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DEVELOPMENT OF ERUCIC ACID AND GLUCOSINOLATE-FREE RAPESEEDS (CRUCIFERS) IN PAKISTAN*

Part V. Performance Evaluation of Introduced Crucifers

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Performance evaluation of "double zero" germ plasm of crucifer species (zero erucic acid and zero glucosinolate), imported from abroad, has been studied. It has been observed that a number of such lines have adapted well in local environmental conditions and their seed and oil yield is comparable with the local oilseed crop.

INTRODUCTION

A detailed evaluation of indigenous crucifers, including cultivated and wild growing species and varieties, for their erucic acid and glucosinolate levels has already been reported [1]. However, a number of imported crucifers either free from or having minimal amounts of erucic acid and glucosinolate in them, are being introduced in Pakistan. This introduction is aimed at multiplying germ plasm for commercial cultivation instead of the local oilseed crop that has a higher level of erucic acid in its seed oil. The present study, therefore, describes the performance of imported germ plasm "double zero" with characters. Their adaptation to local climatic conditions, character retention, diseases resistance and competitive seed and oil yields are some of the aspects that have been studied.

Seeds of the imported species and varieties were evaluated when they were grown either in isolation to avoid cross-pollination or in the open during the normal sowing season (October/November).

MATERIALS AND METHODS

The seeds of various imported species and varieties of crucifers, as studied here, are listed in Table 1 along with their origin, erucic acid and glucosinolate levels.

The imported germ plasm was evaluated by cultivation in local conditions and its performance in various areas showing viability, nature of growth, susceptibility to disease and behaviour on maturation is given in Table 2. Unless stated otherwise the cultivation trials were carried out by direct sowing during normal winter season (October-November) and harvesting was done in April-May.

After harvesting, clean and dry seeds were used for the estimation of oil yield, erucic acid and glucosinolate levels as described previously [1]. The seeds from local cultivars were also similarly evaluated for comparison purposes. The results of these evaluations and comparisons are given in Table 3.

RESULTS

Germ plasm of three seed oil producing species of the genus *Brassica*, with "double zero" characters, was imported for introduction. Cultivars of *B. napus* have already successfully been introduced in the country, particularly in the North West and Punjab provinces [2]. It is noted that though some characters, such as viability of seeds, maturation period and plant agronomy have been retained (Table 1) but the content of erucic acid in their oil has increased considerably as these lines have been grown under local environmental conditions for a number of years (Table 2). These varieties are comparatively more resistant to aphid attack and seed shattering.

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The seeds of *B. campestris* (var. 'Candle') have shown remarkable adaptation to local climatic and soil conditions, particularly in the Punjab and Sind, both in irrigated as well as "barani" areas. Most of the agronomic characters, that is, plant height, habitat, seed shattering and yield are retained by this cultivar but its susceptibility to aphid attack has increased under local conditions (Table 2).

The erucic acid and glucosinolate free lines of *B. juncea*, (Zem-I and Zem-II) have shown better performance at Faisalabad. The plants of these cultivars are comparatively taller (1 – 1.5 m) with more primary and secondary branches. During cultivation trials it has been observed that *B. juncea* and *B. carinata* are comparatively more resistant to diseases and seed shattering than the other species.

It has also been observed that the seeds of *B. napus* are darker in colour and larger in size than those of *B. campestris* and *B. juncea.* The colour of *B. juncea* seeds (brown mustard), however, varies from light yellow to dark brown.

DISCUSSION

Erucic acid and glucosinolate-free ("double zero") rapeseed *(B. napus)* was first developed in Canada through plant breeding for providing a nutritionally superior edible oil [3]. Different varieties of this species have since been introduced in various parts of the world and they all are either free from erucic acid and glucosinolate or are very low in them.

Among the various ecotypes of the genus *Brassica*, which are commonly grown as oilseed crop, it appears that *B. campestris* is the oldest and most widely distributed. Primarily this species has also played a major role in the evolution of other species/varieties with varying agronomical characters and to suit different ecological environments. Thus *B. napus* (2n = 38), *B. juncea,* (2n = 36) and *B. carinata* (2n = 34) have been obtained by natural or artificial hydridization from *B. campestris* (2n = 20) and *B. oleracea* (2n = 18), *B. campestris* (2n = 20) and *B. nigra* (2n = 16) and *B. oleracea* (2n = 18) and *B. nigra* (2n = 16) respectively [4]. It is assumed that the genetic constitution of *B. juncea* and *B. campestris* should be similar as the latter is one of the parents of both *B. juncea* and *B. napus.* The genetic data of *B. napus* indicates that the synthesis of erucic acid is controlled by two genes which display no dominance and act in an additive manner [3].

Table 1. The origin and legend of the imported double zero crucifers

Species	Variety/cultivar	Origin	Legend	
			E. acid (%)	Glucosinolate (%)
1. *Brassica campestris*	Candle	Canada	0.00[a]	0.1
	Span	"	0.94[a]	T[b]
	Sonebra	"		
	Torch	"		
2. *Brassica juncea*	Zem-I	Australia	0.00[a]	0.1
	Zem-II	"	0.43[a]	T
3. *Brassica napus* *c	Oro	Canada	14.96	T
	Erusine	France	35.21	0.1
	Tanka	Canada	35.80	0.25
	Nugget	"	30.39	0.10
	Turret	France	34.51	0.12
	Midas	Canada	12.10	0.10
	Target	"	17.26	0.11
4. *Brassica carinata*	–	Sweden	1.58	0.12
5. *Brassica rapa*	–	Sweden	3.24	T
6. *Sinapis alba*	–	Swden	39.96	0.5
7. *Camelina sativa*	–	Sweden	2.36	T

a. Grown in isolation; b. Traces; *c. These cultivars have been growing in Pakistan for a number of generations now.

Table 2. Cultivation evaluation of imported germ plasm

Sl. No.	Species	Variety/ cultivar	Origin	Viability (%)	Growth	Susceptibility to disease	Shattering
1.	*Brassica campestris*	Candle	Canada	80	Normal	Susceptible	Shattering
		Span	"	50			
		Sonebra	"	80			
		Torch	"	nil			
2.	*Brassica juncea*	Zem-I	Australia	90	Normal	less resistant	"
		Zem-II	"	95			
3.	*Brassica napus*	Oro	Canada	90	Normal	Mild resistant	"
		Erusine	France	50			
		Tanka	Canada	70			
		Nugget	Canada	50			
		Turret	France	2			
		Midas	Canada	80			
		Target	Canada	95			
4.	*Brassica carinata*	–	Sweden	50	Normal	More resistant	No Shattering
5.	*Brassica rapa*	–	Sweden	90	Normal	Mild resistant	Less shattering
6.	*Sinapis alba*	–	Sweden	85	Normal	More resistant	No shattering
7.	*Camelina sativa*	–	Sweden	80	Normal	More resistant	"

The terms normal, susceptible, less and more signify comparison with local cultivars.

Table 3. Comparison of the local and imported cultivars for maturation oil and seed yields

Cultivar		Maturation (in days)	Yield	
			Oil (%)	Seeds (kg) (p.a)
B. campestris	Candle	170–180	40–42	448–460
	Local (BSA)	130–140	40–43	448–485
B. juncea	Zem-I	180–200	33–41	672–680
	Zem-II	180–200	30–40	672–709
	RL -18	160–170	38–39	746–933
	Poorbi Raya	100–110	44–44.5	634–746
B. napus	ORO	190–210	39–40	522–559
	Midas	180–210	42–47	672–746
B. carinata	Local	180–190	37–39	933–940
	Imported	170–180	38–42	730–750

Experimental cultivation of *B. napus* has been in progress for a number of years in Pakistan. Most of the seeds of the advance generations obtained from "double zero" *B. napus*, have shown an increase in erucic acid content (Table 1). This reversion may be the result of open pollination, lack of isolation of selected plants, bulk harvesting and variation of climatic conditions at the time of the maturity of seeds [2]. It seems likely that some variations could also be due to differences in the degree of maturity of the seeds or differences in seed quality.

Recently successful efforts have also been made to identify such lines in *Brassica juncea* (Zem-I and Zem-II) [5] and *Brassica campestris* (var. Candle) species. Since the above mentioned species are commonly cultivated in Pakistan it was, therefore, advantageous to test the behaviour of the cultivars of these species with zero or low erucic acid and glucosinolate contents. The cultivation data of these cultivars, representing various species, are given in Table 2.

In general, the cultivars of *B. campestris, B. juncea* and *B. carinata* have shown remarkable adaptability under local environmental conditions and have been found to complete well with regard to maturation and seed yields (Table 3). Because of these factors and also due to the multifunctionality of these plants to provide edible young leaves for humans and green fodder for animals, it appears that these cultivars have bright chances of becoming the indigenous oilseed crop of future. It, therefore, appears feasible that cultivars having zero or low levels of erucic acid and glucosionlate and belonging to *B. campestris* or " *juncea* will flourish well under Pakistani conditions as these species are already well adapted here. The results of the present efforts also support the above contention.

Introduction of *Camelina sativa, Brassica rapa*, and *Sinapis alba* has also been tried with satisfactory results. However, it seems that due to the presence of high erucic acid, (40%)and linolenic acid (58%) in *Sinapis alba* and in *Camelina sativa* respectively, these may not be preferred as an edible oil crop. Further cultivars with a longer maturation period may also have lesser chances of commercialisation for obvious reasons.

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