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AGRONOMIC CHARACTERISTICS OF SPRING PLANTED SUNFLOWER HYBRIDS AS INFLUENCED BY POTASSIUM APPLICATION

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ABSTRACT

Agronomic traits ultimately contribute to final achene yield and improvement in agronomic traits means increase in achene yield. A field trial was conducted at experimental area of Agronomy Department, PMAS Arid Agriculture University, Rawalpindi during 2008 and 2009 to evaluate the performance of two sunflower hybrids *i.e* S-278 and Hysun-33 under different levels of K application (0, 50, 100, 150, 200, 250 and 300 Kg ha^{-1}). The experiment was laid out in randomized complete block design with three replications in split plot arrangement keeping K levels in main plot and sunflower hybrids in sub plots. It was observed that K application did not significantly improve plant height, head diameter, 1000-achene weight, achene yield, stalk yield and harvest index except number of achene $head^{-1}$, where application of K showed significant improvement. Among sunflower hybrids, S-278 produced significantly taller plants, heavier 1000-achene weight, higher achene and stalk yield, but lesser harvest index than that of Hysun-33. Both hybrids were, however, similar for head diameter and number of achene $head^{-1}$. Sunflower hybrid S-278 produced the highest achene yield when crop was fertilized with K @ 150 Kg ha^{-1} due to heavier 1000-achene weight. Similar trends were observed for stalk yield. Sunflower hybrid Hysun-33 produced the lowest achene yield when crop was grown with K. Hysun-33 produced the highest harvest index when crop was fertilized @ 100 Kg K_2O ha^{-1}. Similarly, S-278 produced the lowest harvest index when crop was fertilized @ 100 Kg K_2O ha^{-1}. It is therefore suggested that sunflower hybrid S-278 should be cultivated with K application @ 150 Kg ha^{-1}.

Key Words: Sunflower, hybrids, K levels, agronomic traits.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in our country. It has shown its potential to contribute its share in domestic edible oil requirements. It has lion's share (34.1 g) in per capita vegetable oil consumption of daily oil intake (83 g) in our country (Anonymous, 2009). Sunflower cooking oil is extensively used by heart patients because of very low cholesterol and high fatty acid concentration (Ahmad and Hassan, 2000; Chaudhary and Mushtaq, 1999).

Pakistan is bestowed with various ecologies, where sunflower can be cultivated because of its wide range of adaptability. Here sunflower can be grown twice in a year during spring and winter. Sunflower grown in spring is usually slower in growth than that sown in autumn (Kaleem *et al*., 2009). Agronomic and yield traits such as plant height (Ahmad and Hassan, 2003), number of achenes $head^{-1}$ (Kaleem *et al*., 2009), 1000-achene weight (Hassan *et al*., 2005) in sunflower are significantly influenced by the temperature, growth durations which are particular characteristics of seasonal changes (Killi *et al*., 2005; Qadir *et al*., 2007). Longer reproductive phase and warmer temperature at the time of seed development (spring sown) of sunflower is favorable for bumper achene yield and its contributing parameters (Kaleem *et al*., 2009) as well as biomass (Ahmad, 1993) than that of autumn season with high temperature and low relative humidity at the time of pollination which affects pollen vigor, causing poor pollination produces less weight and infertile achenes ultimately leading to head infertility and low achene yield (Miralles *et al*., 1997; Weiss, 2000).

Sunflower hybrids available in Pakistani markets exhibited diversity in their response to K application (Matre *et al*., 2009). These hybrids, because of their difference in their root system and penetration capacity, vary in their response to achene yield (Richards, 2006) as well as stalk yield (Weiss, 2000). Other yield contributing parameters also vary in its consequence. The hybrids which remained for longer duration in the field produced higher yield and yield components including head diameter (Matre *et al*., 2009), plant height (Khan *et al*., 1999; Goksoy *et al*., 2004), number of achenes $head^{-1}$ (Sadiq *et al*., 2000; Saeidi, 2007), 1000-achene weight (Razi and Assad, 1999; Bajehbaj *et al.*, 2009) and achene yield (Ayub *et al*., 1999; Weiss, 2000).

Potassium (K), one of the three primary nutrients, is absorbed by plants in larger quantities than any other element; expect N (Bukhsh *et al*., 2009). K plays a vital role as macronutrient in plant growth and sustainable crop production (Pettigrew, 2008). It maintains turgor pressure of cell which is essential for cell expansion. It helps in osmo-regulation of plant cell, assists in opening and closing of stomata (Bukhsh *et al*., 2010). It plays a key role in activation of more than 60 enzymes (Tisdale *et al.*, 1990). Its application has primitive effect on growth and development (Brar and Singh, 1995) and grain yield in maize (Davis *et al.*, 1996). It not only affects the transport of assimilates but also regulates the rate of photosynthesis. It is known for its interaction both antagonistic and synergistic with essential macro and micro nutrients (Dibb and Thomson, 1985). K addition increases its tissue levels in plants and about 80 to 90 % of K absorbed by the plants is found in straw. K is recognized important for efficient N utilization and have a fairly consistent effect on lowering tissue concentration of Ca and Mg (Terman *et al.,* 1975). An adequate supply of K confers drought tolerance and frost resistance in plants (Coranzzina *et al.*, 1991; Jhonson, 1984; Kemmeler and Krauss, 1989). It has been found that foliar application of K has increased quality and yields of maize (Barel and Black, 1979; Giskin *et al.*, 1984; Giskin and Efron, 1986). Another study demonstrated that K salts effectively suppressed and controlled powdery mildew diseases on various crops (Reuveni *et al.*, 1996).

There is general consensus that the soils of Pakistan have large capacity to provide available K to crop under ordinary condition most probably due to dominance of illite soil clay minerals (Ranjha *et al.*, 1990; Bukhsh *et al*., 2009), but the increase in the intensity of cropping (Dobermann *et al*., 1996a, 1996b), substantial removal of straw from the field (Jiyun and Zhang, 1999), excessive use of tube well water and introduction of high yielding varieties in various cropping systems (Regmi *et al*., 2002, Gami *et al*., 2001, Mohsen, 2007, Yadvinder *et al.*, 2005) have resulted in considerable drain of soil K reserves and crops are becoming responsive to K fertilization. It was imperative to conduct a study to evaluate various morphological/agronomic traits of different sunflower hybrids under different levels of potassium in spring conditions of Rawalpindi District.

MATERIALS AND METHODS

The study was conducted at the experimental area, Department of Agronomy, PMAS Arid Agriculture University, Rawalpindi, Pakistan during spring 2008 and 2009. Before sowing the crop, soil samples were collected to a depth of 30 cm from the experimental area and analyzed for physico-chemical properties (Table 1).

The experiment was sown on an irrigated sandy clay loam soil. Replicated four times, the experiment was laid out in split plot design keeping potassium levels (0, 50, 100, 150, 200, 250 and 300 Kg ha^{-1}) in main plots and sunflower hybrids in subplots. Net plot size measured 3.60m x 7.20 m. Crop was sown manually using a dibble on a well prepared bed. Both hybrids Hysun-33 and S-278 were sown on February 7 and 4 during 2008 and 2009, respectively. A recommended rate of 7.5 kg ha^{-1} was used. A basal dose of fertilizer @ 100 kg N+100 kg P_2O_5 ha^{-1} and K in the form of urea, DAP and potassium sulfate was applied. All the P, K and half dose of the N were applied at the time of sowing, while rest of the urea was applied with first irrigation (4 weeks after sowing). Subsequent irrigations were given when needed. In addition to soaking irrigation for seed bed preparation 4 and 6 irrigations of 7.5 hectare centimeters each were given to the crop during spring 2008 and 2009. Thinning was done at 4-5 leaf stage to maintain an intra row plant to plant distance of 20 cm. Plant population was constant in all treatments. Crop was kept free of weeds by providing interculture and hand weeding as required to avoid competition between weeds and sunflower crop. Crop was harvested manually on June 4 and 1 during 2008 and 2009, respectively. Seed yield was recorded at 15 % moisture content.

Table 1: Pre-sowing physico-chemical analysis of soil

	Determination	Unit	Value	
			2008	2009
a.	**Physical analysis**			
	Sand	%	65	63
	Silt	%	15	16
	Clay	%	20	21
	Textural class		Sandy clay loam	
b.	**Chemical analysis**			
	Saturation	%	36	35
	pH		7.9	7.8
	EC_e	dS m^{-1}	2.21	2.19
	Organic matter	%	0.83	0.79
	Total nitrogen	%	0.043	0.032
	Available phosphorus	Ppm	7.2	7.2
	Available K	Ppm	152	165

Plant height was measured (in centimeters) at the completion of flowering. Ten plants were selected at random from each sub plot and their heights were measured from the soil surface up to top of flower. Ten heads were taken from randomly selected plants before harvesting from each sub plot. Diameter of each head was measured with the help of a measuring tape. Five sunflower heads from each sub plot/treatment were selected at random and threshed separately. Their number of achene per head was recorded separately and then averaged.

Two samples of 1000-achenes were taken at random from each sub-plot and weighed on automatic electric balance. Seed yield was recorded on sub plot basis and then converted in to t ha^{-1}. For stalk eight, weight of air dried stalks (along with leaves) per sub plot was recorded after threshing the seed and then converted into t ha^{-1}. Harvest index was calculated by using the following formula as described by Hunt (1978).

Harvest Index= Achene yield x 100/biological yield

Data of both years were pooled and their average was taken. These data were analyzed by Fisher's analysis of variance techniques using least significant difference test at 5% level of probability to compare the differences among treatment means (Steel *et al*., 1997). Weather data for both years were obtained Meteorological office, Islamabad (Table 2).

Table 2: Meteorological data taken during 2008 and 2009

	Max. Temperature (°C)	Min. Temperature (°C)	Relative Humidity (%)	Rainfall (m.m.)
February, 2008	29.90	12.92	60.00	81.00
March, 2008	34.00	15.90	44.00	18.00
April, 2008	37.30	19.80	42.00	80.60
May, 2008	37.60	23.00	51.00	22.30
June, 2008	35.93	21.98	72.06	95.60
Average/Total	34.94	18.72	53.81	297.5
February, 2009	30.05	12.02	51.57	15.00
March, 2009	29.70	15.77	59.33	92.90
April, 2009	37.16	20.76	40.00	10.10
May, 2009	35.57	22.29	62.43	225.0
June, 2009	34.05	22.05	74.40	149.0
Average/Total	33.31	18.57	11.51	641

RESULTS AND DISCUSSION

Plant Height: K did not significantly affect growth in sunflower plant height. By contrast, both hybrids significantly differed from each other with respect to their height. The hybrid S-278 produced significantly taller plants than that of Hysun-33 (Table 3). This difference in plant height may be attributed to varying genetic make up of two hybrids for that trait. Similar plant height was recorded in various treatment combinations as they did not significantly differ from one another. These results are in line with the findings of Ahmad (1993), however, Goksoy *et al*. (2004) and Khan *et al*. (1999) those reported that K application did not influence plant height.

Head Diameter: Head diameter was not significantly influenced by various levels of K application. Non significant effect of K application on head diameter has also been reported by Matri *et al*. (2009), while Weiss (2000) found an increase in head diameter with K application. Both sunflower hybrids recorded statistically equal head diameter. Interactive effects of various K levels and sunflower hybrids on head diameter were found to be non significant. These results are in line with the findings of Saeidi (2007) and Sadiq *et al*. (2000) that K application did not influence head diameter.

No. of achenes $head^{-1}$: Application of K significantly affected number of achene $head^{-1}$. Application of K significantly increased the number of achenes $head^{-1}$ over control. However, all K levels except control produced statistically equal number of achenes $head^{-1}$. Similar positive effect was found by Saeidi (2007) that K application increased number of achenes $head^{-1}$.

As regards sunflower hybrids, both hybrids produced statistically similar number of achenes head. Interactive effects of various K levels and sunflower hybrids on number of achenes $head^{-1}$ were found to be non significant. These results are in line with the findings of Richards (2006) that sunflower hybrids are independent of number of achenes per head in response to K application.

1000-achene weight: Application of K did not affect the 1000-achene weight. However, S-278 produced significantly higher 1000-achene weight as compared to Hysun-33. Various combinations of K levels and sunflower hybrids also significantly produced different 1000-achene weight. Sunflower hybrid S-278 produced the highest 1000-achene weight when crop was fertilized with K @ 150 Kg ha^{-1} which was statistically at par with many other treatments, where as Hysun-33 produced the lowest 1000-achene weight when crop was fertilized with K @ 150 Kg ha^{-1} which was statistically at par with many other treatments. These results are in line with the findings of Razi and Assad (1999) and Bajehbaj *et al*. (2009) concluded that K application did not influence 1000- achene yield; however, sunflower hybrids differed with each other due to their genetic make up.

Achene yield: Application of K did not have significant effect on achene yield, although it gradually increased with the increase in K application (Table 3). This promotive effect is attributed to favorable impact of K on various sunflower achene yield components like more no. of achene haead^{-1} and 1000-achene weight. These results are in conformity with those reported by Matri *et al*. (2009) concluded that K application increased achene yield.

Table 3: Agronomic characteristics of spring planted sunflower hybrids as influenced by potassium application (Mean of two years)

S. No	Treatments	Plant height (cm)	Head Diameter (cm)	No. of achenes head^{-1}	1000-achene weight (g)	Seed Yield (t ha^{-1})	Stalk Yield (t ha^{-1})	Harvest Index (%)
A-Potassium levels (K) (Kg K_2O ha^{-1})								
1	K_0:0	157.38	16.10	1149b	37.73	3.17	5.53	36.50
2	K_1:50	159.25	16.58	1178ab	38.16	3.20	5.70	36.61
3	K_2:100	159.38	16.27	1202ab	38.32	3.26	5.85	36.07
4	K_3:150	159.0	16.16	1239ab	38.25	3.32	5.80	36.67
5	K_4:200	157.75	16.38	1241ab	38.40	3.32	5.85	36.41
6	K_5:250	158.0	16.42	1250ab	38.08	3.34	5.78	36.42
7	K_6:300	157.75	16.81	1259a	38.59	3.36	5.90	36.74
8	LSD (a)	NS	NS	102.71*	NS	NS	NS	NS
B- Sunflower Hybrids (H)								
9	H_1=Hysun-33	132.20b	16.08	1212	36.58b	3.09b	5.14	37.69a
10	H_2=S-278	184.50a	16.70	1222	39.74a	3.48a	6.40	35.28b
	LSD(b)	2.99*	NS	NS	0.86*	0.11*	0.22*	0.71*
C-Interaction (H x K)								
11	K_0 x H_1	128.50	16.00	1149	36.56bc	3.10d	5.01b	37.31abcd
12	K_0 x H_2	186.25	16.85	1149	40.08ab	3.41abc	6.05a	35.68abcde
13	K_1 x H_1	134.00	16.27	1186	36.64bc	3.14cd	5.06b	37.88ab
14	K_1xH_2	184.50	16.40	1170	39.67a	3.41abc	6.35a	35.35cde
15	K_2 x H_1	133.25	16.67	1180	36.63bc	3.11d	5.10b	38.08a
16	K_2 x H_2	185.50	16.75	1223	39.84a	3.40abc	6.60a	34.06e
17	K_3 x H_1	133.75	16.30	1226	36.21c	3.05d	5.01b	37.89ab
18	K_3 x H_2	184.25	16.01	1253	40.29a	3.59a	6.60a	35.45bcde
19	K_4 x H_1	132.75	15.82	1236	36.60bc	3.17bcd	5.26b	37.67abc
20	K_4 x H_2	182.75	16.92	1246	39.40a	3.48a	6.44a	35.15de
21	K_5 x H_1	130.25	15.77	1258	37.02bc	3.01d	5.16b	37.59abcd
22	K_5 x H_2	185.75	16.42	1242	40.15a	3.47ab	6.39a	35.24cde
23	K_6 x H_1	132.75	15.70	1247	36.38c	3.09d	5.40b	37.44abcd
24	K_6 x H_2	182.75	16.85	1272	40.20a	3.63a	6.40a	36.03abcde
	LSD (c)	NS	NS	NS	2.29*	0.29*	0.60*	2.47*

NS= No-Significant, *=Significant

Means followed by different letters in a column are significantly different at 0.05P.

There was statistically significant difference between sunflower hybrids regarding achene yield. Sunflower S-278 significantly produced higher achene yield than that of Hysun-33. Combined effect of K and hybrid on achene yield was also significant. Sunflower hybrid S-278 produced the highest achene yield when it was fertilized with K @ 300 Kg ha^{-1}, which was statistically at par with many other treatments, where as Hysun-33 produced the lowest achene yield when it was fertilized with out K, which was statistically at par with many other treatments. These results are in line with the findings of Weiss (2000) and Miralles *et al*. (1997) recorded that K application did not increase achene yield.

Stalk yield: Application of K did not have significant effect on stalk yield, although it gradually increased with the increase in K application (Table 3). These results are in conformity with those reported by Ahmad (2009) that K application did not increase stalk yield.

There was statistically significant difference among sunflower hybrids regarding stalk yield.

Sunflower S-278 significantly produced higher achene yield than that of Hysun-33.

Interactive effects of K application and sunflower hybrids were significant. S-278 produced the highest stalk yield when crop was fertilized @ 100 Kg K_2O ha^{-1}, which was statistically at par with many other treatments. On the other hand, Hysun-33 produced the lowest stalk yield when crop was fertilized with out any K application, which was statistically similar with many other treatments. These results are in accordance with the findings of Richards (2006) that sunflower hybrids differ in their genetic make up for response to stalk yield.

Harvest Index: Irrespective of K_2O level, application of K significantly increased the harvest index over control. However, its effect was non-significant. As far as the harvest index, Hysun-33 exhibited significantly higher harvest index than that of S-278. Interactive effect of K levels and sunflower hybrids on harvest index was significant. Hysun-33 produced the highest harvest index when crop was fertilized @ 100 Kg K_2O ha^{-1}, which was statistically at par with many other treatments. Similarly, S-278 produced the lowest harvest index when crop was fertilized @ 100 Kg K_2O ha^{-1}, which was statistically at par with many other treatments.

Conclusion: It is therefore suggested that sunflower hybrid S-278 should be cultivated with K application @ 150 Kg ha^{-1}.

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