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CHEMICAL COMPOSITION OF OPEN POLLINATED AND HYBIRD POPULLATION OF SUNFLOWER (HELIANTHUS ANNUUS L.)

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Abstract

Sunflower is the world fourth most important sources of edible oil. A lot of work has been done for varietals improvement through conventional breeding in Pakistan. Sunflower is the cash crop and is easily adapted to many region of Pakistan, genetic and agronomical improvement was needed so that economically valuable crop could be harvested. In the present work, 16 cultivars (open pollinated population "OPP" and hybrid population "HP" eight each) of sunflower was evaluated. The study was aimed at evaluating the mineral composition, estimation of moisture contents, measuring electrical conductivity and 100 seeds weight. The mineral composition was fractionated though Atomic Absorption Spectrometer, which indicate that Zn^{+2} was 8.54 and 9.35%; Cu^{+2} 0.5 and 0.02%; Mn^{+2} 3.48 and 9.72%; Co^{+2} 18.67 and 16.81%; Mg^{+2} 68.27 and 83.53%; Fe^{+3} 4.32 and 4.35% were estimated in HP and OPP respectively. Similarly, moisture contents 6.26 and 6.78%, and 1000-seeds weight 510.8 and 598g were calculated in the HP and OPP respectively. In comparative picture the mineral concentration, moisture contents and 100 seeds weight in open pollinated population were high as compared to hybrid. A total of 11.7 % genetic diversity was observed in mineral composition of both the populations. The EC was high in HP ranging from 70. 85–137.8, while comparatively low in OPP ranged 46.81 – 120.18.

Introduction

Sunflower (*Helianthus annuus* L., Asteraceae), currently cultivated for its seeds, is the world's fourth largest oil-seed crop. World seed production was 25.2 million tones during 1995/1996 from approximately 50 million hectore of cultivated land. Sunflower cultivation has great potential as oilseed crop in Pakistan because it is well adapted to the climatic conditions and is successfully grown in various regions of the country. Sunflower seeds contain 49% oil, which is a rich source of essential fatty acids. The seed cake formed after oil extraction contains 35-40% proteins, minerals, carbohydrates and has a balanced amino acid profile. However, the presence of such undesirable and antinutritive compounds as crude fiber, phytic acid, and polyphenols makes it unsuitable for incorporation in poultry feed. Moreover, industrial processing of oilseeds for maximum oil extraction using expellers causes changes in the natural properties of the oilseed meals (Shah *et al*., 1978). Sunflower protein is of great interest because it represents a potential source of inexpensive protein for feeding livestock and also for human consumption. An additional advantage of using these by-products as a source of protein is that it reduces the environmental problems associated with their disposal. The sunflower (*Helianthus annuus* L.) de-fatted meal that is left after oil extraction is a typical case of such by-products. Sunflower is one of the more important oilseed crops cultivated in the world, representing the fourth-largest source of edible oil (Lühs & Friedt, 1994). The present study was carried out to characterize sunflower populations for mineral composition and physiochemical parameters. The purpose of the study was to investigate the genetic differences among the open pollinated population (OPP) and hybrid populations (HP) of sunflower. This analysis may determine the suitability of any population on the basis of its nutritional value.

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Materials and Methods

Two population of sunflower was included in the present study. Each population contain eight varieties i.e. OPP (Open-V 1, Open-V 2, Open-V 3, Open-V 4, Open-V 5, Open-V 6, Open-V 7 and Open-V 8) and HP (HP-V 1, HP-V 2, HP-V 3, HP-V 4, HP-V 5, HP-V 6, HP-V 7 and HP-V 8). The seeds of the populations were obtained from Agriculture University Peshawar, Khyber Pakhtunkhwa, Pakistan.

Sunflower seeds were processed for the analysis of physiochemical parameters like moisture content, electrical conductivity, 1000-seed mass and elemental composition. Elemental composition of sunflower seeds was determined by dry ashing according to the method as reported by Jones *et al*., (1991). Mineral composition (Zinc, Copper, Manganese, Cobalt, Magnesium and iron) was determined by Atomic absorption spectrophotometer. The percent standard deviation of mineral element was calculated using statistical software (SPSS-Vr 14). The percentage of each element was determined, to check the level of genetic diversity in both the population.

Moisture content was determined by standard method used by Ellis *et al*., 1995. Electrical conductivity of sunflower seeds was determined by imbibitions method at equal interval of 10, 20, 30, 40, 50 and 60 minutes respectively. The 1000-seed mass (TSM) was measured through analytical balance. The percentage was calculated using Microsoft Excel 2007.

Results

Mineral concentrations of eight HP varieties are shown in Table 1, while Table 2 shows the mineral concentration in eight OPP varieties. It is calculated that the amount of Zn ranging from 4.9-12.4% - 3.6-14.9%; Cu 0.1-0.9% - 0.01-0.3%; Co 12.2-23.1% - 13.4-20.6%; Mg 53.41-92.86%-65-100%; Fe 2.9-6.0% - 3.2-6.8%, was recorded in both Hybrid and open pollinated populations respectively (Table 1 and 2).

In comparative analysis Zn^{+2} was 8.54 and 9.35%; Cu^{+2} 0.5 and 0.02%; Mn^{+2} 3.48 and 9.72%; Co^{+2} 18.67 and 16.81%; Mg^{+2} 68.27 and 83.53%; Fe^{+3} 4.32 and 4.35% were estimated in HP and OPP respectively (Table 1 and 2).

A total of 11.7% genetic diversity was observed in mineral composition of both the populations. High level of %RSD was recorded in Cu^{+2} (23.21%), Fe^{+3} (20.89%) and Mn^{+2} (11.56%) (Table 3).

Moisture contents in percent were measured in order to know the level of water content of sunflower seeds which is important in terms of yield. The moisture content ranged 5.3-7.039% - 5.581-8.411% in both the populations respectively. Furthermore, high level moisture contents were observed in OPP as compare to HP (Table 4).

Electrical conductivity of sunflower seeds was determined by conductometer after different time intervals i.e., 10 minutes, 20 minutes, 30 minutes, 40 minutes, 50 minutes and 60 minutes respectively. The data regarding electrical conductivity of the two populations are present in Table 4. The property of a sample to pass electric current is due to the oozing of ions from sample material in the solution is known as electrical conductivity (EC). Maximum EC in HP was found to be 94.2 µs for HP-PV 6 variety after 10 minutes. The highest value of 159.4 µs was found for HP-PV 8 after 60 minutes. While in OPP, the maximum value was found to be 77.3 µs for Open V6 after 10 minutes, and after 60 minutes the highest value of 210 µs was found for Open-V2. Comparatively, high level of EC was observed in HP ranging 70.85–137.88 µs, while low in OPP ranged 46.81 – 120.18 µs (Table 4).

Table 1. Minerals concentration of eight varieties of hybrid Population (HP) of Sunflower seeds.

varieties	Mineral composition											
	Zn^{+2}		Cu^{+2}		Mn^{+2}		Co^{+2}		Mg^{+2}		Fe^{+3}	
	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD
HP-PV 1	8.4	4.82	ND	ND	2.9	13.42	20.8	2.68	64.25	0.52	3.2	18.05
HP-PV 2	4.9	5.63	ND	ND	1.7	15.24	23.1	2.35	62.54	1.53	2.9	34.94
HP-PV 3	7	0.73	ND	ND	3.7	31.22	21.8	1.89	63.87	1.2	4.6	29.39
HP-PV 4	9.2	2.94	ND	ND	2.8	3.78	12.2	13.07	57.85	0.77	5	12.56
HP-PV 5	10.1	1.83	0.9	40.61	4.5	4.05	15.8	10.36	79.49	4.12	6	3.62
HP-PV 6	7.8	5.53	ND	ND	3.3	34.47	17.1	8.68	71.89	2.32	3.4	32.8
HP-PV 7	12.4	0.94	0.1	35.16	5.2	18.37	18.4	10.78	92.86	2.81	4.4	11.29
HP-PV 8	8.5	6.01	ND	ND	3.7	7.59	20.1	10.11	53.41	0.32	5.1	12.36
AVA	**8.54**	**3.55**	**0.50**	**37.89**	**3.48**	**16.02**	**18.66**	**7.49**	**68.27**	**1.70**	**4.33**	**19.38**

Sample percentage of each trace element; % RSD = Percent Standard deviation; ND = Not detected, %age= Percentage.

Table 2. Minerals concentration of eight varieties of Open Pollinated Population of Sunflower seeds.

Open pollinated	Mineral composition											
	Zn^{+2}		Cu^{+2}		Mn^{+2}		Co^{+2}		Mg^{+2}		Fe^{+3}	
	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD	% Age	%RSD
Open-V1	13.9	1.71	ND	ND	10.9	12.68	17	4.61	100	9.42	6.8	9.89
Open-V2	10.1	3.3	ND	ND	8.9	5.63	20.6	11.03	88.91	2.27	3.9	19.9
Open-V3	3.6	6.28	ND	ND	7.5	9.23	15.5	22.57	65.7	1.32	3.5	21.03
Open-V4	6.5	1.38	ND	ND	8.4	11.9	13.4	3.93	78.67	1.62	4.1	30.7
Open-V5	4.4	6.95	0.03	9.21	9.1	2.92	16.9	4.83	80.09	2.42	3.2	27.03
Open-V6	9.9	3.49	ND	ND	10.1	3.58	15.8	8.19	56.03	0.83	3.6	48.11
Open-V7	11.5	2.57	0.001	7.86	11.2	6.93	18.3	13.23	100	2.47	4.5	11.34
Open-V8	14.9	3.92	ND	ND	11.7	3.93	17.01	8.3	94.82	3.91	6.8	11.15
AVA	**9.35**	**3.7**	**0.016**	**8.535**	**9.725**	**7.1**	**16.81**	**9.5863**	**83.03**	**3.0325**	**4.55**	**22.394**

Sample percentage of each trace element; % RSD = Percent Standard deviation; ND = Not detected, %age= Percentage.

Table 3. The level of genetic diversity in both hybrid and open pollinated population.

	Zn^{+2}	Cu^{+2}	Mn^{+2}	Co^{+2}	Mg^{+2}	Fe^{+3}	AVA %RSD
Hybrid population	3.55	37.89	16.02	7.49	1.70	19.38	14.34
Open pollinated population	3.70	8.54	7.10	9.59	3.03	22.39	9.06
% RSD	**3.63**	**23.21**	**11.56**	**8.54**	**2.37**	**20.89**	**11.70**

% RSD = Percent Standard deviation; AVA-average

Thousand seed mass is an important parameter regarding productivity of crop. Thousand seed mass of the varieties of two populations of sunflower seeds was carried out by measuring the weight of thousand seeds of each variety through electrical balance. The TSM values had variations due to different varieties of Sunflower used. Data regarding thousand seed mass of Sunflower are given in the Table 3 for Hybrid and Open pollinated populations respectively. Significantly, OPP showed maximum yield as compare to HP (Table 4).

Discussion

This study was carried out to evaluate the physiochemical and elemental characterization of seeds of two different populations of Sunflower, that is Hybrid and Open pollinated populations having eight varieties in each population.

The amount of *Zn* ranges from 4.9% to 12.4% in the varieties of HP, while in the OPP the range is from 3.6% to 14.9%. In HP, the lowest value of Zn was 4.9% for HP-P V 2 variety and the highest value was 12.4% for HP-P V 7. In OPP, the lowest value was 3.6% for Open-V 3 and the highest value was 14.9% for Open-V 8. Seeds of Sunflower plants may accumulate more Zn in environment having high Zn concentration (Murillo *et al*., 1999). The recommended dietary allowances are 8mg/day (Ensminger *et al*., 1993). The Zn deficiency associated with malabsorption, acrodermatitis, chronic lever disease and many more (Parsad, 2003). The cultivar having high percentage of Zn, would be better sources for human healthcare against the diseases caused by Zn deficiency.

The sunflower is a good source of Copper and daily requirement is 0.9mg/day. The deficiency can often produce anemia and also produces depression (Ensminger *et al*., 1993). In the present investigation, high level of genetic diversity was recorded in Cu percentage. The plant breeder can develop a cultivar having significant level of Cu concentration. The range of Cu in HP is 0.1% to 0.9%, the highest value is for HP-P V 5 and the lowest value is for HP-P V 7. In OPP, the range is 0.01% to 0.3%, the maximum value is for Open-V 5 and the minimum value is for Open-V 7. Najib & Al-Khateeb (2004) observed the amount was 0.71% which does not satisfy the present results.

Manganese is an essential trace nutrient in all form of life (Emsley 2001). The human body contains about 10 mg of Mn, mainly stored in the liver and kidney. In this study the range of Mn in HP is 1.7% to 5.2%. The highest value is for HP-P V 7 and the lowest value is for HP-P V 2. While in OPP the range is 7.5% to 11.7%, the lowest value is for Open-V3 and the highest value is for Open-V 8, the finding deviates from that of Anderson *et al.,* (1993). A gradual increase in the concentration of Mn occurs from Open population to Hybrid population as shown in the Tables 1 and 2 respectively. That is due to the location of the growth of OPP in the open field. The amount of Co ranges from 12.2%-23.1% in HP, the lowest value is for HP-P V 4 and the highest value is for HP-P V 2. While in Open pollinated population the range is 13.4%-20.6%, the lowest and highest value is for Open-V4 and Open-V 2, which are the corresponding varieties of the HP. The concentration of Co in HP is more than that of the OPP as shown in Tables 1 and 2 respectively. The present result is against the results of Nwokolo & Sim (1989).

Table 4. Physicochemical parameters and 1000-seeds weight of eight varieties of Hybrid Population (A) and Open pollinated (B) of Sunflower seeds.

S. No	Population	Electrical conductivity (µS)												Moisture contents (%)		1000 seeds ass (g)	
		10 min		20 min		30 min		40 min		50 min		60 min					
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	V1	42.3	39.1	67.5	50.4	79.1	66.3	86.4	75.3	97.5	83.7	99.9	87.9	6.2	6.26	500	575
2	V2	72.7	73	94.3	145.5	109.6	173.3	126	197.9	135.4	199	146.1	210	7.04	8.41	483	535
3	V3	85.5	44.8	91.8	64.4	101.2	82.9	108.9	94.8	120.2	106.9	131.2	117.7	5.3	7.26	566	620
4	V4	65.6	17.4	85.9	30.3	113.7	39.4	121.6	47	130.3	54.5	132.3	58.3	6.64	6.02	542	515
5	V5	64.2	38.5	96.6	51.8	119.5	67.7	126.2	78.7	136.9	92.5	142.7	101.2	6	5.58	550	842
6	V6	94.2	77.3	98.4	79.4	106.7	95.5	124	116.3	130.9	138	143.8	150.8	6.71	7.09	447	494
7	V7	64.1	47.7	91.3	73.6	110.9	85.1	118.6	100.3	132.7	118.3	147.6	128.4	6.17	6.82	535	762
8	V8	78.2	36.7	114.6	61	132.4	71.7	149.6	87.8	152.4	98.7	159.4	107.1	6.03	6.8	464	441
AVA	**70.85**	**46.81**	**92.55**	**69.55**	**109.14**	**85.24**	**120.16**	**99.76**	**129.54**	**111.45**	**137.88**	**120.18**	**6.26**	**6.78**	**510.88**	**598.00**	

Mg is essential nutrients for human health; the daily intake is 300-400 mg/day. The deficiency/inadequate magnesium intake cause cardiovascular disease, diabetes, high blood pressure, anxiety disorders, migraines, osteoporosis and cerebral infarction (Larsson *et al*., 2008). The amount of Mg detected in the present study ranges from 53.41-92.86% in HP, while lowest was in HP-P V 8 and the highest is for HP-P V 7. In OPP, the range was 65.03s-100%, the minimum value is for Open-PV 6 and the maximum value is for Open-V 1 and Open-V 7. In HP the amount of Iron (Fe) ranges from 2.9% to 6.0% in and in OPP it was 3.2% to 6.8%. Lopez-Millan (2000) determined that Fe concentration in Sunflower plant ranges from 5.7% to 6.3%. The lowest value deviate from the Lopez-Millan (2000) work, while the largest value correlate with each other. In the present study the concentration of Fe in OPP is greater than the HP. The variety Open V 1 has largest values (6.8%) while the corresponding variety in HP (P V 1) values 3.2%.

The amount of moisture contents observed in the present study ranges from 5.3% to 7.039% in HP, Maximum value was found for HP-P V 2 (7.039%) and minimum value is for HP-P V 3 (5.3%) in HP. while in OPP the range is 5.581% to 8.411%. the highest value is for Open-V 2 (8.41%) and the smallest value is for Open-V 5 (5.581%). The moisture contents of the HP are less than their corresponding varieties in OPP. The decrease is due to the high fat contents in HP**.** The EC is negatively correlated to germination frequency i.e., higher the level of EC lower be the germination frequency and vice versa (Hsu *et al*., 200). In the present study the EC of OPP (46.81-120.18 µs) was lower as compare to HP (70.85-137.88 µs).

The TSM values had variations due to different varieties of sunflower used. In the present study the high value of TSM was found 566g for HP-P V 3 and low value 447 g for HP-P V 6 in Hybrid population. While in OPP, maximum value is 842 g for Open-V 5 and minimum value is 441 g for Open-V 8. By comparing the data of the two populations, it was concluded that TSM value of OPP are greater than their corresponding varieties in HP. This is due to the high genetic variability in the pollens in Open field pollination. The present study deviates from the results of Laoniste *et al*., (2004).

Conclusion

Based on our results, with the exception of EC, the percentage of mineral composition, percent moisture contents and 1000-seeds mass (g) were high in OPP, in comparison to HP. High level of genetic diversity have been documented in the population. It might be the fact that important genes have been transferred to OPP through different pollination vectors from different sources of sunflower plant, while the HP was pollinated with mono-culture pollens (the pollens was from the selected sunflower plant) and was not diverse, which reflect low level of mineral composition, moister content, 1000-seeds weight and EC value.

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