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YIELD AND QUALITY OF TWO SESAME VARIETIES AS AFFECTED BY DIFFERENT RATES OF NITROGEN AND PHOSPHORUS

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A field experiment was conducted during summer seasons of 1996 and 1997 to study the response of two sesame genotypes to variable rates of nitrogen and phosphorus. Application at increased rate of N (120 kg) and P (40 kg) increased significantly the seed and stalk yield ha^{-1} as well as protein and concentration of oil. This response was higher with cv. TS3 than cv. 92001.

Key words: oil and protein concentration, seed and stalk yield, Sesame

INTRODUCTION

The sesame seed is consumed as a spice for food products such as hamburger buns and other bakery products. Minor uses of sesame oil include Pharmaceutical and skin care products and as synergist for insecticides. Seed meal contains 42% protein and is rich in tryptophan and methionine. Sesame oil is colourless and odourless with excellent stability due to the presence of natural antioxidants such as sesamolin, sesamin and sesamal, The fatty acid composition of sesame oil varies considerably among different cultivars worldwide (Amin an Kothari, 1989; Dashak and Fali, 1993, Bakhali et al., 1998).

Inspite of its multidimensional uses, the commercial and mechanized cultivation of sesame in Pakistan is very discouraging and hence its per hectare yield is very low. It is grown as a Kharif oilseed crop on a total area of 96 thousand hectares with a total production of 42 thousand tonnes, giving an average yield of 438 kg ha^{-1}, which is much lower than its average yield in other countries such as Egypt (1172 kg ha^{-1}), Mexico (497 kg ha^{-1}) and China (527 kg ha^{-1}) (Anonymous, 1998).

Sesame is a short duration crop and is capable of utilizing solar energy very efficiently. It is potentially capable of producing large quantities of seed per unit area, but low yield ha^{-1} in Pakistan is due to its sowing on the marginal lands, low plant population density, high insect pests and disease incidence, heavy weed infestation, non-availability of promising genotypes and improper fertilization of the crop. The latter two factors limit the sesame yield considerably.

Sesame does not respond to fertilizer under water stress but it responds well to fertilizers with, appropriate moisture as the seed has high content of the elements supplied by fertilizers. The dry matter production of plant parts and its conversion to economic yield is the cumulative effect of various physiological processes of plant system. Nitrogen plays a dominant role in plant growth precess being an integral part of chlorophyll molecule. However, the optimum requirement of nitrogen and phosphorus and screening of potent genotypes of sesame which may ensure maximum crop production and net income per unit area/ time need further investigation.

The present study was undertaken to investigate the influence of variable N and P rates on seed and ~ yield, oil and protein concentration of two genotypes of sesame, under Faisalabad conditions.

MATERIALS AND METHODS

The study was conducted on sandy-clay loam soil at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan. The quadruplicate experiment was laid out in a randomized complete block design with split-split plot arrangement, keeping nitrogen in main plots, phosphorus in subplots and genotype in sub-subplots. Net plot size was 2.4m x 7m. Seedbed was prepared by cultivating the soil thrice with a tractor-mounted cultivator, each followed by planking. The crop was sown in 40-cm spaced rows with a single-row hand drill, on 25 and 27 July in 1996 and 1997 respectively. For each genotype seed rate was 4 kg ha^{-1} during both years. The plant population was maintained uniform through thinning at 4-leaf stage. Nitrogen and phosphorus were applied as per treatment along with a basal dose of potash i.e. 60 kg ha^{-1}. Nitrogen, phosphorus and potash were applied as urea, triple super phosphate and SOP (K_2SO_4). Half of the N and whole the phosphorus and potash were applied at the time of sowing. Remaining 1/2 of the N was applied at 1st irrigation. Insect pests and weeds were kept under control through chemical and mechanical means. Sucking insects were controlled by spraying Novacuran @ 1250 ml ha^{-1}.

The crop was harvested manually at its physiological maturity on November 25 and 27 in 1996 and 1997 respectively. Since seed shattering from the capsule at harvesting/threshing can cause substantial losses in the seed yield of sesame, special care was taken to minimize such losses. For this purpose, crop plants were tied into small bundles from each experimental unit and were placed vertically for sun drying. Threshing was done manually. Total nitrogen contents of the sample were determined by micro Kjeldahl method (AOAC, 1990). Nitrogen and crude protein contents were worked out as under:

$$\sim\sim g\sim\sim) = \frac{\text{Volume of acid used} \times 0.0014 \times 250 \times 100}{\text{Sample weight} \times 10 \text{ ml}}$$

The sesame seeds were dried in an oven at 60°C for 10-12 hr. After drying, the seeds were weighed and crushed into powdered form. The oil was extracted from the crushed seeds by using n-henane as a solvent through soxhlet apparatus. All the data were analysed using Fisher's analysis of variance technique to differentiate the effects of treatments, and means were separated using the least significant difference (LSD) test at P = 0.05 (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Seed Yield: In both seasons, increasing rate of nitrogen application significantly and linearly enhance see yield. The average seed yield in 1996 was 0.61, 0.69, 0.71 and 0.75 t ha-' in No,NI' N_2 and N) treatments respectively. Equivalent values were 0.46,0.51,0.56 and 0.60 t ha"· in 1997 season. Averaged over two years, the mean seed yield varied from 0.53 to 0.67 t ha". Increasing rates fo phosphorus application also increased seed yield and this response was also linear i nature. The PI' P_2 and P, rates of phosphorus application were, however, statistically at per in seed yield during 1997. P, also showed fairly similar trend as P,. However, during the first year, there was no significant difference in the seed yield between 40 ad 80 kg *Pps* application rates. Seed yield was markedly influenced by cultivar. The cv. TS3 enhanced seed yield by 245.16% (1,07 vs 0.21 t) in 1996ad 196.30%(0.80vs 0.27 t) in 1997respectivelyAveraged over two years, the seed yield was 0.29 t in cv. 92001 compared to 0.93 t ha'! in cv. TS3. In the present study, seed yield of sesame increased in response to N fertilizer application over control (NO or lower rate (N,) of application with maximum yield of 0.88-1,10 t ha"· being attained at N) rate of application in both the seasons. Rao et al. (1994) reported higher seed yield up to 1165 kg ha-, with application of 80 kg N ha" and 13 kg P ha".

Stalk Weight: In both seasons, application of increasing rates of nitrogen significantly enhanced stalk yield and this response was cubic in nature. The average stalk yield varied from 2.80 to ha? in 'No to 3.43 t ha:' in N) (120 kg ha") treatment. In 1996, the highest stalk yield was obtained by the application of 120 kg N ha:. However, in 1997 there was no statistical difference in the stalk yield between 120 and 80 kg N ha", Similarly, application of various rates of phosphorus also enhanced stalk weight but the difference among various rates were non-significant in 1997, and this response was also cubic. Cultivar differences in stalk yield were also significant. The cv. TS3 markedly increased stalk yield over cv. 92001 in both the seasons. The mean stalk yield over the two seasons was 2.29 t ha" in cv. 92001 and 3.85 t ha" in cv. TS3. Suryavanshi et al. (1993) also reported significant differences in stalk yield between different cultivars of sesame in India.

Protein Concentration: The protein concentration in sesamum seed 'was affected by nitrogen, phosphorus and cultivar during both the season (Table 1). Increasing rate of nitrogen application significantly enhanced protein concentration and this response was linear in 1996 and quadratic in 1997. In 1996, the average protein concentration was 18.11% in No, 19.14% in NI' 20.46% in N_2 and 20.70% in N). Equivalentvalues in 1997were 18.750/019.940/020.46% an 20.675, respectively. Averaged over two years, protein concentration varied from 18.43% to 20.69010among different rates of nitrogen application. Effects of different rates of phosphorus application were significant in 1997 only and the response was cubic in nature. The average protein concentration varied from 19.69% to 20.07% among various phosphorus application rates. Cultivar differences in protein concentration were highly significant in both the seasons. The cv. TS3 enhanced protein concentration by 4.91% in 1996 and 7.19% in 1997 compared to cv. 92001. Overall, average protein concentration was 19.60% in 1996 and 19.95% in 1997. These results substantiate the findings of ~wyavanshi et al. (1993) who also reported 21,6 to 22.6% protein concentrations in sesame in India.

Oil Concentration: Effect of various rates of nitrogen on oil concentration was highly significant in both the seasons (Table 1). In 1996, oil concentrations increased from 46.91% in Noto 48.95% in N_2; thereafter oil concentrations slightly declined at (48.55%) in N) and this response was cubic. Both N_2 or N) rates of nitrogen application were, however, at par in respect of oil concentration. Similarly, both No or NI rates of application were also at par with each other. A similar effect of increasing nitrogen rates on oil concentration was observe during 1997 and this response was, however, linear in nature. Averaged over two years, oil concentration varied from 46.75 - 48.62% among various rates of nitrogen application. In both seasons, application of variable phosphorus rates did not affect seed oil concentration, and it varied from 47,41-47.90%. The cv. TS3 increased seed oil concentrations over cv. 92001 by 1.79% in 1996 and 2.17% in 1997. Overall, average seed oil concentration was 47.95% in 1996 and 47.45% in 1997 (Table 1).

Oil Yield: As indicated increasing rates of nitrogen application from 0-120 kg ha:' significantly enhanced oil yield ha" in both the seasons, except for N_2 and N) (1996) where the differences in oil yield were non-significant. This response of oil yield to nitrogen application was, however, linear in nature. The average oil yield for No, NI' N_2 and N3 in 1996 varied from 287 kg, 326 kg, 351 kg and 367 kg ha" respectively while equivalent values in 1997 were 216, 240, 272 and 289 kg ha:¹ respectively. Increasing rate of phosphorus application up to 80 kg ha'l increased oil yield than lower rates of application in 1996 but was not so in 1997. The difference in oil yield between P_2 and P3 rates of application was however, non-significant in 1996. Cultivar differences in oil yield were highly significant. The cv. TS3 enhanced oil yield Over cv. 92001 by 246.69% in 1996 and 203.7% inn 1997. Overall, average oil yield was 333 kg inn 1996 and 254 kg in 1997 (Table 1).

In 1996, interaction between N x P affecting oil yield was significant: Higher oil yield (382 kg ha-1) was obtained when increasing rates of N and P were used and these higher rates (N3P3) were statistically 'at par In oil yield with N_3P_1 and N~P2 rates of application. The minimum oil yield of 267 kg ha'l was given by NOPO treatment combination.

These results indicated that oil yield (254.333 kg ha:') obtained in the present study is similar (251-342 kg ha'l) to that of reported by Suryavanshi et al. (19930 for different varieties of sesame in India. The higher oil yield (product of seed yield and oil percentage) responded similarly to seed yield with increasing levels of nutrition, a conclusion similar to that reported by Pawar et al. (1993).

Table 1. Effect of various nitrogen and phosphorus application rate. on yield and yield components of two genotypes of sesame.

Treatment	Seed yield (t ha-I) 1996	Seed yield (t ha-I) 1997	Stalk yield (t ha") 1996	Stalk yield (t ha") 1997	Oil concentration (%) 1996	Oil concentration (%) 1997	On'ield (kg ha") 1996	On'ield (kg ha") 1997	Protein concentration (%) 1996	Protein concentration (%) 1997
Nitrogen										
No = 0 kg ha-I	0.61 c	0.46 d	2.27 c	3.33 b	46.91 b	46.58 b	287 c	216 d	18.11 c	18.75 c
NI = 40 kg ha-I	0.69 b	0.51 c	2.31 c	3.30 b	47.38 b	46.92 b	326 b	240 c	19.14 b	19.94 b
N_2 = 80 kg ha-I	0.71 b	0.56 b	2.77 b	3.80 a	48.95 a	48.29 a	351 a	272 b	20.46 a	20.46 a
N_3 = 120 kg ha-I	0.75 a	0.60 a	2.95 a	3.91 a	48.55 a	48.00 a	367 a	289 a	20.70 a	20.67 a
Phosphorus										
Po = 0 kg ha-I	0.65 c	0.51 b	2.57 a	3.49NS	46.64NS	47.17NS	311 c	243NS	19.66NS	19.72 b
PI = 40 kg ha'}	0.69 b	0.53 ab	2.42 b	3.53	48.21	47.72	333 b	254	19.81	20.32 a
P_2 = 80 kg ha-I	0.70 b	0.54 a	2.63 b	3.67	48.18	47.61	340 ab	261	19.45	19.89 b
P3 = 120 kg ha-I	0.72 a	0.54 a	2.68 a	3.65	47.76	47.29	347 a	259	19.45	19.89 b
Cultivar										
92001	0.31 b	0.27 b	2.08 b	2.51 b	47.52 b	46.94 b	149 b	126 b	19.13 b	19.26 b
TS3	1.07 a	0.80 a	3.06 a	4.65 a	48.37 a	47.96 a	516 a	382 a	20.07 a	20.64 a
Mean	0.69	0.53	2.58	3.58	47.95	47.45	333	254	19.60	19.95

Values in the same column having different letters differ significantly (p ~ 0.05); NS = Non-significant

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