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PERFORMANCE OF SUNFLOWER IN RESPONSE TO NITROGEN MANAGEMENT AT DIFFERENT STAGES

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Studies were conductesd for two years (2004 and 2005) to access the comparative productivity of sunflower to nitrogen application in various splits. Nitrogen was applied at 100 Kg ha^{-1} as full at sowing, full at 1st irrigation, full at flowering, ½ at sowing + ½ at 1st irrigation, ½ at sowing + ½ at flowering, ½ at 1st irrigation + ½ at flowering, 1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering, 1/3 at sowing + 1/3 at 1st irrigation + 1/3 at seed formation and 1/3 at sowing + 1/3 at flowering + 1/3 at seed formation. The highest achene yields of 2446 kg ha^{-1} and 2370 kg ha^{-1} were obtained in 2004 and 2005, respectively from plots, where nitrogen was applied in three equal splits at sowing, at first irrigation and at flowering. The mean crop growth rate (21.52 and 20.95 g m^{-2} day^{-1}) and mean net assimilation rate (8.97 and 8.78 g m^{-2} day^{-1}) also gave significantly highest values in the same treatment during both years. All the quality traits were significantly affected with the application of nitrogen in splits and had a positive correlation with the achene yield except achene oil content (%) and oleic acid (%) in oil.

Keywords: Splitting, nitrogen, sunflower, achene, management

INTRODUCTION

Pakistan is facing a severe shortage of edible oil because its domestic production is far below the demand. Consequently, a lion share of foreign exchange has to incur on oil import, which is increasing every year. Total availability of edible oils during 2004-05 was 2.764 million tons, where as local production stood at 0.857 million tons which accounted for 31 percent of the total availability. The remaining 69 percent was made available through imports. Sunflower is an important oilseed crop and adopted to agro-ecological conditions of Pakistan. In Pakistan sunflower was grown on an area of 315.66 thousand hectares with total production of 569 thousand tons with an average yield of 1802.57 kg ha^{-1} (GOP, 2006). Despite concerted efforts its yield potential could not be fully explored. The potential of any variety can only be fully exploited by the judicious use of inputs at proper growth stages. Application of nitrogen in three equal splits gave the highest yield, which was higher than that of basal or two equal splits (Reddy *et al*; 1996). Keeping this in view, the present study was undertaken to identify the best nitrogen application strategy to attain maximum yield of sunflower.

MATERIALS AND METHODS

The proposed study was conducted at the Agronomic Research Farm, University of Agriculture, Faisalabad, Pakistan, on a sandy clay loam soil having an average of 0.039 % N, 9.50 ppm P_2O_5 and 175.50 ppm K_2O for two consecutive years of 2004 and 2005. The experiment comprised of nine treatments; full N at sowing, full N at 1st irrigation, full N at flowering, ½ N at sowing + ½ N at 1st irrigation, ½ N at sowing + ½ N at flowering, ½ N at 1st irrigation + ½ N at flowering, 1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at flowering, 1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at seed formation and 1/3 N at sowing + 1/3 N at flowering + 1/3 N at seed formation. Nitrogen, phosphorus and potash were applied at 100-75-50 kg ha^{-1} in the form of urea, single super phosphate and potassium sulphate. The whole phosphorus and potash were applied at the time of sowing while nitrogen was applied at different times as per treatment. The experiment was laid out in randomized complete block design with three replications using a net plot size of 4.5 m x 7 m. Sunflower was sown during February in 75 cm apart rows with the help of dibbler keeping plant to plant distance of 25 cm and using a seed rate of 6 Kg ha^{-1}. Two seeds per hill were placed. The first irrigation was given thirty days after sowing and afterwards the crop was irrigated at a regular interval of fifteen days. One plant per hill was maintained by thinning at 2-4 leaf stage of the crop. The crop exhibited no sign of insect/pest attack and disease incidence, therefore no pesticide was used. Crop was kept free of weeds by hand hoeing. Crop was harvested manually in last week of May, 2004 and 2005. Harvested crops were sundried and threshed manually. Observations pertaining to different agro-physiological and quality traits of the crop were recorded by using standard procedures. The dry weight per plant was calculated and used to estimate crop growth rate, net assimilation and leaf area duration were also calculated by the methods of Hunt (1978).

Table 1. Comparative agro-physiological response of sunflower to nitrogen management at different growth stages

Treatment	Achene yield (kg ha^{-1})		Biological yield (kg ha^{-1})		Mean crop growth rate (g m^{-2} day^{-1})		Net assimilation rate (g m^{-2} day^{-1})	
	2004	2005	2004	2005	2004	2005	2004	2005
Full N at sowing	1487 d *	1440 d	11043 cd	10863 cd	14.49 h	14.13 h	6.49 h	6.32 h
Full N at 1st irrigation	1602 cd	1561 cd	11874 bcd	11587 bcd	15.82 g	15.39 g	6.74 g	6.56 g
Full N at flowering	1126 e	1090 e	9796 d	9540 d	10.99 i	10.76 l	5.26 l	5.12 l
½ N at sowing + ½ N at 1st irrigation	1890 bc	1850 bc	13019 abc	12880 abc	16.95 e	16.56 e	7.27 e	7.10 e
½ N at sowing + ½ N at flowering	1852 bc	1800 bc	12910 bc	12791 abc	16.43 f	16.04 f	6.93 f	6.76 f
½ N at 1st irrigation + ½ N at flowering	2079 b	2020 b	13477 ab	13149 ab	18.06 c	17.65 c	7.73 c	7.56 c
1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at flowering	2446 a	2370 a	15165 a	14802 a	21.52 a	20.95 a	8.97 a	8.78 a
1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at seed formation	2113 b	2083 ab	13604 ab	13239 ab	20.91 b	20.36 b	8.78 b	8.59 b
1/3 N at sowing + 1/3 N at flowering + 1/3 N at seed formation	1921 bc	1867 bc	13049 abc	12920 abc	17.52 d	17.08 d	7.52 d	7.34 d
LSD 5%	330	314	2149	2274	0.09	0.07	0.10	0.10

*Means having different letters in the same column differ significantly (P ≤0.05)

Table 2. Comparative quality response of sunflower to nitrogen management at different growth stages

Treatment	Achene protein content (%)		Oil content (%)		Oleic acid (%) in oil		Linoleic acid (%) in oil	
	2004	2005	2004	2005	2004	2005	2004	2005
Full N at sowing	14.44 h*	14.49 h	42.06 b	41.94 b	40.87 b	40.71 b	46.20 e	45.66 f
Full N at 1st irrigation	14.68 g	14.74 g	41.50 c	41.35 c	40.57 c	40.38 c	46.50 d	45.98 e
Full N at flowering	13.15 l	13.22 i	43.15 a	43.03 a	42.20 a	42.09 a	44.04 f	43.48 g
½ N at sowing + ½ N at 1st irrigation	15.04 e	15.16 e	41.12 e	40.80 e	40.13 d	39.82 e	47.27 c	46.91 c
½ N at sowing + ½ N at flowering	14.97 f	15.06 f	41.27 d	41.05 d	40.33 cd	40.12 d	47.07 c	46.50 d
½ N at 1st irrigation + ½ N at flowering	15.30 c	15.48 c	40.87f	40.41 g	39.50 f	39.06 g	48.44 b	48.22 b
1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at flowering	16.05 a	16.26 a	38.75 h	38.26 i	38.23 h	37.74 i	49.82 a	49.69 a
1/3 N at sowing + 1/3 N at 1st irrigation + 1/3 N at seed formation	15.97 b	16.16 b	39.50 g	39.05 h	38.58 g	38.13 h	49.65 a	49.47 a
1/3 N at sowing + 1/3 N at flowering + 1/3 N at seed formation	15.15 d	15.31 d	41.09 e	40.67 f	39.80 e	39.48 f	48.25 b	48.00 b
LSD 5%	0.54	.054	0.05	0.05	0.26	0.23	0.24	0.26

*Means having different letters in the same column differ significantly (P ≤0.05)

Data were analysed statistically using Fisher's analysis of variance technique (Steel and Torrie 1997). and least significant difference test was used to compare the differences among treatments means.

RESULTS AND DISCUSSION

Data (Table-1) revealed that nitrogen application in different splits at different stags had significant effect on achene yield, biological yield, mean crop growth rate (CGR) and net assimilation rate (NAR) during both the years In 2004, the maximum achene yield (2446 kg ha^{-1}), biological yield (15165 kg ha^{-1}), mean CGR (21.52 g m^{-2} day^{-1}) and NAR (8.97 g m^{-2} day^{-1}) were obtained in treatment where nitrogen at 100 kg ha^{-1} was applied in three equal splits at sowing, at first irrigation and at flowering stage of sunflower. While minimum achene yield (1126 kg ha^{-1}), biological yield (9796 kg ha^{-1}), mean CGR (11 g m^{-2} day^{-1}) and NAR (5.26 g m^{-2} day^{-1}) were obtained in treatment where full nitrogen was applied at flowering. Almost similar trend was observed in 2005. The increased achene and biological yield might be attributed to enhanced nitrogen use efficiency as its losses by leaching, washing and volatilization were reduced by its split application at different stages. This led to enhanced root proliferation and more leaf area expansion for maximum light interception. Leaves are an important source of seed nitrogen (Hocking and Steer, 1983 and Hall *et al.*, 1989). It resulted in more CGR and NAR which ultimately increased number of achenes per head, 1000-achene weight, achene and biological yield. Nitrogen deficiency during the early vegetative period affects the development and growth of both sinks (floret and seed) and source (leaves) (Radin & Boyer, 1982). This can lead to reduced CGR and NAR, thus decreasing the achene and biological yield of sunflower as in the treatment, where full dose of nitrogen (100 kg ha^{-1}) was applied at flowering. Increase in achene and biological yield of sunflower with nitrogen application in splits has also been reported by Castro *et al.* (1999) and Sarmah *et al.* (2000). Data (Table-2) revealed that all the treatments of nitrogen application in splits at different stages had significant effect on quality parameters such as seed oil content, protein content, oleic acid and linoleic acid in oil during both years. In 2004, the highest achene oil content (43.15 %) and oleic acid in oil (42.20 %) were recorded in treatment where full nitrogen was applied at flowering. The lowest achene oil content (38.75 %) and oleic acid in oil (38.23 %) were obtained from the treatment where nitrogen was applied in three equal splits at sowing, at first irrigation and at flowing stage of sunflower. Similar trend was found in 2005. These results are in agreement with those of Steel and Seiler (1990), Allam and Galal (1996), Ramesh *et al.* (1999) and Khaliq (2004).

In 2004, the application of nitrogen in three equal splits at sowing, at first irrigation and at flowering produced the maximum achene protein content (16.05 %) and linoleic acid in oil (49.82 %). The lowest achene protein content (13.15 %) and linoleic acid content in oil (44.04 %) were recorded in treatment, where full nitrogen was applied at flowering. Almost similar trend was exhibited in 2005. Steer *et al.* (1984) also reported that seed nitrogen content and concentration were affected by nitrogen supply at all development stages. These results are in accordance with the results of Ghani *et al.* (2000), Steer and Seiler (1990) and Khaliq (2004) reported that percentage of protein and linoleic acid in oil responded positively with increase in nitrogen supply before floret initiation.

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