Pak. Jour. Agri. Sci,
23 (3-4) 170, 1986

DIFFERENTIAL RESPONSE OF SPRING SUNFLOWER TO NPK APPLICATIONS ON SANDY CLAY LOAM SOIL

M. Shafi Nazir, M. Rafiq, Ghazanfar Ali and Riaz Ahmad

Department of Agronomy, University of Agriculture, Faisalabad

In a replicated field trial the effect of different NPK rates viz. 0-0-0, 50-50-0, 75-50-0, 100-50-0 and 100-50-50 kg/ha on the seed yield and seed oil contents of two varieties of sunflower, Cargil and IS-894, was investigated on sandy clay loam soil having on an average 0.067% N, 7 ppm available P_2O_5 and 225 ppm K_2O. The crop was planted on March 20 in 90 cm apart double row strips with 30 cm space between the rows of each strip. Application of NP fertilizer beyond the level of 75 kg N + 50 kg P_2O_5/ha did not help increasing the seed yield of spring sunflower to a substantial extent. The results further revealed that application of K_2O in addition to NP did not show any effect on the final seed yield and seed oil contents suggesting thereby that the initial K_2O status of the experimental soil was high enough to fulfil the K_2O requirements of the crop. Both the varieties under study exhibited almost similar growth and yield potential probably because of equal genetic Potential and response behaviour.

INTRODUCTION

At present the total production of edible oil in Pakistan amount to 0.26 million tonns as against the total national consumption of 0.96 million tonnes, leaving a shortage of 0.70 million tonnes, so there is an urgent need to accelerate the production of oil seed in the country either by increasing the area under crltivation or by enhancing the productivity per unit area through the adoption of improved production technology. Besides cotton seed which contributes more than half of the country's total production, the major sources of edible oils are rape seed and mustard, ground-nut, sesamum and soybean. However, sunflower - a newly introduced oilseed crop having high yield potential, wider range of adaptability and the highest seed oil contents ranging from 40-45 per cent has the maximum potential for bridging the edible oil gap in the country.

Since its introduction in Pakistan, sunflower is still being grown on a limited scale which is of course due to lack of adequate production technology and marketing system. Establishment of proper cultural practices, optimal management of inputs, identification of suitable ecological zones and better performing cultivars for each zone will definitely go a long way in enhancing the production of sunflower in the country. Consequently, the percent study was designed to determine the effect of NPK application in different combinations on the growth, yield and quality of two cultivars of sunflower planted in spring under the irrigated conditions at Faisalabad.

Review of literature :

Verghese *et al.* (1976) found that increasing rates of applied N from 0 - 90 kg/ha increased seed yield from 0.56 to 1.47 t/ha. The highest seed oil content of 37.6 % were recorded at 45 kg N/ha as against 34.6 and 36.0 % in case of 0 and 90 kg N/ha. They further indicated that increasing rates of applied N also significantly increased the head diameter, number of seeds/head, percentage of filled seeds. 1000-seed weight and seed protein contents while increasing rates of applied P had no significant effect on yield or yield components except 1000-seed weight.

Singh *et al.* (1977) in field trials of sunflower crop in the winters of 1972-75 on a sandy clay loam soil with all combinations of 0, 30, 60 or 90 kg N and 0, 13, 26 or 39 kg P_2O_5/ha observed that application of N or P did not significantly affect head diameter or 1000-seed weight while percentage of filled seeds decreased with increased N or P. They further indicated that seed yield increased with increased N application upto 60 kg N/ha, P application did not significantly affect the yield while seed oil contents increased with increasing P and decreasing N.

Mohammad and Rao (1981) reported that spacing did not affect the seed oil contents and oil yield of sunflower. They further observed that oil contents slightly increased with 40 kg N/ha in some years, but decreased with 80-120 kg N/ha.

Singhi and Pacheria (1981) stated that sunflower grown in rows 30, 45 and 60 cm apart, gave average seed yields of 0.95, 1.19 and 1.2 t/ha, respectively. They further revealed that yields were higher with 20 kg N/ha than with 0-60 kg N/ha while the crop showed no response to applied phosphorus (0-60 kg P_2O_5/ha).

Tripathi and Kalra (1981) obtained the highest seed yield of summer sunflower with 40 kg N/ha in 1974 and 120 kg N/ha in 1975 while the higher N rate delayed the developmental stages. They further observed that phosphorus and potash each at 60 kg/ha increased the head diameter, seed per head and yield and also accelerated the developmental stages.

Fick and Sweller (1972) found that hybrid sunflower varieties had significantly higher yields (some exceeding 2000 kg seed/ha), greater uniformity for rust resistauce, flowering, height, head size and seed oil concents than open pollinated varieties. They suggested that as a result of improved method of seed production, hybrid could be produced for commercial use freely.

Francesco (1972) observed that the best sunflower cultivars were Record, Peredovik and Donskoi which yielded 1.96, 1.86 and 1.81 tons of seed/ha, respectively. He further pointed out that application of N fertilizer increased seed yields but decreased seed oil contents in sunflower.

Gowda and Cajanan (1979) in sunflower varietal trials with various fertilizer combinations observed that 60 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha was the economical and the optimum fertilizer dose for hybrids BSH-I, BSH-II and cv. EC. 68415 which gave yields of 1.6, 1.76 and 1.34 t seed/ha, respectively.

MATERIALS AND METHODS

Investigation into the effect of different levels of NPK on the growth, yield and oil contents of two sunflower varieties, Cargil and IS-894, were carried out at the University of Agriculture Faisalabad on a sandy clay loam soil having on an average 0.067 percent nitrogen, 7 ppm available P_2O_5 and 225 ppm K_2O during the spring of 1984. The preceding crop was cotton. The experiment was quadruplicated in split plot design using a net plot size measuring 2.40 x 5.10 m. The fertilizer rates and the varieties were randomized in the main and sub-plots, respectivaly. The fertilizer treatments comprised 0-0-0, 50-50-0, 75-50-0, 100-50-0 and 100-50-50 kg NPK/ha.

The crop was sown in 90 cm apart paired rows (30/90 cm) on March 20 on a well prepared seed-bed with the help of single row hand drill. The whole of N, P_2O_5 and K_2O were applied at sowing in the from of Urea, DAP and SOP, respectivcly in the respective treatments. Thinning was done at 3-4 leaf stage keeping 30 cm distance between the plants within the rows. The crop was ear-

thed up after second irrigation. First irrigation was given 32 days after planting while the subsequent irrigations were applied as and when needed. In all six irrigations of 7.5 hectare centimeters each were given in addition to 26.2 mm rainfall received duting the growing period of the experimental crop. The crop was kept free of weeds by giving two hoeings before the earthing up operation.

For recording individual observations on plant height, stem girth, head diameter, number of seeds per head, seed weight per head etc. 10 plants were taken at random from three different places in each plot. The seed oil contents were determined in the laboratory of Directorate of oilseed, Ayub Agricultural Research Institute, Faisalabad by "Soxhlet" method. The experimental soil was analysed for N, P and K before sowing the crop. The crop was harvested manually on July 7, 1984 when tt was fully ripe, sun dried for about a week and then threshed. The seed yield was recorded on plot basis and then converted to per hectare.

The data collected were subjected to Fisher's analysis of variance technique using Duncan's New Multiple Range Test at 5% level of probability to compare the significance of treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The data pertaining to various growth and yield parameters including seed oil contents are given in Table 1. It is evident from the table that different combinations of NPK significantly increased the plant height of spring sunflower over no application of fertilizer (control). Application of NP each at the rate of 50 kg per hectare increased the plant height by 18.50 cm over check but was at par with the treatment of 75 kg N + 50 kg P_2O_5, 100 kg N + 50 kg P_2O_5, and 100 kg N + 50 kg P_2O_5 + 50 kg K_2O_5/ha. However, the tallest plants of 206.68 cm were obtained in plots fertilized at 100 kg N + 50 kg P_2O_5 + 50 kg K_2O_5 per hectare. As regards varieties, there was non-significant difference in the plant height of both the varieties which ranged between 198.17 and 200.87 cm.

The potential growth of a sunflower plant is determined by its vigorously growing stem. The data on stem girth of the two varieties revealed that NPK application significantly increased the stem girth over check. A combination of NP each at the rate of 50 kg ha^{-1} increased the stem girth by 0.13 cm over control but was at par with rest of the NPK treatments. On the other hand both

Table 1. *Yield and yield components of two sunflower cultivars as affected by NPK application*

Treatments NPK rates Kg ha^{-1}	Plant height (cm)	Stem Girth (cm)	Head Diameter (cm)	No. of filled seed/ head	Seed weight per head (gm)	1000-seed weight (gm)	Seed yield (q/ha)	Seed oil content (%)
N P K	(1)	(1)	N.S.	(1)	(1)	(1)	(1)	N.S.
0-0-0	185.12 b	1.53 b	16.21	1091.25 c	59.39 b	48.75 c	30.64 b	46.00
50-50-0	203.62 a	1.66 a	17.13	1131.02 bc	60.76 b	49.18 bc	31.65 b	44.15
75-50-0	201.81 a	1.68 a	17.51	1247.95 ab	69.24 a	50.43 ab	35.84 a	44.03
100-50-0	200.37 a	1.64 a	17.52	1325.97 a	72.55 a	51.12 a	37.43 a	43.01
100-50-50	206.68 a	1.67 a	17.56	1333.26 a	73.46 a	51.62 a	37.90 a	44.60
Varieties								
	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
V1 = Cargil	198.17	1.63	17.14	1224.19	66.56	49.97	34.53	44.17
V2 = IS-894	200.87	1.64	17.24	1227.59	67.60	50.47	34.86	44.55

N.S. = Non-significant.

1 = Any two means not sharing a letter differ significantly at the 5 per cent level of probability (DMRT).

the varieties under study did not differ significantly from each other with regard to stem girth which varied from 1.63 to 1.64 cm.

Similarly the data regarding the head diameter indicated that although there was a progressive increase in head diameter with the application of each successive rate of NPK but the differences among them were not large enough to reach the level of significance. However, the head diameter on an average varied from 16.21 to 17.56 cm. Taking the varieties into consideration, there was also non-significant difference between them in respect of head diameter which ranged betwean 17.14 and 17.24 cm. These results are in conformity with that of Singh *et al.* (1977) but do not accord with those of Tripathi and Kalra (1981) and Verghese *et al.* (1976) who reported that increasing rates of applied N significantly increased the head diameter.

The productivity potential of a sunflower plant is determined from the number of filled seeds per head. The data on the number of filled seeds per head revealed that there was a linear increase in the number of filled seeds per head by each successive rate of NPK. The highest number of 1333.26 filled seeds per head was recorded in plots fertilized at 100-50-50 kg NPK/ha as against 1325.97, 1247.95, 1131.02 and 1091.25 for the treatments of 100-50-0, 75-50-0, 50-50-0 and 0-0-0 kg NPK/ha, respectively. The highest number of filled seeds per head at 100-50-50 kg NPK/ha was attributed to balanced fertilization which facilitated the process of seed formation and its subsequent development. As regards varieties, there was non-significant difference in the number of filled seeds per head. Cargil and IS-894 produced on an average 1224.19 and 1227.59 filled seede per head, respectively. These results are supported by the findings of Verghese *et al.* (1976), who found that increasing the rate of N increased % age of filled seed, but do not accord with those of Singh *et al.* (1977).

Seed weight per head is the most important yield parameter in sunflower which contributes materially towards the final crop yield. Thedata pertaining to seed weight per head indicated that there was a gradual increase in the seed weight per head by the application of each successive dose of NPK. Plots fertilized at the rate of 50 kg N + 50 kg P_2O_5/ha although increased seed weight per head over check but the difference was not large enough to reach the level of significance. Addition of 25 kg N to 50 kg N + 50 kg P_2O_5/ha increased the seed weight per head by 11.69 and 15.44 percent over 50 kg N + 50 kg P_2O_5/ha

and Check, respectively, while subsequent addition of 25 kg N + 50 kg P_2O_5/ha did not cause any significant increase in seed weight per head. However, the maximum seed weight of 73.46 gm per head was obtained in plots fertilized at the rate of 100 kg N + 50 kg P_2O_5 + 50 kg K_2O/ha which was attributed to higher number of filled seeds per head. As regards varieties, it appeared from the results that both the varieties produced almost similar seed weight per head which ranged between 66.56 and 67.60 grams. These results are in agreement with those of a Tripathi and Kalra (1981).

Seed size is also another important yield component in sunflower. The data on seed weight revealed that different combinations of NPK affected the 1000-seed weight significantly over check, The highest 1000-seed weight of 51.62 grams was recorded in plots fertilized at 100-50-50 kg NPK/ha as against 51.12, 50.43, 49.18 and 48.75 grams for 100 kg N + 50 kg P_2O_5, 75 kg N + 50 kg P_2O_5 50 kg N + 50 kg P_2O_5/ha treatments and control, respectively. These results are in agreement with those of Verghese *et al.* (1976) but do not accord with that of Singh *et al.* (1977) who reported that N or P did not significantly affect the 1000-seed weight. As regard varieties, there was non-significant difference in 1000-seed weight of both the varieties. On an average the 1000-seed weight of Cargil and IS-894 was recorded 49.97 and 50.47 grams, respectively.

The data pertaining to seed yield per hectare revealed that there were highly significantly differences among the fertilizer treatments. Plots fertilized at the rate of 50 kg N + 50 kg P_2O_5 per hectare although gave higher seed yield per hectare than check but the difference was statis-ically non-significant. Application of 75 kg N + 50 kg P_2O_5 per hectare although increased the seed yield significantly over 50 kg N + 50 kg P_2O_5 ha^{-1} including check but was at per with treatments of 100 kg N + 50 kg P_2O_5 and 100 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1}. However, the highest seed yield of 37.90 quintals per hectare was obtained from plots fertilized at the rate of 100 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1} as against 37.43, 35.84, and 31.65 for the treatment of 100 kg N + 50 kg P_2O_5, 75 kg N + 50 kg P_2O_5 and 50 kg N + 50 kg P_2O_5 ha^{-1}, respectively. These results led to the conclusion that application of NP fertilizer beyond the level of 75 kg N + 50 kg P_2O_5 ha^{-1} did not help increasing the seed yield of spring sunflower to a considerable extent.

It was further observed that application of K_2O at the rate of 50 kg ha^{-1} in the addition to NP did not appear to have any effect on the final seed yield

of sunflower, suggesting thereby that the initial K_2O status of the experimental soil was high enough to meet the K_2O requirement of the crop.

Varieties, on the other hand did not differ significantly from each other with regards to seed yield per hectare. The average seed yield per hectare of Cargil and IS-894 was recorded as 34.53 and 34.86 quintals per hectare, respectively. The non-significant difference in seed yield per hectare of both the varieties indicates that the genetic potential and growth behaviour of both of them is almost similar. These results are supported by the findings of Tripathi and Kalra (1981) and Fick and Sweller (1972) and Francesco (1972), but do not accord with those of Gowda and Cajanon (1979).

The data on seed oil contents revealed that all the fertilizer treatments although decreased the seed oil contents of both the varieties over check but the differences were statistically non-significant. However, the seed oil contents on an average varied from 43.01 to 46.00 percent.

As regards varieties, there was non-significant difference between them with regards to seed oil contents and recorded on an average 44.17 and 44.55 percent for Cargil and IS-894, respectively. These results are in accordance with those of Singh *et al.* (1977), Mohammad and Rao (1981) and Francesco (1972).

REFERENCES

Fick, G. N. and C. M. Sweller. 1972. Higher yield and greater uniformity with hybrid sunflower. North Dakota Farm Research, 20 (6) : 7-9. (Fld. Crop Absts., 27 (5) : 2342; 1974).

Francesco, T. 1972. Research on sunflower carried out at the Agronomy Institute of the Faculty of Agri. at Milan. Adnali dell, Academia di Agricultture de Torino (14) : 254-258. (Fld. Crop Absts., 28 (3) : 1602; 1975).

Gowda, K. T. K., and G. N. Gajanan. 1979. Differential response of sunflower to N levels on red sandy loam soils. Current Research, 8 (4) : 59-60. (Soil and Fert. Absts., 43 (4) : 3557; 1980).

Mohammad, S. and S. R. Rao. 1981. Effect of spacing and levels of Nitrogen on oil contents of Sunflower. Indian J. Agron· 26 (2) : 105-109. (Soils and Fert. Absts., 46 (8) : 8872; 1983).

Singh, A. R., O. P. Singh, H. C. Sharma and M. Sinah. 1977. Effect of levels of N and P on yield, oil content and moisture use pattern of rainfed winter sunflower. Indian J. Agri. Sci., 47 (2) : 96-99. (Soils and Fert. Absts., 42 (1) : 620; 1979).

Singhi, S. M. and R. K. Pacheria. 1981. Effect of varying row spacing, nitrogen and phosphorus levels on sunflower. Indian J. Agri. Sci., 47 (2) : 96-99. (Fld. Crop Absts., 36 (5) : 3919; 1983).

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of Statistics. McGraw Hill Book Co. Inc., New York.

Tripathi, P. N. and G. S. Kalra. 1981. Effect of NPK on maturity and yielr of sunflower. Indian J. Agron., 26 (1) : 66-70. (Fld. Crop. Absts., 36 (5) : 3922; 1983).

Verghese, P. T., N. Sadamandan and R. V. Nair. 1976. A study on the yield attributes on sunflower variety 'Peredovik' as affected by graded dozes of N and P. Agri. Res. J. Kerala, 14 (2) : 121-126. Indian. (Soil and Fert. Absts., 41 (12) : 7267; 1979).