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Effect of Potassium on Protein, Oil and Fatty Acid Contents in Two Autumn Planted Sunflower Hybrids

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ABSTRACT

Effect of K application on protein, oil and fatty acid contents of oil in two autumn planted sunflower hybrids viz. SF-100 and C-206 was determined. The K levels comprised 50, 100, 150, 200, 250 and 300 kg ha^{-1}. Sunflower fertilized @ 300 kg K_2O ha^{-1} had the maximum achene oil content (40.83%) as against the minimum (39.50%) with no K. Sunflower hybrid C-206 exhibited significantly higher seed oil content (42.84%) than SF-100 (37.74%) while vice versa was true for achene protein content. Application of potassium @ 300 kg K_2O ha^{-1} caused substantial increase in linoleic acid content of oil but significant reduction in oleic acid and stearic acid while had no significant effect on linolenic acid. However, significant increase in palmitic acid content over control was recorded at 200 kg K_2O ha^{-1}. The results suggest that application of potassium not only increases the achene oil content in sunflower but also improves quality of the oil by enhancing its linoleic acid content.

Key Words: Potassium application; Autumn planted sunflower; Achene oil; Fatty acid content

INTRODUCTION

Sunflower is one of the non-conventional oilseed crops and has the ability to improve the domestic production of edible oil due to its high oil content and wide adaptability to our soils and climatic conditions. Dwarf varieties have been reported to be superior to tall cultivars in yielding ability and due to increased productive development (Goldworthy, 1970). However, dwarf varieties require different agro-management practices for their successful production.

Nitrogen, phosphorus and potassium are major elements essential for plant growth and development. To date use of chemical fertilizers has been confined mainly to the application of nitrogen and phosphorus and due attention has not been paid to the application of potassium. Its role is well documented in photosynthesis, increasing enzyme activity, improving synthesis of protein, carbohydrates and fats, translocation of photosynthates, enabling their ability to resist pests and diseases. Potassium also plays key role in increasing crop yield and improving the quality of produce (Tisdale *et al.*, 1985).

Soils of Pakistan, in general, are constituted of such minerals that have large capacity to provide potassium to crops under normal conditions. However, introduction of high yielding crop varieties have resulted in considerable drain in soil potassium reserves (Malik *et al.*, 1989) and the need for fertilizing the crops with potassium is becoming evident. Present study was, therefore, undertaken to determine the response of semi-dwarf and standard height sunflower hybrids to potassium application in irrigated conditions.

MATERIALS AND METHODS

The experiment was conducted at research area of Agronomy Department, University of Agriculture, Faisalabad. The experiment comprised two sunflower hybrids *viz.* SF-100 (Semi-dwarf) and C-206 (standard height) while K levels were 50, 100, 150, 200, 250 and 300 kg K_2O ha^{-1}. Replicated four times the experiment was laid out in Randomized Complete Block Design with split plot arrangement. The K levels were randomized in main plots and sunflower hybrids in sub-plots. The net plot size was 3.60 m 7.20 m. The crop was sown manually with the help of single row hand drill on a well prepared seed bed. A recommended seed rate of 7.5 kg ha^{-1} was used. Nitrogen and phosphorus were applied each @ 100 kg N and P_2O_5 ha^{-1}. Three fertilizers (NPK) were added in the respective treatments in the form of urea, SSP and SOP, respectively. Thinning was done at 4 to 5 leaf stage to maintain the desired plant population in all the treatments. In addition to "Rouni" (soaking irrigation for seed bed preparation) four irrigations each of 7.5 cm were given to mature the crop. Weeds were kept under control by interculture and hand weeding. The crop was harvested manually in the first week of December. Harvested crop was sundried and threshed manually. Seed yield was recorded at 15% seed moisture content. For achene oil and protein content seed samples were taken randomly from each sub-plot and determined with the Nuclear Megnatic Resonance (NMR) techniques.

Similarly oil of sunflower seeds obtained from each sub-plot was analysed for determining the relative composition of different fatty acids (Palmitic

acid, stearic acid, oleic acid, Linoleic acid and Linolenic acid) in sunflower oil by GC-9A Fatty Acid Analyser. The data obtained were analysed by Fisher's analysis of variance techniques and LSD test at P = 0.05 was used to compare the differences among treatment means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Achene protein content. Application of potassium caused slight to significant reduction in achene protein content as compared to control. Maximum reduction in achene protein content was recorded in crop fertilized @ 200 kg K_2O ha^{-1}, which was, however, statistically equal to all K levels except 50 kg K_2O ha^{-1} and control (Table I). It is evident from these results that K, in general, suppresses sunflower achene protein content. Similar effect of K on sunflower seed protein content has also been reported by Rollier *et al.*, (1975) and Choudhry and Mushtaq (1999). Perusal of Table I also indicated that SF-100 and C-206 exhibited achene protein contents of 23.83 and 22.32%, respectively, and differed significantly from each other. Higher achene protein content in SF-100 than C-206 might be due to varying genetic potential of the hybrids.

Achene oil content. Sunflower crop fertilized @ 300 kg K_2O ha^{-1} recorded maximum achene oil content (40.83%) but was statistically equal to that fertilized @ 150, 200 or 250 kg K_2O ha^{-1}. By contrast, minimum achene oil content (39.50%) was recorded by crop grown without K fertilization; that however, did not significantly differ from the application of K_2O @ 50 kg ha^{-1}. Moreover, there was a slight but progressive increase in achene oil content with each increase of K level. These results are in line with those reported by Osman and Lila (1984), Nazir *et al.* (1987) and Choudhry and Mushtaq (1999) and contrary to the findings of Guar *et al.* (1987) who found that application of K had no effect on seed oil content.

Sunflower hybrids SF-100 and C-206 significantly differed with regard to seed oil content (Table I). Hybrid C-206 exhibited significantly more seed oil content than that of SF-100. On an average C-206 and SF-100 exhibited achene oil content of 42.84 and 37.74%, respectively.

Stearic acid. Application of K @ 300 kg K_2O ha^{-1} significantly reduced stearic acid percentage as compared to that of control, while all other K levels did not cause a significant reduction in stearic acid percentage. Contradictory effects of K application on unsaturated/saturated fatty acids ratio have been reported by R ollier *et al.* (1975) and Gla *et al.* (1988).

Sunflower hybrids had a non-significant effect on stearic acid percentage in their oil (Table I). C-206 and

Table I. Achene oil and oil quality of two sunflower hybrids as affected by K application

	Achene protein content (%)	Oil content (%)	Stearic acid (%)	Palmitic acid (%)	Oleic acid (%)	Linoleic acid (%)	Linolenic acid (%)
A. K-levels (kg ha^{-1})							
K_0 : 0	23.57 a*	39.50 d	3.54 a	5.21 b	8.12 ab	80.67 b	0.11^{NS}
K_1 : 50	23.46 ab	39.92 cd	3.58 a	5.14 b	8.03 ab	81.62 ab	0.12
K_2 : 100	23.16 abc	40.12 bc	3.45 ab	5.29 b	8.17 ab	81.47 ab	0.12
K_3 : 150	22.87 bc	40.45 abc	3.56 a	5.38 ab	8.10 ab	81.33 ab	0.13
K_4 : 200	22.61 c	40.47 abc	3.41 ab	5.61 a	7.92 ab	81.02 ab	0.13
K_5 : 250	22.85 bc	40.59 ab	3.40 ab	5.37 ab	8.32 a	81.33 ab	0.13
K_6 : 300	22.87 bc	40.83 a	3.25 b	5.35 ab	7.69 b	82.00 a	0.12
LSD	0.67	0.57	0.23	0.27	0.53	1.27	
B. Sunflower hybrids							
SF-100	23.83 a	37.74 b	3.44^{NS}	5.50 a	8.64 a	80.68 b	0.12^{NS}
C-206	22.32 b	42.84 a	3.48	5.17 b	7.63 b	82.01 a	0.13
LSD	0.33	0.41	-	0.11	0.30	0.57	-

NS = Non-significant

*Any two means not sharing a letter differ significantly at 5% level of probability (LSD).

SF-100 recorded 3.48 and 3.44% stearic acid in their achene oil.

Palmitic acid. Application of K @ 200 kg K_2O ha^{-1} produced oil with maximum percentage (5.61) of palmitic acid that was statistically equal to K levels of 50 and 100 kg ha^{-1} and control treatment. Minimum palmitic acid percentage (5.14) was recorded at 50 kg K_2O ha^{-1} that was, however, on a par with all K levels except 200 kg K_2O ha^{-1} (Table I). Sunflower hybrid SF-100 oil contained significantly higher palmitic acid content than that of C-206. SF-100 and C-206 produced oils with palmitic acid content of 5.50 and 5.17%, respectively and significantly differed from each other.

Oleic acid. Data given in Table I revealed significant differences in oleic acid content among different K levels. Sunflower fertilized @ 250 kg K_2O ha^{-1} exhibited significantly higher concentration of oleic acid than that fertilized @ 300 kg K_2O ha^{-1}. Later K level produced lowest oleic acid percentage (7.69). However, differences among other K levels were non-significant. Variation in unsaturated/saturated fatty acids ratio by K application has been reported by Rollier *et al.* (1975).

Sunflower hybrids SF-100 and C-206 significantly differed from each other in oleic acid concentration. SF-100 and C-206 produced oleic acid percentage of 8.46 and 7.63, respectively.

Linoleic acid. High content of linoleic acid in oil not only controls the level of cholesterol in human blood, but also reduces incidence of coronary diseases (Voila, 1970). Application of K had a significant effect on linoleic acid percentage (Table I). Crop applied K_2O @ 300 kg ha^{-1} recorded significantly higher linoleic acid content than that grown without K. However, former K level was on a par with other K levels.

Sunflower hybrid C-206 contained significantly higher linoleic acid than that of SF-100. So it is clear from Table I that when the concentration of oleic acid in oil increases the concentration of linoleic acid decreases and vice versa.

Linolenic acid. Application of K did not significantly influence linolenic acid concentration of sunflower oil. However, linolenic acid concentration varied from 0.11 to 0.13%. Similarly sunflower hybrids SF-100 and C-206 produced oil with statistically equal concentration of linolenic acid and that was 0.12 and 0.13% in case of SF-100 and C-206, respectively.

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