassica rapa , B.napus) and mustard (B.juncea) are the important crop of brassica group grown as oilseed crop in Pakistan. The genus Brassica has over 150 species and 8 species was reported in Pakistan, among them 2 species, Brassica tourniforti and Brassica deflexa are reported from wild while 6 are agriculturally important species (Ahmad, 2009; Jafri, 1973). Brassica juncea Czern. and Coss. Brassica. carinata Burn and Brassica nigra Koch. are placed in the mustard group (Khan et al., 1987) and are cultivated for mustard oil. Brassica oleracea is known for its potential as vegetable. Brassica rapa L. and Brassica napus L. are grouped into rapeseed (Khan and Munir, 1986; and Islam et al., 2009). Rape and mustard are generally related morphologically and the term “rape “ is derived from Latin word “rapum” meaning turnip and signifies oil seed forms of Brassica campestris and B. napus, collectively called rapes or rapeseed (Khan et al., 1987). Leaves of B. napus are partially clasping and typically glaucous or have a few scattered hairs near the margins. The stem is always ramified, the degree of ramification is however dependent upon variety and the environmental conditions (Musil, 1950). Islam et al. (2004) however showed non-significant variation for branches per plant within the variety. The spring-type oleiferous B. napus, a cool season, not drought tolerant and performed well under a range of soils, provided that moisture and fertility levels are adequate. The optimum temperature however, for maximum growth and high yield of spring-type oilseed rape is between 20 and 30°C. Brassica species generally grow will on rich sulphur soils. Seedlings prefer relatively cool temperatures up to flowering; high temperatures at flowering render earliness, reducing the time from flowering to maturity. Winter oilseed rape covers the soil for seven to nine months. It has high nutritional demands in autumn and reduces soil erosion in winter. In oilseed rape, crop rotation should be practiced for prevention of diseases and pest attacks (Anonymous, 1997). These have remained one of the major source of oil in the sub-continent for centuries. Rapeseed and Mustard are rich source of oil and contains 44-46% good quality oil and its meal has 38-40% protein that has complete profile of amino acids including lysine, methionine and cysteine. Rapeseed is an important oilseed crop in the agricultural systems of many arid and semiarid areas where its yield is often restricted by water deficit and high temperatures during the reproductive growth. Seed yield can be primarily limited even by the relatively short period of soil moisture shortage during the reproductive development. Edible oil is one of the important commodities of everyday use. Pakistan has been constantly and chronically deficient in its production. About 70% of the domestic requirements are met through imports. Since 1970s its import increased at the rate of 12.5% annually and the trend will further not only continue but will also get worsen with increase in population. The area under oilseed crops during 1990-1991 was 473,000 hectare with the production of 3650,000 tones, which was 693,000 ha, producing 4940,000 tonnes in 2009-2010. . The total consumption of edible oil amounted to 2.381 million tons during 2007 - 2008; local production of edible oil was estimated at 0.833 million tons and the remaining 1.548 million tons were imported (Anonymous, 2007). The per capita oil consumption increasing day by day is impaired by the growth rate of more than 3%. Hence there is no way, but to improve the oilseed production for getting self-sufficiency in edible oils demand (Anonymous, 2007 Besides their use for extracting vegetable oil and getting the precious protein cake for livestock feed, the leaves of B.napus are also used as salads, pot herb and fermented for later use (Facciola, 1990; Manandhar, 2002). Its oil is used for cooking purposes and salad dressings. Roots, leaves and oil are also used medicinally as diuretic, expectorant, bronchitis, coolants and rheumatism (Manandhar, 2002). Genetic elaboration of Brassica started with the conformation of its chromosomal numbers (Ahmad, 2009). B. rapa (2n = 20, genome AA) was confirmed by Takamine (1916), B. nigra (n = 8, genome = BB), B. oleracea (n = 9, genome = CC) and B. rapa were thought to constitute the three basic species which give rise to the amphidiploid species, B. juncea (n = 18, genome = AABB), B. napus (n = 19, genome = AACC) and B. carinata with n = 17, genome = BBCC (Morinaga, 1934). Ahmad and Hasnain (2004) observed that the colchiploid recovery was very high but latter stages of development nearly half of the conformed colchiploids reverted in to diploid. Islam et al. (2006) conducted meiotic analysis of the advance line HS- 98 and conformed 2n = 38. No univalent, secondary association or B- chromosomes were recorded hence the genotype were considered as stable. Rapeseed has attained the status of alternate crop of wheat, in the rainfed areas of District Mansehra and Swat. Some traditional landraces of Turnip Rape are widely cultivated as conventional crop mostly for fodder, hair oil and green vegetable. Commercial cultivation of B. napus is not in practice due to unavailability of certified seed. Keeping in view the importance of edible oil and its shortage in the country, the present study was conducted to evaluate best genotypes on the basis of yield and oil quality.

MATERIALS AND METHODS

Eight high yielding rapeseed genotypes Oscar, H-19, Dunkled, Bulbul, PI-26369, PI-25985, PI-26391 and PI-26337 were planted in field .The experiment was conducted during Rabi 2014 at Agricultural Research Institute Mingora Swat. The experiment was laid out in Randomized complete block design with three replication, having plot size 1.2×5m. . Fertilizers were applied at the rate of 75 kg nitrogen and 60 kg phosphorus ha^{-1} at the time of sowing. Thinning was carried out after 30 days of emergence Composite soil samples from the experimental site at ARI, Swat were taken before sowing and analyzed. Monthly rain fall and temperature recorded during the crop growth period is given in Fig 2. All agronomic practices were adopted uniformly for the plots to observe the most economical and suitable date of sowing for obtaining high yield. The data recorded were days to flowering, days to maturity, Plant height, pods $plant^{-1, seed}$ pod^{-1} and yield kg ha^{-1}.

RESULTS AND DISCUSSION

Days to 50% flowering:

Statistical analysis for days to 50% flowering showed that all genotypes were significantly different at 5% level of significance. Maximum days to 50% flowering were taken by PI-26369 (125) followed by PI-26337 (123).Whereas minimum days to 50% flowering was taken by Oscar (111).

Pods $plant^{-1}$:

Analysis of variance showed that genotypes were significant at 5% level of significance for pods $plant^{-1}$. More number of pods $plant^{-1}$ (343) was found in genotype PI-26369, followed by genotypes PI-26337 (338), while minimum number of pods $plant^{-1}$ (156) was obtained from genotype PI-26391. Pods $plant^{-1}$ directly affects the seed yield. Having more pods $plant^{-1}$ will give more seed yield and also oil (Islam et al.2004). The number of pods $plant^{-1}$ will increase when rapeseed crop planted after legumes crop (Sieling et al.1997).

Seed pod^{-1} :

Genotypes were statistically significant at 5% level of significance. Highest number of seed pod^{-1} (20) was obtained from genotypes PI-26369, followed by PI-26337 (19).Lowest number seed pod^{-1} (12) was obtained from genotype Oscar. Seed pod^{-1} is affected by plant density and also plant spacing Ahmad and Mohammad (1999).Number of seed pod^{-1} increased at 120 N kg ha^{-1} but above this dose has adverse effect on production of number of seed pod^{-1} Qayyum et al.(1999). Number of seed pod^{-1} enhance with increased level of sulphur Govahi and Saffari, 2006).

1000 seed weight (g):

Statistical analysis showed that 1000 seed weight were significantly different. Maximum 1000 seed weight (4g) was obtained from Oscar and PI-26337 whereas minimum was obtained from genotype PI-25985 (3.4 g). 1000 seed weight affect from sowing time and spacing (Rehman and Ali, 2000).

Yield kg ha^{-1}:

Analysis of variance for seed yield showed significant difference at 5% level of probability. Highest yield (3118 kg ha^{-1} was recorded by genotype PI-26369 ,followed by genotype PI-26337 (2422kg ha^{-1}).Lowest yield (1445 kg ha^{-1}) was recorded by genotype H-19. Rapeseed yield reduced when at flowering and grin filling stage water stress occurred (Ghobadi et al.2006). The seed yield of Rapeseed increase 50% over control when chemical fertilizer applied (Yasir 2006).

Table 1: Days to 50% flowering, pods plant^{-1}, seed pod^{-1}, 1000 seed weight and yield(kg ha^{-1}) of rapeseed genotypes.

Genotypes	Days to 50% flowering	**Pods plant^{-1}**	**Seed pod^{-1}**	**1000 seed weight (g)**	**Yield kg ha^{-1}**
Oscar	111 d	313 ab	12 b	4 a	1488 b
H-19	119 c	280 ab	13 ab	3.5 b	1445 b
Dunkled	119 c	284 ab	14 ab	3.8 b	1884 b
Bulbul	117 bc	192 cd	17 ab	3.6 b	1527 b
PI-26369	125 a	343 a	20 a	3.8 b	3118 a
PI-25985	114 cd	250 bc	15 ab	3.4 b	2197 ab
PI-26337	123 b	338 a	19 a	4 a	2422 ab
PI-26391	121 b	156 d	15 ab	3.5 b	1723 b
Lsd value	5.34	40.043	3.534	0.356	488.69

Oil percentage:

Oil analysis of the Brassica is very important parameter for Quality determination. Canola type B.napus oil contains about 70% or more unsaturated fatty acids. In presence of certain toxic compound, erucic acid and glucosinolates in rapeseed oil lower its quality (Khalil et al., 1989). It is recommended that the canola cultivars are well for human consumption. The highest amount for oil percentage (52.2 %) was observed for genotype PI-26369. Hayat et al. (1997) and Islam et al. (2004), reported difference in oil contents for different sowing dates and application of Sulphur contain fertilizers.

Protein percentage:

The processing of rapeseed for oil production provides animal meal as by-product. The feed is mainly used for livestock feeding and also for chickens. Highest amount of protein were found in Dunkled (23.2 %) while lowest amount was present in PI-25985 (21.5). Ping et al. (2003) found that significant values for protein meal ranging from 30 to 46%. Ahmad et al. (2008) reported highest amount of protein % in B.napus types while the lowest amount of protein % in B.rapa.

Glucosinolate:

Glucosinolate interfere with the catalyst, nickel. High glucosinolates have deleterious effect, especially in monogastric animals and largely restricted to use as cattle feed. The specific odor of Brassica species is also due to glucosinolate (GSL). Table of mean shows that genotype PI-26391 had high amount (121.5 µmol/gm) of glucosinolate while genotype PI-26369 (16.4 µmol/gm) had the lowest amount of Glucosinolate. Our results are in agreement with Islam et al. (2004), who reported that highest amount of glucosinolates was found in B.juncea types while the lowest amount of glucosinolates present in B.napus type . Bhardwaj and Hamama (2000) reported that glucosinolate content were higher in B. rapa than the B. napus meal (49.2 vs. 43.8 µmol/g).

Erucic acid (umol/g):

Genotype Dunkled and Bulbul have high amount of erucic acid (40 and 39.8% respectively), while genotypes PI-26369 and H-19 have lowest for erucic acid amount (21.5 &34.5). Rahman (2002) reported that the erucic acid content in resynthesized B. napus (AACC) lines derived from these crosses was only about half that of the high erucic acid CC genome parents, indicating equal contributions of the two genomes to oil (fatty acid) synthesis and accumulation. Sowing date also affect the amount of erucic acid. The lowest erucic acid 3.83% was also obtained for B. napus genotype CON-1 (Hayat et al., 1997).

Oleic acid %:

Genotype PI-26369 have high value (63.3 %) of oleic acid, whereas genotypePI-26337 have lowest value (34.9 %) for oleic acid. Canola and peanut oil are rich in monosaturated (oleic acid) whereas corn, soybean and sunflower oil are rich in polyunsaturated (linoleic and linolenic) acid. Dimic et al. (1992). The oleic acid percentage observed for five genotypes viz. H-19, Bulbul, Oscar, Dunkled and showed significant result at 5% level of probability (Ahmad, 2009).

Conclusion:

The present Study was conducted to find out genotypes for quantitative and qualitative parameters. Old varieties are eliminated with the passage of time due to low yield and susceptible to diseases and insect pest attack and new varieties take over their place because of their high yield and resistant to diseases and pest attack. The plant breeder has to stress on the improvement of yield, oil quality and quantity and for early maturity. The data showed that genotype PI-26369 is the better variety on the basis of yield; it produced (3118 kgha^{-1}) in the study area followed by PI-26337which produced (2422 kgha^{-1}) .It may concluded that genotype PI-26337 is fit for commercial cultivation in the Malakand division.

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Table 2 : Quality analysis of rapeseed genotypes throgh Near Infrared Reflectance Spectroscopy.

S.No	Genotypes	Oil (%)	Protein (%)	GSL (umol/g)	Moisture(%)	Oleic Acid(%)	Linolenic Acid(%)	Erucic Acid (umol/g)
1	**PI-26369**	50.6	21.9	16.4	6.7	63.3	10.3	21.5
2	**PI-26337**	46.7	22.2	113.4	4.3	34.9	12.3	59.8
3	**PI-25985**	47.8	21.5	68.5	5.9	49.0	7.5	44.4
4	**PI-26391**	44.7	22.2	121.5	5.1	36.4	10.1	56.3
5	**H-19**	47.9	22.9	54.9	5.7	55.6	10.1	34.5
6	**Dunkled**	49.6	23.2	56.0	5.6	55.0	9.7	40.0
7	**Bulbul**	49.1	22.3	67.8	5.4	55.5	9.9	39.8
8	**Oscar**	49.2	21.9	57.5	5.1	56.1	9.1	35.5

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