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Research Article

Management of Macro-Nutrients for Sesame (*Sesamum Indicum*) under Changing Climate Scenarios of Thai Region

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Abstract

Sesame (*Sesamum indicum*) is an important oil seed crop containing more than 50% quality oil and a good source of protein in the world. Its economic production is governed by its management practices. To find the optimum dose of NPK fertilizer in the sandy loam soils under arid conditions, two-year field experiment was carried out during Kharif season 2021 and 2022 at Adaptive Research Farm (ARF), Karor Zone, Layyah Punjab Pakistan. Five treatments of NPK were used to optimize the NPK for Sesame cultivar TH-6 with three replications. Results showed that the maximum grain yield 765.3 kg ha^{-1} was recorded in 2021 as compared to 738.6 kg ha-1 in 2022 at ARF, where $N_{113}P_{113}K_{60}$ (113 kg Urea ,113 kg P_2O_5,60 kg ha^{-1} K_2O) was applied. Minimum yield and yield components were produced where NPK were not applied. It was concluded that the application of NPK at the rate of could improve yield and yield components of sesame in the agro-climatic conditions of Karor, Layyah.

Introduction

There is botanical and textual evidence for sesame cultivation in the ancient world [1]. Sesame is a plant of the genus Sesamum, also called benne. Sesame is considered an important oilseed crop. It is called the queen of oilseeds because of its high quality of oil (50-58%) and high protein content (22%). Sesame seeds are commonly produced to obtain the essential oil. The high content of unsaturated fatty acids, proteins, minerals and antioxidants in sesame seeds results in the high value of sesame products. The nutritional and pharmaceutical benefits of sesame in the food industry and medicine are well recognized and appreciated [2]. Sesame *(Sesamum indicum)* is a plant of the genus Sesamum, also called benne. Sesame *(Sesamum indicum L.)* is considered an important oilseed crop. It is called the queen of oilseeds because of its high quality of oil (50- 58%) and high protein content (22.0%). Sesame oil qualities similar to olive. Its feed best for animals and birds. Sesame is use in confectionery, bakery products, as well as soaps, spices, vegetable oils, and carbon paper. Due to these uses demand of sesame is increasing day by day. And now cultivated as a cash crop.in 2021-21 sesame was grown in an area 148.84 thousands hectares with 90.66 thousand tons grain production. Sesame cultivated area was more in 2021 as compared to last year due to encouragement of government of Punjab (government of Punjab).

Grain yield of sesame in Thal zone is lower as compared to potential yield. It is mostly grown on marginal land with insufficient fertilization and irrigations which does not fulfill crop requirements. Farmers of Thal zone are facing different problems such as higher input rates, canal water shortage and marginal soils. Among different inputs, especially fertilizers are the expensive and not available easily in the market. Furthermore, farmers have less awareness about the balance use of fertilizer. As compared to potential yield of 1500 kg/ha, farmers of Thal zone achieve 1000 kg ha. This yield gap can be minimized through optimum use of fertilizers. Fertilizers are good to make the soil more fertile for higher yield of sesame. Soil of Pakistan are deficient in nitrogen (N), about 30% deficient in potassium, and 80 to 90% in phosphorus [3]. Soil is natural medium that provides essential nutrients to plants for better growth and development. Among all essential nutrients nitrogen and phosphorus are considered as macronutrients. Nitrogen is essential for cell division, root development, leaf area enlargement, protein metabolism and growth that results in increased crop and dry matter yield [4]. Jouyban & Moosavi [5] stated that significant increase in seed yield, plant height, pod diameter, number of auxiliary branches/plant, first capsule distance from ground and capsule length were observed with increase in N level from 0- 200 kg/ha. While Shehu et al. [6] reported highest number of branches, leaves, seed/pod, seed yield, and dry matter against N application rate of 112.5 kg/ha. Elnakhlawy & Shaheen [7] concluded that Saudi local cultivar under 150 and 200 kg N/ha produced highest yield of 862- 869 kg/ha.

While phosphorus play vital role for energy transformation, early root development, storage in plant cell, flowering, maturity and seed development [8]. Haruna et al. [9] stated that sesame production gave significantly better yield and economic return under with application of 13.2 kg P/ha of phosphorus fertilizer. Shehu et al. [10] concluded that application of 45 kg P/ha produced highest seed yield. Potassium increases the yield and quality of agricultural products and increases the ability of plat to resist disease, insect attack, cold and drought stress [11]. Potassium play a crucial role in activation of enzymes [12]. Potassium aids in development of strong healthy root system. Potassium is involved in transport of products of the photosynthesis to the pod and transformation into oil [13]. This experiment had been performed to find out a best integrated nutrients management practice for sesame using chemical fertilizer which helps in higher crop production by improving fertility of soil. Hence, this study was made to find out the optimum nutrition to kharif sesame. Sesame nutrition remained agonistic very for a long time [14]. The role of the nutrients in terms of their uptake, distribution and translocation in sesame plant is a critical phase that will help in taking decision and improving its production management [10]. It will help in the adjustment of proper package and practice for sesame crop and reduce the cost of fertilizer.

The purpose of this experiment is to achieve the potential yield of sesame and benefit given to the farmers of Thal zone. To find out the best combination of the nutrients for sesame, experiment was conducted in arid condition at adaptive research farm of karor during kharif season. Optimum use of the fertilizers helps in to conserve the natural resources and farmers resources. And also help to improve the economy of the Pakistan [15-20].

Balance use of fertilizer is beneficial for farmers to attain potential yield. The importance of balance use of fertilizers to achieve the potential yield cannot be denied.

Materials and Methods

Experimental site

A field experiment was conducted in 2021 and 2022 at Adaptive Research Farm Karor, Layyah, Punjab Pakistan (31°N, and 71°E at an altitude of 145m (above sea level). The region has a desert climate and hot summers (25.2°C-48°C) and dry cool winters (0°C-2°C). Most of the rainfall was received during (January-March) with a mean value of 120mm. This region has diverse soil with sand dunes, sandy laom soil and clay soil. Details of soil analysis have been given in Table 1.

Table 1: Soil physical and Chemical Characteristics of the Adaptive Research Farm Karor.

Parameter	Quantity
Sand	41%
Silt	38.50%
Clay	22%
Organic matter	0.91%
$CaCO_3$	6.90%
EC	1.61 ds/m
PH	8.5
Available N	0.60 g/kg
Available P	11 mg/kg
Exchangeable K	123 mg/kg
AB-DTPA Extractable Zn	1 mg/kg
AB-DTPA Extractable Fe	2.90 mg/kg
AB-DTPA Extractable Mn	1.20 mg/kg

Experimental detail

The experiment was conducted at Adaptive Research Farm, (31.200 N and 71.090 E), and farmers' field, Karor Lal Eason, Layyah, Pakistan during Kharif season 2021 and 2022. The experiment was arranged in a randomized compete block design (RCBD), conducted in triplicate with five treatments (Table 2) using sesame variety TH-6. The plot size was 6 m×10 m (W × L). The crop was sown on last week of May in sandy loam soil with PH 8.4-8.5 having organic matter 0.69%. Sesame TH-6 was sown by broadcast method at the rate of 2 kg/acre and applied Nitrogen (N), Phosphorus (P) & Potash (K) according to treatments at the time of land preparation. N was applied at the time f flowering and pod formation.

Table 2: Treatments of the experiments during 2021 & 2022

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
$T_1=N_{28}P_{28}K_{16}$	28	28	16
$T_2= N_{57}P_{57}K_{32}$	57	57	32
$T_3= N_{85}P_{85}K_{48}$	85	85	48
$T_4= N_{113}P_{113}K_{60}$	113	113	60
$T_5= N_0P_0K_0$	No NPK (control)		

Plant population measures were adapted to control weeds, insects and pests uniformly to check the real effect of fertilizers. All others factors except treatments were kept uniform for all the experimental units. Data on emergence dynamics, plant population (m^2), pods per plant, plant height (cm), 1000 grain weight (g) and grain yield (kg ha^{-1}) were recorded following standard procedures. Collected data was subjected to statistics analysis of variance technique and differences among treatments means were separated using Least Significance Difference (LSD) test at 5% probability.

Results and Discussion

Plant population

Data given in Tables (Tables 3 & 4), showed that the effect of plant population was non-significant and at par with each other. Plant population of the sesame crop was not affected significantly with the treatments during both years (2021 and 2022) at ARF is and Farmers' field.

Maximum plant population count was 39.3 in 2021 as compared to 2022 where maximum plant population was 35.3 Farmer's field data given in Tables, showed that the effect of plant population was non-significant and statistically similar with each other. Average plant population of the sesame crop during both years (2021 and 2022) at farmer field is given. Average maximum plant population count was non-significant in both year (2021 and 2022) at farmer field.

Plant height (cm)

The combined effect of genetic makeup, environment and management practices determines the plant height. The tallest plants were observed in the treatment T_4 (144cm) followed by T_3 (138.3cm), and T_2 (130 cm) during 2022 at ARF. Minimum plant height was observed in T_5 during both years (2021 & 2022). During 2021, plant height under T_4 (147cm) was maximum with statistically different from all others treatments. ARF Data given in Tables (Tables 3 & 4), showed that the plant height at T1, T2, T5 was highly significant, while plant height at T_3 and T_4 was non-significant in year 2022.while plant height at T_1, T_2 was significant from T_3 and T_4 in year 2021. Average maximum plant height was significant in both year (2021 and 2022) at ARF.

Table 3: Influence of different nutrient treatments on yield and yield parameters Mean Table of ARF 2022 data.

Treatment	Plant population (m^2)	Plant height (cm)	No of pods / plant	1000 grain weight (g)	Grain Yield (Kg/ha)
T1=N28P28K16	36 NS	113.3 b	16.3 b	2.72 d	520.6 c
T2= N57P57K32	36 NS	119.6 b	19.0 a	3.16 c	617.0 b
T3= N85P85K48	39.3 NS	134.3 a	19.3 a	3.40 b	717.0 a
T4= N113P113K60	38.3 NS	147.0 a	20.0 a	3.57 a	765.3 a
T5=N0P0K0	33.6 NS	98.3 d	13.6 d	1.92 c	371. c

Table 4: Influence of different nutrient treatments on yield and yield parameters at ARF Karor during 2022.

Treatment	Plant population (m^2)	Plant height (cm)	No of pods / plant	1000 grain weight (g)	Grain Yield (Kg/ha)
$T1=N_{28}P_{28}K_{16}$	33.6 NS	121.3 c	18 c	2.42 b	503. b
$T2= N_{57}P_{57}K_{32}$	35.3 NS	130. b	21.6 b	2.61 ab	557. b
$T3= N_{85}P_{85}K_{48}$	33.3 NS	138.3 a	25.6 a	2.74 a	693.6 a
$T4= N_{113}P_{113}K_{60}$	35. NS	144. a	27 a	2.79 a	738.6 a
$T5 =N_0P_0K_0$	33.6 NS	98.3 d	13.6 d	1.92 c	371. c

No of pods plant^{-1}

Pods per plant is a significant component of final yield. ARF Data given in Tables (Tables 3 & 4), showed that the significant difference among the treatments for the number of bolls plant^{1} during experimental year 2022. Average maximum no of pods plant^{1} of the sesame recorded in T_4 (27), while minimum no of pods plant^{1} recorded in T_5 (13.6) during 2022 at ARF is show (Table 3) while during 2021, a similar response of the no of pods plant, T_2, T_3 T_4 was non-significant to each other, while T1 was significant to others. Average maximum no of pods per plant of the sesame recorded in T_4 (20). Mean of no of pods per plant was higher during the experimental year 2022 as compared to 2021.

1000 grain weight (g)

100 grain weight help to determine the grain yield of the sesame crop. ARF Data given in Tables (Tables 3 & 4), showed that the significant difference among the treatments for the 1000 grain weight in both years (2021 & 2022) The average maximum grain weight was recorded in T_4 (2.79g), while minimum grain weight was recorded in T_5 (1.92g) during 2022 (Table 3). While during 2021, average maximum weight was recorded in T_4 (3.57g), minimum grain weight was recorded in T_1 (2.72g) (Table 4). Mean of 1000 grain weight was higher during the experimental year 2021 as compare to 2022 (Tables 3 & 4).

Grain yield (kg ha^{-1})

Grain yield contribute in the economy of any country. ARF Data given in Tables (Tables 3 & 4), showed that the effect of fertilizer on grain yield was non-significant in T_1, T_2 and also between T_3, T_4. While significant between T_1, T_2 as compare to T_3, T_4 and T_5. Maximum grain yield was recorded (738.6 kg ha^{-1}) in T4, while minimum recorded 371 kg ha^{-1} in T_5 where no NPK applied during 2022 (Table 3). During 2021 maximum grain yield 765.3 kg ha^{-1} in T_4 was recorded, while minimum grain yield (520.6 kg ha^{-1}) was recorded in T1 (Table 4). Farmer field data given in Tables, showed that the effect of fertilizer on grain yield was significant in both years (2021 & 2022). Maximum grain yield was recorded (702.6 kg ha^{-1}) in T_4, while minimum recorded 405.3 k g ha^{-1} in T_5 where N0P0K0 (control, without N, P and K) applied during 2022 (Table 4). During 2021 maximum grain yield 828.6 in T_3 was recorded, while minimum grain yield (645.3 kg ha^{-1}) was recorded in T_1. Mean of grain yield was higher during the experimental year 2021 as compare to 2022.

Conclusion

Under the agro-ecological condition of karor lal Eson, Punjab Pakistan, the application of NPK significantly influenced the growth and yield parameters of the sesame crop grain yield was maximum (738.6 kg ha^{-1}) during 2022 and 765.3 kg ha^{-1} in 2021 where $N_{113}P_{113}K_{60}$ (113 kg Urea ,113 kg P_2O_5,60 kg ha^{-1} K_2O) was applied. And in the farmer field the maximum grain yield was produced 828.6 kg ha^{-1} in 2021. All over the conclusion is that TH-6 variety of sesame is best for arid zone at optimum NPK doses as a grain propose. So, This $N_{113}P_{113}K_{60}$ (113 kg Urea, 113 kg P_2O_5, 60 kg ha^{-1} K_2O) fertilizer doses is recommended to attain maximum yield for farmers of arid zone.

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