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Selection and Evaluation of Exotic Genotypes of Sugar Beet (*Beta vulgaris* L.) in Peshawar Valley

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Abstract: To evaluate and select exotic genotypes of sugar beet in Peshawar valley, an experiment was conducted at Sugar Crops Research Institute, Mardan during 2000-2001. The experiment was laid out in a Randomized Complete Block design with four replications. The plot-size was 9.50 x 3.6 m^2 with row-to-row distance of 60 cm and plant-to-plant distance 22 cm. The germplasms included Kawe Terma, Prima Poly, KWS Pak-9211, Allyx, Aura, Sibel, KWA Pak-937, KWS Pak-961, Cadyx and KWS Pak-238. Statistical analysis of the data revealed that bolting, disease resistance, root length, pol%, leaf length and width were significantly different. Plant population, root girth, root yield, aphid and cutworm infestation, top $root^{-1}$ ratio, brix and purity were not significantly different. Mean values of the data showed that KWS Pak-238 produced maximum bolting%, leaf length and leaf width. Sibel attained maximum beet length. Highest pol% and sugar yield was recorded for Aura. From the results it is concluded that Aura produced maximum pol% and sugar yield and is recommended for commercial cultivation after confirmation of these results in future evaluation.

Key words: Sugar beet, beta vulgaris, exotic genotypes

Introduction

Sugar beet (*Beta vulgaris* L.) locally known as "chequandar" belongs to family Chenopodiacae. It is a plant of Temperate Zone, which includes garden beet, sugar beet and mangold. It was derived from Beta maritima. Sugar beet is more economical crop than sugarcane. It contains 30% more sugar than that of sugarcane and requires less fertilizer and water as compared to sugarcane. Sugar beet, being a short season crop, offers an excellent opportunity for better crop rotation in NWFP. It provides not only sugar but also green fodder for cattle. Sugar beet has been in commercial cultivation in NWFP, particularly in the Peshawar valley, since 1959.

Haijichristodoulou (1984) tested different sugar beet varieties and reported that varieties were significantly different for plant population, which is not in agreement with the present situation. Bolting character not only reduce root and sugar yields but also create problem at harvest and slicing in the factory (Kamil, 1991). Mokadem (1993) stated that root length increases with increasing plant density while root diameter and purity were high at low plant density. Bolting is undesirable because sugar accumulated in roots is used in the formation of bolters, and reduced the total yield and sugar content in the roots as reported by Ayaz *et al.* (1996). Itoh (1998) reported that root yield increase with increasing plant. Takahashi *et al.* (1999) compared the new variety with a standard variety for disease resistance and reported that the new variety had more resistance to Cercospora Leaf Spot Disease than standard variety. Hayashida *et al.* (1999) tested a new variety for various characteristics and stated that the new variety had a little more resistance to Cercospora Leaf Spot disease as compared to standard variety.

As we are totally dependent on imported breeding material for our varietal selection programmes, therefore screening of imported germplasms for finding out suitable sugar beet varieties for Peshawar valley will have positive impact on improving yield and quality of the crop. Therefore the study was conducted with the objectives to identify germplasm with high sugar content, tolerance to pests and disease and adaptability.

Materials and Methods

An experiment was conducted at the Department of Plant Breeding and Genetics NWFP Agricultural University Peshawar, during 2000-2001 crop season in order to study the selection and evaluation of exotic genotypes of sugar beet in Peshawar Valley. The venue of research was Sugar Crops Research Institute, Mardan. The experiment was carried out under Randomized Complete Block Design with four replications. The ridges were erected 60 cm apart (row to row distance) and seed was planted on the top of ridges 22 cm apart (plant to plant distance) with gross plot

size of 9.50 x 3.6 m^{-2}. The experiment included ten sugar beet varieties of different origin and genetic background. Varieties selected at the time of crop sowing season on the basis of their characteristics are as follows.

Varieties	Source	Varieties	Source
Kawe Terma	Germany	Sibel	Belgium
Prima Poly	Denmark	KWS Pak-937	Germany
KWS-9211	Germany	KWS Pak-691	Germany
Allyx	Belgium	Cadyx	Belgium
Aura	Germany	KWS Pak-238	Germany

The data were recorded on the following parameters i.e. plant population, bolting, disease resistance, root length, root girth, pol%, root yield, sugar yield, insect pest, leaf root ratio, leaf length, leaf width, brix and purity.

The number of seeds were counted and planted. The data on plant population was recorded after thinning of the crop. After germination, the plant population was determined. Data on bolting was recorded in March and April. Data on the three prevalent diseases i.e. Cercospora, Phoma and Schlerotium rot was recorded on %age basis of diseased plants in April and May. The leaf length and leaf width was determined with the help of measuring tap at the time of harvest. Root length and girth was calculated on the basis of beet length + girth using measuring tap and vernier calliper at the time of harvest. Root girth was measured at three girth sites, upper, central and lower tips and averaged each root. For pol%, beetroots were washed and then crushed with crusher. Samples were taken and mixed with distilled water, then stirred thoroughly for 3 min in a juicer. After full stirring the fluid was poured in a beaker and filtered in another beaker through a funnel with filter paper. The filtered fluid was subjected to Saccharimetry, which gave reading for pol%. Data on root yield tons ha^{-1} was measured by using spring balance at harvest time. The formula was as follows.

$$\text{Root yield tons ha}^{-1} = \frac{\text{Root yield kg} \times 10000}{1000 \times \text{Plot size}}$$

Data for sugar yield (tons ha^{-1}) was determined by using the following formula.

$$\text{Sugar yield (tons ha}^{-1}) = \frac{\text{Root yield tons ha}^{-1} \times \text{Pol \%}}{100}$$

The data on insect/pest attack was recorded in March 2001. The No. of plants affected by insect/pest was assessed. Leaf root ratio was determined as leaves weight $root^{-1}$ weight of the same variety $plot^{-1}$. For Brix reading the samples of root beets were collected, washed thoroughly and slices were made through a cutter, these pieces were further crushed with a crusher, giving juicy material. The fluid was taken from the material and a drop of it was poured on a hand referactometre screen. This gave brix, reading. The Purity % was calculated by using the data of brix and pol % by using the following formula.

$$\text{Purity \%} = \frac{\text{Pol \} \times 100}{\text{Brix reading}}$$

Results

Data relating to plant population of sugar beet are reported in Table 1. Analysis of the data indicated that differences in plant population among 10 varieties were non-significant. Mean values of plant population data indicated that maximum plant population was recorded in variety Cadyx (327.000 $plot^{-1}$) followed by variety Aura (325.250 $plot^{-1}$) while minimum plant population was observed in variety KWS Pak-238 (298.250 $plot^{-1}$). The plant population of the rest of the varieties ranged from 305.500 to 319.500 $plot^{-1}$. Haijichristodoulou (1984) tested different sugar beet varieties and reported that varieties were significantly different for plant population, which is not in agreement with the present situation. Itoh (1998) reported that root yield increase with increasing plant density. Mokadem (1993) stated that root length increase with increasing plant density while root diameter and purity were high at low plant density.

Data referring bolting % of sugar beet are shown in Table 1. Perusal of the data depicted that differences in bolting among 10 varieties were highly significant at 5% and 1% level of probability. Mean values of bolting data indicated that maximum bolting was produced by variety KWS Pak-238 (6.750%) followed by variety Cadyx (2.000%) while minimum bolting was observed in variety Prima Poly, KWS-9211, Sibel and KWS Pak-691 (0.000%). The bolting of the rest of the varieties ranged from 0.250 % to 1.750 %. Bolting is undesirable character, because sugar accumulated in roots is used in the formation of bolters, and reduced the total yield and sugar content in the roots as reported by Ayaz *et al.* (1996). Likewise Kamil (1991) also reported that bolting character not only reduce root and sugar yields but also create problem at harvest and slicing in the factory.

Data regarding Cecrcospora Leaf Spot % of sugar beet are given in Table 1. Perusal of the data revealed that differences in disease resistance among 10 varieties were significant at 5 and 1% level of probability. Mean values

Table 1: Plant population, bolting, cercospora leaf spot, beet length and girth of exotic genotypes of sugar beet

	Mean values				
Genotypes	Plant population	Bolting (%)	Cercospora leaf spot (%)	Beet length (cm)	Beet girth (cm)
Kawe Terma	309.000	0.250	30.000	39.125	14.688
Prima Poly	319.500	0.750	30.000	38.250	15.188
KWS-9211	314.000	0.000	20.000	43.750	14.688
Allyx	312.750	0.000	17.500	43.125	17.125
Aura	325.250	6.750	6.250	38.125	18.250
Sibel	319.000	0.00	12.500	49.125	17.125
KWS Pak-937	305.500	1.750	26.250	42.750	15.375
KWS Pak-691	318.000	0.500	27.500	39.125	15.563
Cadyx	327.000	2.000	22.50	41.000	16.313
KWS Pak-238	298.250		0.000	41.500	15.688

Table 2: Pol, Root yield, Sugar yield, Aphid and Cutworm infestation of Exotic Genotypes of Sugar beet

	Mean values				
Genotypes	Pol (%)	Root yield (tons ha^{-1})	Sugar yield (tons ha^{-1})	Aphid ($Plant^{-1}$)	Cutworm (%)
Kawe Terma	15.275	74.315	11.36	0.668	2.505
Prima Poly	15.200	79.335	12.06	0.833	2.505
KWS-9211	15.275	74.932	11.45	0.668	2.923
Allyx	14.875	82.810	12.32	0.668	2.922
Aura	15.760	81.035	12.77	0.668	2.505
Sibel	14.650	82.878	12.14	0.583	2.923
KWS Pak-937	14.750	72.540	10.70	0.833	2.923
KWS Pak-691	14.400	76.090	10.96	0.750	2.920
Cadyx	15.250	80.725	12.31	0.583	2.923
KWS Pak-238	15.100	73.232	11.06	0.668	3.340

Table 3: Top $root^{-1}$ ratio, Brix, Purity, Leaf length and Leaf width of Exotic Genotypes of Sugar beet at Sugar Crops Research Institute, Mardan during 2000-2001

	Mean values				
Genotypes	Top $root^{-1}$ ratio (gm)	Brix reading	Purity (%)	Leaf length (cm)	Leaf width (cm)
Kawe Terma	0.369	18.500	82.563	52.950	11.450
Prima Poly	0.332	18.750	81.073	46.725	11.625
KWS-9211	0.305	18.675	81.827	54.050	13.275
Allyx	0.341	18.125	82.060	54.250	12.200
Aura	0.350	19.050	82.050	50.800	13.075
Sibel	0.274	18.025	81.273	52.750	12.200
KWS Pak-937	0.351	18.300	80.583	56.500	12.775
KWS Pak-691	0.326	17.750	81.132	53.900	12.525
Cadyx	0.332	18.500	82.432	53.600	12.625
KWS Pak-238	0.441	18.550	81.413	62.800	14.650

From the results it is concluded that Aura produced maximum pol % and sugar yield and is recommended for commercial cultivation in Peshawar valley.

of disease resistance data indicated that maximum disease resistance was observed in variety KWS Pak-238 (0.000%) followed by variety KWS Pak-691 (27.500%) while minimum disease resistance was observed in variety Kawe Terma and Prima Poly (30.000%). The disease resistance of the rest of the varieties ranged from 6.250 to 26.250%. Ogata *et al.*(1999) developed a new variety and compared with target variety, he observed that the new variety had the same degree of resistance to Cercospora Leaf Spot disease as the target variety. Takahashi *et al.* (1999) compared the new variety with a standard variety for disease resistance and reported that the new variety had more resistance to Cercospora Leaf Spot disease than standard variety. Hayashida *et al.* (1999) tested a new variety for various characteristics and stated that the new variety had a little more resistance to Cercospora Leaf Spot disease as compared to standard variety.

Data referring beet length of sugar beet are shown in Table 1. Analysis of the data indicated that differences in beet length among 10 varieties were significant at 5% level of probability. Mean values of the data indicated that maximum beet length was produced by variety Sibel (49.125 cm) followed by variety KWS-9211 (43.750 cm) while minimum beet length was observed in variety Aura (38.125 cm). The beet length of the rest of the varieties ranged from 38.250 to 43.125 cm. Mokadem (1993) has reported that root length increased with increasing plant density.

Data relating to beet girth of sugar beet are given in Table 1. Statistical analysis of the data revealed that differences in beet girth among 10 varieties were non-significant. Mean values of beet girth data indicated that maximum beet girth was produced by variety Aura (18.250 cm) followed by varieties Allyx and Sibel (17.125 cm) while minimum beet girth was observed in varieties Kawe Terma and KWS-9211 (14.688 cm). The beet girth of the rest of the varieties ranged from 15.188 to 16.313 cm. Mokadem (1993) reported that root diameter was large at low population density.

Data relating pol% of sugar beet are given in Table 2. Statistical analysis of the data showed that differences in pol% among 10 varieties were significant at 5% level of probability. Mean values of pol% data indicated that maximum pol% was produced by variety Aura (15.760) followed by variety Kawe Terma and KWS-9211 (15.275) while minimum pol% was observed in variety KWS Pak-691 (14.400). The pol% of the rest of the varieties ranged from 14.650 to 15.250 which is at par with the results of Haijichristodoulou (1984). Similarly Cermin *et al* .(1988) tested foreign varieties for different characteristics and observed four varieties with highest sugar content. Kajiyama *et al.* (1998) compared the new variety with two other standard varieties and reported that the new variety had lower sugar concentration than one standard variety while having more sugar content than the other standard variety because the standard variety had low Amino-N content but high content of Ca and Na which are impurities. Ahmed *et al.* (1998) tested varieties from different genetic background and reported that Sibel variety was superior for sugar content. Gribanova *et al.* (1998) reported that minimum concentration of Na, K and alpha-amine led no marked difference in sugar

concentration and also stated that root yield and sugar content was negatively correlated. Itoh *et al.* (1998) reported that plant density increases sugar content and compared a new variety with standard variety and observed that new variety was superior to standard varieties in respect of sugar content and had low level of harmful non-sugars.

Data regarding root yield tons ha^{-1} of sugar beet are presented in Table 2. Statistical analysis of the data revealed that differences in root yield tons ha^{-1} among 10 varieties were non-significant. Mean values of root yield tons ha^{-1} data indicated that maximum root yield tons ha^{-1} was produced by variety Sibel (82.878) followed by variety Allyx (82.810) while minimum root yield tons ha^{-1} was observed in variety KWS Pak-937 (72.540). The root yield tons ha^{-1} of the rest of the varieties ranged from 73.232 to 81.035. Sarwar *et al.* (1994) tested ten varieties and reported two varieties with highest root yield. Todorcic *et al.* (1983), Haijichristodoulou (1984) and Becvar *et al.* (1998) observed significant differences in root yield for varieties, which is not in conformity with the present situation. But Rosenfeld (1984) reported non-significant differences among varieties for root yield, which support the present situation. Cermin *et al.* (1988) tested some varieties and stated that two varieties exceeded the standard variety for root yield. Hayashida *et al.* (1997) tested a new variety against two standard varieties and observed that new variety was superior to both of the standard varieties in root yield. Almani *et al.* (1997) reported that one of the reason for low root yield was the low water supply. Ahmed *et al.* (1998) tested varieties of different origin and genetic background and observed that Sibel variety gave the highest root yield, which is similar to the present situation.

Data regarding sugar yield tons ha^{-1} of sugar beet are presented in Table 2. The data revealed that sugar yield tons ha^{-1} was different from variety to variety. Statistical analysis of the data showed that differences in sugar yield tons ha^{-1} among 10 varieties were significant at 5% level of probability. Mean values of sugar yield tons ha^{-1} data indicated that maximum sugar yield tons ha^{-1} was produced by variety Aura (12.77) followed by variety Allyx (12.32) while minimum sugar yield was observed in variety KWS Pak-937 (10.70). The sugar yield of the rest of the varieties ranged from 10.96 to 12.31 t ha^{-1}. Cermin *et al.* (1988) reported a commercial variety with the highest sugar yield. Mac Donald and Mc Cullagh (1991) observed the highest sugar yield in three varieties with lowest impurities level and least bolting. Ahmed *et al.*(1998) observed that Sibel variety was superior to commercial variety Kawe Terma in respect of sugar yield, which support the present situation. Takahashi *et al.* (1999) compared a new variety with standard variety and reported that the new variety had high sugar yield than standard variety because it had high root yield. Itoh *et al.* (1998) stated that sugar yield increase with high plant population.

Data concerning aphid $plant^{-1}$ infestation in sugar beet are shown in Table 2. Analysis of the data depicted that differences in aphid infestation among the 10 varieties were non-significant. Mean values of aphid infestation data indicated that maximum infestation was observed in variety Prima Poly and KWS Pak-937 (0.833) aphids $plant^{-1}$ while minimum infestation was observed in variety Sibel and Cadyx (0.583) aphids $plant^{-1}$. Bennewicz (1995) reported that aphid population depends on the variety. He further studied that due to the presence of phenolic compound the varieties become resistant to aphids attack and the number of aphids is directly proportional to free amino acids.

Data referring cutworm % infestation of sugar beet are given in Table 2. Perusal of the data showed that differences in cutworm infestation among 10 varieties were non-significant. Mean values of cutworm infestation data indicated that maximum infestation was observed in variety KWS Pak-238 (3.340%) while minimum infestation was observed in variety Kawe Terma, Prima Poly and Aura (2.505%).

Data concerning top $root^{-1}$ ratio of sugar beet are reported in Table 3. Perusal of the data depicted that differences in top $root^{-1}$ ratio among 10 varieties were non-significant. Mean values of top $root^{-1}$ ratio data indicated that maximum top $root^{-1}$ ratio was produced by variety KWS Pak-238 (0.441 gm) followed by variety Kawe Terma (0.369 gm) while minimum top $root^{-1}$ ratio was observed in variety Sibel (0.274 gm). The top $root^{-1}$ ratio of the rest of the varieties ranged from 0.305 gm to 0.351 gm. Takahashi *et al.* (1999) compared a new variety with a standard variety and reported that the new variety had lower top $root^{-1}$ ratio than standard variety because it had lower top weight and high root weight. Marlander and Rover (1994) reported that competition for light at high plant density causes an increase in top $root^{-1}$ ratio but decreases root yield.

Data regarding brix of sugar beet are presented in Table 3. Statistical analysis of the data revealed that differences in brix values among the 10 varieties were non-significant. Mean values of brix data indicated that maximum brix value was given by variety Aura (19.050) followed by variety Prima Poly (18.750) while minimum brix value was observed in variety KWS Pak-691 (17.750). The brix value of the rest of the varieties ranged from 18.025 to 18.675.

Data relating purity % of sugar beet are reported in Table 3. Analysis of the data depicted that differences in

purity among 10 varieties were non-significant. Mean values of purity data indicated that maximum purity was attained by variety Kawe Terma (82.563%) followed by variety Cadyx (82.432%) while minimum purity was observed in variety KWS Pak-937 (80.583%). The purity of the rest of the varieties ranged from 81.037 to 82.060%. Mokadem (1993) tested different sugar beet varieties for certain characteristics and reported that purity was maximum at low plant density.

Data regarding leaf length of sugar beet are presented in Table 3. Statistical analysis of the data revealed that differences in leaf length among the 10 varieties were highly significant. Mean values of leaf length data indicated that maximum Leaf length was produced by variety KWS Pak-238 (62.800 cm) followed by variety KWS Pak-937 (56.500 cm) while minimum leaf length was observed in variety Prima Poly (46.725 cm). The leaf length of the rest of the varieties ranged from 50.800 to 54.250 cm. Data relating leaf width of sugar beet are reported in Table 3. Analysis of the data indicated that differences in leaf width among 10 varieties were significant. Mean values of leaf width data indicated that maximum leaf width was produced by variety KWS Pak-238 (14.650 cm) followed by variety KWS-9211 (13.275 cm) while minimum leaf width was observed in variety Kawe Terma (11.450 cm). The leaf width of the rest of the varieties ranged from 11.625 to 13.075 cm.

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