

## Effect of foliar application of nitrogen on productivity and economics of sunflower (*Helianthus annuus*)

B.A. SARVARI<sup>1</sup>, V.K. SINGH<sup>2</sup>, KAPILA SHEKHAWAT<sup>3</sup>, H. OBAID<sup>4</sup> AND BUAHANUDDIN WIQAR<sup>5</sup>

Afghanistan National Agricultural Sciences and Technology University, Kandahar, Afghanistan 3801

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### ABSTRACT

A field experiment was conducted during the summer season of 2017 at the research farm of the National Agricultural Science and Technology University, Kandahar, Afghanistan to evaluate the effect of foliar application of nitrogen on growth, productivity and economics of sunflower (*Helianthus annuus* L.). Treatments 12 were laid out in a randomized block design with 3 replications on the sandy clay loam soil. The treatment of 50 kg N as basal + 1.5% urea foliar spray at 20 and 40 days after sowing (DAS) resulted in the highest seed yield (2,461 kg/ha), maximum cost of cultivation (54,800 AFN ₹/ha), higher gross return (148,516 AFN/ha), maximum net returns (93,716 AFN/ha) and higher benefit: cost (2.71) ratio. However, this treatment was found significantly at par where 50 kg N/ha was applied basal, followed by a 1.5% foliar spray either at 20 or 40 days after sowing (DAS). Thus, a foliar spray of 1.5% N, either at 20 or 40 DAS along with 50 kg N/ha resulted in higher productivity and economics in sunflower under the semi-arid conditions of Afghanistan.

**Key words:** Economics, Foliar application, Nitrogen, Productivity, Sunflower

Sunflower is the world's fourth largest oilseed crop and is a major source of vegetable oil owing to its nutritive value. Besides high oil content (45–50%), its cake is rich in protein (40–45%) and has high demand as cattle and poultry feed (Azouz and Selim, 2007). The seeds are consumed as food and the dried stalk as fuel (Harter *et al.*, 2004). In addition to this, several medicinal uses of sunflower oil for pulmonary afflictions have also been reported (Kunduraci *et al.*, 2010). Sunflower is sown in warm to moderate semi-arid climatic regions of the world (Farid *et al.*, 2000). The agro-climatic conditions of Afghanistan are very favourable for sunflower cultivation in spring or summer season through intensification of the existing cropping systems. Amidst the huge demand of vegetable oils (0.498 million tonnes), sunflower is cultivated on 170 ha area, with an annual production and productivity of 230 tonnes and 1,300 kg/ha, respectively, in Afghanistan. The present productivity is very less as com-

pared to the world's average of 1,850 kg/ha. Sunflower, being rich in oil content, can offer a solution to the shortage of edible oil in Afghanistan, if the present yield level and total production are enhanced. The low productivity of sunflower in Afghanistan is mainly associated with poor soil fertility, lack of advanced production technology and poor input management. Soil-fertility improvement through chemical fertilization becomes very important, but again, the low fertilizer-use efficiency is a major concern. Thus real-time nitrogen (N) management as per the crop demand through foliar spray at different crop-growth stages can overcome soil-fertility limitation and results in improvement of sunflower yield (Ullah *et al.*, 2010). The judicious application of fertilizer by the farmers of Afghanistan, including the foliar application for higher yield has been suggested, but information on the optimum dose and application strategy of N foliar spray at appropriate growth stages in sunflower is meagre in Afghanistan. Therefore, the present investigation was undertaken to evaluate the effect of foliar application of N on growth, productivity and economics of sunflower.

The field experiment was laid out at the research farm of ANASTU, Kandahar, Afghanistan, during summer season of 2017. The soil was sandy clay loam, low in oxidizable N (175 kg/ha), medium in 0.5 N NaHCO<sub>3</sub>-extractable P (19 kg/ha) and high in 1.0 N NH<sub>3</sub>OAC<sub>4</sub>-exchangeable

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<sup>3</sup>Corresponding author's Email: drathorekapila@gmail.com

<sup>1</sup>M.Sc. Scholar, <sup>4,5</sup>Professor, Kandahar, Afghanistan 3801; <sup>2</sup>Head and Principal Scientist, <sup>3</sup>Senior Scientist, Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi 110 012

K<sub>2</sub>O (290 kg/ha) with a pH of 8.1. The experiment was laid out in a randomized block design (RBD) with 3 applications. The treatments were: control, 25 kg/ha N as basal, 50 kg/ha N as basal, 25 kg/ha N as basal + 12.5 kg at 20 and 40 DAS, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS, 25 kg/ha N as basal + 1.5% urea foliar spray at 40 DAS, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 and 40 DAS, 25 kg/ha N as basal+ 12.5 kg N at 20 DAS + 1.5% foliar spray at 40 DAS, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS + 12.5 kg N at 40 DAS, 50 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS, 50 kg/ha N as basal + 1.5% urea foliar spray at 40 DAS and 50 kg/ha N as basal + 1.5% urea foliar spray at 20 and 40 DAS. Sunflower Canadian seed was sown with recommended spacing 60 cm × 30 cm. Other agronomic practices like irrigation, weed and insect-pest-disease management was done as per the requirement and the standard methodologies.

The yield attributes were recorded from 3 randomly selected plants from each plot. The head diameter was measured in two diagonal directions with measure tape. The seeds were then counted as the average number of seeds from three randomly selected heads. The total number of seeds, the number of filled seeds/head were counted and the mean was recorded as number of filled seeds/head. The percentage of filled seeds per head was also recorded. The 1,000-seed weight was recorded and expressed in gram. The seed yield was adjusted to 12.5% moisture and converted to hectare basis. For stover yield, the sunflower plants after harvesting the heads were collected at physiological maturity and sun-dried. The harvest index was calculated as the ratio of seed yield to biological yield multiplied by 100. The prevailing costs of several inputs/practices such as seeds, fertilizers, pesticide, weeding, land preparation, sowing, irrigation, harvesting, threshing, were considered for calculating the common cost of cultivation of sunflower during 2017. Gross returns were obtained from the seed and straw yield of sunflower was multiplied with the respective prices of these produces. The net returns of each treatment was worked out individually by deducting the cost of cultivation from the gross returns and the net benefit: cost ratio (B:C ratio) was also determined. Data on sunflower crop were subjected to the analysis of variance (ANOVA) by using MSTATC software (CIMMYT, Mexico City, Mexico), and the significance was tested by the variance ratio (i.e. f-value) at 5% level (Gomez and Gomez, 1984). The standard error of mean (SEM±) and critical difference (CD) were worked out for comparing treatment means of each studied variables of sunflower.

Yield attributes, including head diameter, filled seeds/ha, seed filling (%) and 1,000-seed weight were signifi-

cantly influenced by foliar application of N (Table 1). Application of 50 kg N/ha as basal, followed by foliar application 1.5% N, either at 20 or 40 DAS showed significantly higher yield-attributing characters than 50 kg N as basal. The maximum head diameter was recorded with 50 kg/ha N as basal + 1.5% urea foliar spray at 20 and 40 DAS, which was statistically at par with 50 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS or at 40 DAS. Balancing the N application as basal and foliar spray at optimum plant growth stages improves the yield attributes of sunflower owing to the availability of N at right stage and in right amount (Tuncay *et al.*, 2004; Hassanlouee and Farhad, 2013). The improvement in 1,000-seed weight, number of filled seeds/head and total number of seeds/head was noted owing to foliar application of N (Patil *et al.*, 2006; Siam *et al.*, 2008).

Significantly higher seed yield, stover yield and higher harvest index of sunflower were recorded with the application of 50 kg N as basal and 1.5% of foliar application of N at 20 and 40 DAS, followed by 50 kg N as basal + 1.5% of foliar application of urea at 20 DAS and 40 DAS over the rest of treatments. An increase of 39.4% in seed yield of sunflower was recorded with 50 kg N as basal, followed by two foliar sprays over basal alone. Nitrogen application both as basal, followed by foliar application resulted in more assimilating surface area, dry-matter accumulation and higher yield attributes and also better partitioning from source towards seed formation and higher carbohydrate assimilation (Shekhawat and Shivay, 2008; Bakery *et al.*, 2009). Garcia and Hanway (1976) also reported a yield increase of 27–31% when liquid N : P : K and S fertilizer were sprayed as foliar application due to readily available N. Nitrogen nutrition alters the cell-wall structure, with a transitory decrease in elasticity modulus, followed by a secondary hardening and reduction in the incidence of plasma membrane-bound reductase activity, thus increasing the assimilation period by sink (Nelson *et al.*, 2005).

Highest gross returns were recorded where the treatment included 50 kg N/ha as basal + 1.5% urea foliar spray at 20 and 40 DAS. It was found statistically at par with 50 kg N/ha as basal, followed by 1.5% urea foliar spray either at 20 DAS or at 40 DAS. The gross returns obtained under 50 kg N/ha as basal + 1.5% urea foliar spray at 20 and 40 DAS were 47.6% higher than the gross returns obtained with 50 kg N/ha as basal owing to higher seed yield (Table 1). Urea as a source of N application through foliar application is an economic alternative for sunflower as it is readily available and easily soluble also (Freser, 2005; Hollis, 2005). The higher net returns and the benefit: cost ratio were also recorded with the similar treatment, 50 kg N/ha as basal + 1 spray of 1.5% urea fo-

**Table 1.** Effect of foliar application of nitrogen on yield attributes, yield and economics of sunflower

Treatment	Head diameter (cm)	Filled seeds (Nos./head)	Seed filling (%)	1,000-seed weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Cost of cultivation ( $\times 10^3$ AFN/ha)	Net returns ( $\times 10^3$ AFN/ha)	Benefit: cost ratio
T <sub>1</sub>	11.9	111.5	48.6	77.4	0.98	2.87	25.5	42.2	8.2	1.2
T <sub>2</sub>	14.1	166.6	59.3	75.3	1.24	3.00	29.2	45.0	18.6	1.42
T <sub>3</sub>	16.4	198.8	67.2	84.0	1.75	3.32	34.5	45.6	39.2	1.86
T <sub>4</sub>	17.9	212.3	69.3	91.7	1.95	3.46	36.0	46.6	45.8	1.98
T <sub>5</sub>	16.1	195.3	67.1	83.3	1.73	3.31	34.3	45.5	38.9	1.86
T <sub>6</sub>	16.0	192.4	67.0	83.0	1.70	3.31	34.0	45.4	38.5	1.85
T <sub>7</sub>	18.1	213.9	69.4	91.5	1.95	3.47	36.0	46.0	49.2	2.07
T <sub>8</sub>	16.9	201.8	67.4	85.1	1.76	3.34	34.6	46.4	41.1	1.9
T <sub>9</sub>	16.5	203	67.5	85.3	1.79	3.43	34.2	46.0	42.2	1.92
T <sub>10</sub>	19.7	295.5	78.0	103.4	2.44	4.09	37.4	46.1	73.9	2.61
T <sub>11</sub>	19.5	289.7	76.8	103.2	2.38	3.99	37.3	46.1	72.3	2.57
T <sub>12</sub>	20.3	298.2	78.2	104.2	2.46	4.09	37.6	47.1	79.6	2.71
SEm $\pm$	0.7	28.8	0.21	4.8	0.14	0.16	0.8	–	2.71	0.083
CD (P=0.05)	2.0	85.2	0.62	14.1	0.42	0.48	2.4	–	8.03	0.27

T<sub>1</sub>, Control; T<sub>2</sub>, 25 kg/ha N as basal; T<sub>3</sub>, 50 kg/ha N as basal; T<sub>4</sub>, 25 kg/ha N as basal + 12.5 kg 20 and 40 days after sowing (DAS); T<sub>5</sub>, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS; T<sub>6</sub>, 25 kg/ha N as basal + 1.5% urea foliar spray at 40 DAS; T<sub>7</sub>, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 and 40 DAS; T<sub>8</sub>, 25 kg/ha N as basal + 12.5 kg N at 20 DAS + 1.5% urea foliar spray at 40 DAS; T<sub>9</sub>, 25 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS + 12.5 kg N at 40 DAS; T<sub>10</sub>, 50 kg/ha N as basal + 1.5% urea foliar spray at 20 DAS; T<sub>11</sub>, 50 kg/ha N as basal + 1.5% urea foliar spray at 40 DAS and T<sub>12</sub>, 50 kg/ha N as basal + 1.5% urea foliar spray at 20 and 40 DAS  
AFN (Afghani) = 0.85 INR

liar spray either at 20 and 40 DAS remained at par with it. The foliar application of 1.5% N along with 50 kg basal resulted in increase of B:C ratio of sunflower by 40.3% over 50 kg N as basal. Basal N application along with foliar spray attributed to higher gross returns and net returns owing to higher grain yield and straw yield, resulting in higher economic returns (Thavaprakash and Malligwad, 2002; Reddy *et al.*, 2002).

It can be inferred that, an application of 50 kg N/ha along with 1 foliar spray of 1.5% N either at 20 or 40 DAS in sunflower results in higher growth, yield and economic returns in the semi-arid areas of Afghanistan.

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