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Yield Potential and Oil Quality of two Sunflower Hybrids as affected by K Application and Growing Seasons

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ABSTRACT

Field experiments were conducted to see the response of two sunflower hybrids viz. SF-100 and C-206 to potassium application in spring and autumn season. The K levels comprised of 50, 100, 150, 200, 250 and 300 kg ha^{-1}. Hybrid SF-100 produced significantly higher seed yield ha^{-1} than that of C-206 during spring while in autumn SF-100 gave significantly lower seed yield than C-206. There was a progressive but non-significant increase in seed yield with each increase of K level except 300 kg ha^{-1}, which gave significantly more seed yield than control. K application significantly affected achene protein concentration of autumn sunflower but differences were non-significant in spring season crop. The achene oil concentration was significantly affected by K application in both the seasons. Similarly, in autumn achene oil stearic acid and linoleic acid concentrations were almost double than that of spring crop.

Key Words: Yield potential; Oil quality; Hybrids; K application; Growing season

INTRODUCTION

Potassium performs several important physiological functions in plants like photosynthesis, enzyme activity, synthesis of protein, carbohydrates, fats, translocation of photosynthates, enabling the plants to develop tolerance against drought and resistance to pests and diseases (Tisdale *et al.*, 1985). Potassium also plays a key role in increasing crop productivity and improving the quality of the produce.

Soils of Pakistan in general are constituted of such minerals, which have large capacity to provide potassium to crops under normal conditions because of the dominance of Illite clay minerals (Ranjha *et al.*, 1990). However, introduction of high yielding crop varieties have resulted in considerable drain on soil potassium reserves and need for fertilizing the crops with potassium is becoming evident (Malik *et al.*, 1989). Although increase in seed yield by potassium has been reported but it has no effects on achene oil concentration (Lewis *et al.*, 1991).

Oilseed crops like sunflower has very high potassium requirement. Potassium applied at lower dose than its optimum level will not allow the crops to perform its physiological functions. In contrast, potassium at higher dose may create some problems for the crops besides increase in the cost of production. The objective of this study was, therefore, to determine the optimum dose of potassium and its effects on the yield and oil quality of semi-dwarf and standard height sunflower hybrids grown both in spring and autumn season under the irrigated conditions of Faisalabad.

MATERIALS AND METHODS

This study was conducted at the Research Area, Department of Agronomy, University of Agriculture, Faisalabad during the spring and autumn seasons for two consecutive years. Two sunflower hybrids *viz*. SF-100 (semi-dwarf) and C-206 (standard height) and seven levels of potassium, i.e. 0, 50, 100, 150, 200, 250 and 300 kg ha^{-1} were tested in this experiment. Replicated four times the experiment was laid out in a RCBD with split plot arrangements. The K levels were randomized in main plots and sunflower hybrids in subplots. The net plot size was 3.60 m x 7.20 m. The crop was sown manually with the help of single row hand drill on a well prepared seed bed during the first week of February and last week of August in the spring and autumn season, respectively. A recommended seed rate of 7.5 kg ha^{-1} was used. Nitrogen and phosphorus were applied @ 100 kg N and 100 kg P_2O_5 ha^{-1}. All the three fertilizers (NPK) were added in the respective treatments in the form of Urea, SSP and SOP, respectively. Thinning was done at 4-5 leaf stage to maintain the desired plant population in all the treatments. In addition to "Rouni" (soaking irrigation for seed bed preparation) four and seven irrigations each of 7.5 cm were applied to the autumn and spring crops, respectively. Both the spring and autumn crops were harvested manually in the first week of June and December, respectively. Seed yield was recorded at 15% seed moisture content. The achene oil and protein concentration were determined with the Nuclear Magnetic Resonance (NMR) techniques. Similarly, the composition of achene oil was determined by GC-9A Fatty Acid Analyser. The data collected were analyzed by Fisher's analysis of variance technique, and LSD test at 0.05 P was used to compare the differences among treatment means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Seed yield. The data presented in Table I indicated that sunflower hybrid C-206 produced significantly higher seed yield than that of SF-100 during autumn. On the contrary, in spring season C-206 exhibited significantly lower seed yield than SF-100. It is evident that environmental

Table I. Seed yield, protein and oil concentration of two sunflower hybrids as affected by K application and growing season

	Seed yield (t ha^{-1})		Achene protein concentration(%)		Achene oil concentration(%)	
	Spring	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**
A. K levels (kg ha^{-1})						
K_0 : 0	2.90 b$^{(1)}$	2.93 b$^{(1)}$	18.85^{NS}	23.57 a$^{(1)}$	43.47 c$^{(1)}$	39.50 d$^{(1)}$
K_1 : 50	3.08 ab	2.97 ab	18.63	23.46 ab	43.04 bc	39.92 cd
K_2 : 100	3.15 a	3.04 ab	18.19	23.16 ab	44.77 ab	40.12 bc
K_3 : 150	3.22 a	3.09 ab	18.21	22.87 bc	44.68 ab	40.45 abc
K_4 : 200	3.24 a	3.12 ab	18.05	22.61 c	44.92 a	40.47 abc
K_5 : 250	3.24 a	3.14 ab	18.01	22.85 bc	45.25 a	40.59 ab
K_6 : 300	3.27 a	3.24 a	17.85	22.87 bc	45.30 a	40.83 a
LSD	0.20	0.21	-	0.67	1.00	0.57
B. Sunflower hybrids						
V_1 : SF-100	3.34 a	2.77 b	18.84 a	23.83 a	41.86 b	37.74 b
V_2 : C-206	3.04 b	3.40 a	17.72 b	22.32 b	47.64 a	42.84 a
LSD	0.09	0.12	0.58	0.33	0.58	0.41

NS =Non-significant; (1) =Any two means not sharing similar letter differ significantly at 5% level of probability (LSD)

conditions during autumn at Faisalabad favored development of tall sunflower hybrids like C-206 while semi-dwarf hybrids like SF-100 performed better in spring. Similar results were reported by Ahmad *et al.* (1997).

In autumn, there was a progressive but non-significant increase in seed yield with each increase in K level except 300 kg K_2O ha^{-1}, while in spring season application of K_2O @ $\geq$ 100 kg ha^{-1} produced significantly higher seed yield than control.

Achene protein concentration. Application of K did not significantly affect achene protein concentration in spring season (Table I). Maximum reduction in achene protein concentration was recorded in crop fertilized @ 200 kg ha^{-1} which was, however, statistically equal to rest of the K levels except 50 kg K_2O ha^{-1} and control. These results indicated that K, in general, suppressed achene protein concentration. These results are supported by the findings of Rollier *et al.* (1975), Choudhry and Mushtaq (1999) and Ahmad *et al.* (1999).

As regards sunflower hybrids, SF-100 exhibited significantly higher achene protein concentration than that of C-206 in both spring and autumn season crops.

Achene oil concentration. Application of K had a significant effect on achene oil concentration in both spring and autumn season crops. Crop fertilized @ 300 kg K_2O ha^{-1} although recorded maximum achene oil concentration but was statistically equal to that fertilized @ 100, 150, 200 or 250 kg K_2O ha^{-1}. By contrast, minimum achene oil concentration was recorded in crop grown without K which was at par with the treatment 50 kg K_2O ha^{-1}. These results suggested that application of $K_2O \geq$ 100 kg ha^{-1} significantly increased achene oil concentration over control. The results reported by Lewis *et al.* (1991), Ahmad *et al.* (1999) and Choudhry and Mushtaq (1999) are in line with these findings.

Sunflower hybrid C-206 showed significantly higher achene oil concentration than that of SF-100 in both the seasons (Table I).

Saturated fatty acids

(a) Stearic acid. During the autumn season achene oil stearic acid concentration were almost double than that of spring crop. On the contrary, oil obtained from spring crop had higher palmitic acid concentration than the autumn crop (Table II). Application of K had a non-significant effect on stearic acid concentrations of spring sunflower oil while in autumn season application of K @ 300 kg K_2O ha^{-1} significantly reduced stearic acid percentage as compared to control. All other K levels did not cause significant reduction in stearic acid percentage. Contradictory effects of K application on unsaturated/saturated fatty acids ratio has been reported by Rollier *et al.* (1975) and Glas *et al.* (1988). However, both the hybrids produced oil with similar concentration of stearic acid in the both seasons.

(b) Palmitic acid. Application of K did not significantly affect palmitic acid concentration of sunflower oil during spring. On the contrary, in autumn season application of K @ 200 kg K_2O ha^{-1} produced oil with maximum percentage of palmitic acid that was statistically equal to K levels of 50 and 100 kg ha^{-1}, and control. Among the hybrids, SF-100 oil contained significantly higher palmitic acid concentration than that of C-206.

Unsaturated fatty acids (oleic acid, linoleic acid and linolenic acid). Unsaturated fatty acid concentrations in sunflower oil were greatly influenced by growing seasons (Table II). Oleic acid concentration varied from 7.69 to 8.32 in autumn as against 39.66 to 41.92% in spring season. Similarly, linoleic acid concentration in autumn crop ranged between 80.67 and 82.00% while in spring crop it varied from 47.06 to 47.99%. As regards sunflower hybrids, SF-100 planted in autumn produced oil with significantly higher concentration of oleic acid than that of C-206. However, this difference was non-significant in spring season. By contrast, in autumn linoleic acid concentration was significantly higher in C-206 than that of SF-100 while statistically equal linoleic acid concentration was produced by the two hybrids in spring season.

Table II. Fatty acids concentration in oil of two sunflower hybrids as affected by K-application and growing season

	Saturated Fatty Acids (%)				Un-saturated Fatty Acids (%)					
	Stearic acid		Palmitic acid		Oleic acid		Linoleic acid		Linoleic acid	
	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
A. K-levels (kg ha^{-1})										
K_0 : 0	1.97 ab$^{(1)}$	3.54 a$^{(1)}$	6.25^{NS}	5.21 b$^{(1)}$	40.14^{NS}	8.12 ab$^{(1)}$	47.27^{NS}	80.67 b$^{(1)}$	0.26^{NS}	0.11^{NS}
K_1 : 50	2.10 a	3.58 a	6.24	5.14 b	41.92	8.03 ab	47.06	81.62 ab	0.24	0.12
K_2 : 100	2.05 ab	3.45 ab	6.12	5.29 b	39.66	8.17 ab	47.52	81.47 ab	0.26	0.12
K_3 : 150	2.03 ab	3.56 a	6.20	5.38 ab	40.08	8.10 ab	47.96	81.33 ab	0.25	0.13
K_4 : 200	1.89 ab	3.41 ab	5.98	5.61 a	39.85	7.92 ab	47.85	81.02 ab	0.24	0.13
K_5 : 250	1.89 ab	3.40 ab	6.05	5.37 ab	41.23	8.32 a	47.69	81.33 ab	0.25	0.13
K_6 : 300	1.86 b	3.25 b	6.18	5.35 ab	40.78	7.69 b	47.99	82.00 a	0.26	0.12
LSD	0.21	0.23	-	0.27	-	0.53	-	1.27	-	-
B. Sunflower hybrids										
V_1 : SF-100	1.94^{NS}	3.44^{NS}	6.26^{NS}	5.50 a	41.03^{NS}	8.64 a	47.66^{NS}	80.68 b	0.25^{NS}	0.12^{NS}
V_2 : C-206	1.98	3.48	6.04	5.17 b	40.58	7.63 b	47.57	82.01 a	0.26	0.13
LSD	-	-	-	0.11	-	0.30	-	0.57	-	-

NS=Non-significant

The composition of unsaturated fatty acids was not influenced significantly by K application in spring season while in autumn crop the K @ 300 kg K_2O ha^{-1} caused substantial increase in linoleic acid concentration of oil but significant reduction in oleic acid while had no significant effect on linolenic acid. These findings are partially in line with those of Ahmad *et al.* (1999). The results further led to the conclusion that application of potassium not only increased the achene oil concentration in sunflower but also improved quality of the oil by enhancing its linoleic acid concentration during autumn season.

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