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Original Article

Growth and Yield of Sunflower under the Integrated Farmyard Manure and Potassium Fertilization

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ABSTRACT

The study was conducted during the autumn of 2022 Session at the Students' Experimental Farm Department of Agronomy, Sindh Agriculture University Tandojam, using a Randomized Complete Block Design. **Objective:** To assess how varying levels of Farmyard Manure and potassium affect the growth and seed production of sunflowers. **Methods:** The study utilized five different Farmyard Manure treatments and three potassium stages. The variety HO-1 underwent the following treatments: T_1 = Control (0-ton Farmyard Manure+ 0 kg ha^{-1} potash), T_2= 5-ton Farmyard Manure+ 30 kg ha^{-1} potash, T_3= 5-ton Farmyard Manure+ 60 kg ha^{-1} potash, T_4 = 5-ton Farmyard Manure+ 80 kg ha^{-1} potash, T_5 = 5-ton Farmyard Manure+ 120 kg ha^{-1} potash. **Results:** The best results were found in T5 (5 tons of Farmyard Manure + 120 kg ha-1 Potash), which had the largest plant girth (11.2 cm), largest head diameter (48.5 cm), tallest plant (247.4 cm), highest number of seeds per head (1971.3), heaviest seed weight (69.5 g) per head, seed index (34 g), and maximum seed yield (2725.7 kg ha-1). T4 closely trailed, showing positive results (5 tons of farmyard manure plus 80 kg ha-1 potash). **Conclusions:** In conclusion, the study demonstrates that the optimal combination for maximizing sunflower growth and yield is the application of 80 kg ha^{-1} of potassium and 5 tons of Farmyard Manure.

INTRODUCTION

The sunflower plant, (*Helianthus annuus.* L). belongs to the *Asteraceae* family and holds significant importance as an oilseed crop. It ranks as one of the most prominent oilseed crops within the *Asteraceae* family and serves as a crucial source of vegetable oil. The term "sunflower" finds its origins in the Greek words *'Helios*,' signifying the sun, and *'Anthos*,' denoting flower. Globally, sunflower stands as the second most essential oil crop, following soybean. It is employed in animal feed, containing protein levels ranging from 20 to 21 percent and oil content ranging from 30 to 42 percent [1]. Its oil contains more than 90% of healthy unsaturated fatty acids, such as oleic (18:1) and linoleic (18:2) acids, which are essential for daily life. Sunflower is the primary source of oil that Pakistan needs [2]. With 0.606 million tons of domestic production, Pakistan imported 1.72 million tons of edible oil seed between 2013 and 2014 at a cost of US$ 1.43 billion. Pakistan is grappling with a severe shortage of edible oil, driven by a relentless population growth that has led to a surge in demand. The country's domestic production falls significantly short of

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meeting this rising demand, resulting in a substantial disparity between what is produced and what is consumed [3]. To fill this gap, Pakistan relies heavily on importing edible oil, a practice that incurs an annual expenditure of over Rs. 45.0 billion. This makes Pakistan the world's third-largest importer of edible oil. Oilseed crops are a significant component of Pakistan's economy, providing more than 17% of the country's domestic edible oil needs. Within this category, sunflower cultivation alone contributes approximately 11% to the overall production of edible oil in the nation [4]. Farmyard manure increases soil's organic matter content, acting as a reservoir for water and nutrients and preventing compaction and surface crusting [5]. Additionally, it enhances the accessibility of nutrients for plant absorption, enhances soil's physical characteristics, and fosters an ideal habitat for the activity of soil microorganisms [6]. Micronutrients are vital for plant growth and are required in minimal quantities throughout their lifecycle to regulate various physiological processes. These elements are essential for plant development, even though they are utilized in minute quantities [7]. Potassium stands out as a crucial macro-nutrient and is by far widely assimilated cation in higher plants. Its significance extends to various aspects of plant growth and development. Beyond its role in plant metabolism, potassium contributes to enhancing the quality of crops. This is accomplished by prolonging the grain-filling period, enhancing grain filling, increasing kernel weight, strengthening the plants straw, improving resistance to diseases, and supporting the plant's ability to withstand stress [8]. Potassium plays a crucial role as a nutrient, contributing to the improvement of crop yield and the quality of production [9]. Elevating the levels of potassium (K) in crops not only enhances their growth and overall productivity but also plays a crucial role in reinforcing their resilience to environmental stressors, particularly by enhancing their ability to endure drought conditions [10]. Sunflower plants receiving sufficient potassium demonstrate increased resilience to drought stress, leading to higher yields and greater allocation of dry matter to the grain-filling process compared to plants with insufficient potassium. Additionally, potassium fosters the activation of enzymes, thereby contributing significantly to the metabolism of carbohydrates, proteins, and fats in sunflowers, ultimately influencing the quality of sunflower seeds [11]. While the uptake of potassium by sunflower plants can vary significantly depending on the specific species and growing conditions, it generally surpasses the uptake of nitrogen (N) or phosphorus (P) [12].

METHODS

The field experiment was carried out at Students' Experimental Farm, Department of Agronomy, Sindh Agriculture University in Tandojam, during autumn 2022 to assess the growth and yield of sunflower under the integrated farmyard manure and potassium fertilization. The experiment was designed with randomized complete block design with net plot size 6m x 5m ($30m^2$). In accordance with the suggested practice for sunflowers, mechanical implements were employed to adopt a good seedbed and prepare the area appropriately. The experiment was carried out in three repetitions, where different amounts of nitrogen (N), phosphorus (P), and potassium (K) were administered. Five treatments, involving the application of potassium (K) and farmyard manure, were applied. The treatments were labeled as follows:

T1 = Control (0 tons of Farmyard Manure + 0 kg/ha of potash)
T2 = 5 tons of Farmyard Manure + 30 kg/ha of potash
T3 = 5 tons of Farmyard Manure + 60 kg/ha of potash
T4 = 5 tons of Farmyard Manure + 80 kg/ha of potash
T5 = 5 tons of Farmyard Manure + 120 kg/ha of potash

In each experimental plot, five plants were chosen when they were mature, and the units of measurement. Plant population (m^{-2}) with help of measurement tap, plant height (cm), stem girth (cm), head diameter (cm), number of seeds $head^{-1}$, seed weight $head^{-1}$ (g), seed index (1000-seed wt.(g)), seed yield kg ha^{-1} were recorded. The Statistix-8.1 computer program (Statistix, 2006) was used to do an ANOVA study of the data using statistics been gathered.

RESULTS

The outcome demonstrated the important significant difference ($p < 0.05$) in sunflower at various levels of Farm Yard Manure and potassium. The maximum plant population (9.6) square meters were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash plant population (m^{-2}) of (8.3) and the least plant population (m^{-2}) of (6.2) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Plant height (cm) the maximum plant height (247.7) centimeter were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash plant height (cm) of (224.0) and the minimum plant height (190.0) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Stem girth (cm) the maximum stem girth (cm) of (11.2) were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash stem girth (cm) of (10.2) and the minimum stem girth (7.7) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Head diameter (cm) the maximum head diameter (cm) of (48.5) were recorded in treatment T_5 = (5-

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ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash head diameter (cm) of (44.7) and the minimum head diameter (22.7) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Number of seeds head^{-1} the extreme number of seeds head^{-1} of (1971.3) were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash, number of seeds head^{-1} of (1789.3) and the least number of seeds head^{-1} (1363.0) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Seeds weight head^{-1} (g) the supreme nnumber of seeds weight head^{-1}(g) of (69.5) were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash seeds weight head^{-1} (g) of (52.6) and the minimum seeds weight head^{-1} (g) (32.2) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Seed index (1000-seeds weight, g) the maximum number of seed index (g) of (34.0) were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash seed index (g) of (29.0) and the minimum seed index (g) (22.0) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1}. Seed yield (kg ha^{-1}) and the maximum numbers of seed yield of (2725.7 kg ha^{-1}) were recorded in treatment T_5 = (5-ton Farm Yard Manure and 120 kg ha^{-1} potash), followed by T_4 = 5-ton Farm Yard Manure and 80 kg ha^{-1} potash, seed yield of (2556.7 kg ha^{-1}) and the minimum seed yield (2070.3 kg ha^{-1}) was observed in control T_1 = 00 Farm Yard Manure and Potash kg ha^{-1} (Table 1).

Table 1: Growth and Yield Traits of Sunflower under the Integrated Farmyard Manure and Potassium Fertilization

Treatments	Plant population (m^{-2})	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	Number of seeds head^{-1}	Seeds weight head^{-1} (g)	Seed index (1000-seeds wt., g)	Seed yield kg ha^{-1}
T_1 = 00 kg K + FARMYARD MANURE	6.2 d	190.0 de	7.7 d	22.7 d	1363.0 d	32.2 de	22.0 d	2070.3 d
T_2 = 30 kg K + FARMYARD MANURE @ 5 ton	6.8 cd	202.7 c	8.6 c	33.8 c	1448.3 cd	36.7 c	24.3 cd	2206.7 c
T_3 = 60 kg K + FARMYARD MANURE @ 5 ton	7.7 b	215.0 bc	9.0 b	42.3 b	1586.0 bc	44.8 bc	27.0 b	2316.7 b
T_4 = 80 kg K + FARMYARD MANURE @ 5 ton	8.3 ab	224.0 a	10.2 ab	44.7 a	1789.3 a	52.6 ab	29.0 a	2556.7 a
T_5 = 120 kg K + FARMYARD MANURE @ 5 ton	9.6 a	247.7 a	11.2 a	48.5 a	1971.3 a	69.5 a	34.0 a	2725.7 a
S.E. (±)	0.281	2.4313	0.1065	1.3825	22.601	3.6122	0.6912	57.750
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DISCUSSION

The results demonstrated that the high plant population (m^{-2}) (9.6), plant height (cm) (247.4), stem girth (cm) (11.2), head diameter (cm) (48.5), number of seeds head^{-1} (1971.3), seeds weight head^{-1} (g) (69.5), seed index (34 g), and seed yield (2725.7 kg ha^{-1}) were recorded on T_5 = Farmyard Manure@ 5 ton + potash @ 120 kg ha^{-1}. Similarly, T4 = (Farmyard Manure@ 5 ton + potash @ 80 kg ha-1) with plant population (m^{-2}) (8.3), plant height (cm) (224), stem girth (cm) (10.2), head diameter (cm) (44.7), number of seeds head^{-1} (1789.3), seeds weight head^{-1} (g) (52.6), seed index (29.0 g) and seed yield (2556.7 kg ha^{-1}), no fertilizer) with plant population (m^{-2}) (6.2). However minimum results were observed in $T_{1=}$ control (plant height (cm) (190.0), stem girth (cm) (7.7), head diameter (cm) (22.7), number of seeds head^{-1} (1363), seeds weight head^{-1} (g) (33.2), seed index (22.0 g) and seed yield (2070 kg ha^{-1}). Sial *et al.*, noted similarly that the results seem to indicate that sunflower plant growth and productivity, including seed output and other agricultural features, were restricted [13]. On the basis of results found in potassium applications the seed yield was markedly higher (2725.7 kg ha^{-1}) where K_5 @ 120 kg ha^{-1} Followed by K_4 @ 80 kg ha^{-1} (2556.7 kg ha^{-1}) whereas the lowest seed yield (2070 kg ha^{-1}) was achieved where potassium was controlled. Therefore, it can be inferred that employing a well-balanced fertilizer surpasses the efficacy of employing separate treatments. It is advised that the application has a major impact on sunflower yield and yield-enhancing people. The optimal approach for achieving peak growth and maximizing seed yield in sunflowers involves applying potassium at a rate of 120 kg per hectare, with the next favorable option being potassium at a rate of 80 kg per hectare. A commonly employed method to enhance soil fertility is the application of farmyard manure. In this discourse, it has been explored how various quantities of farmyard manure influence sunflower development and yield [14]. Farmyard manure serves as a valuable organic matter source, delivering essential nutrients and improving soil structure. Moreover, it enhances the soil's water retention capacity, making it more resistant to drought conditions. The utilization of farmyard manure has been identified as a factor contributing to increased crop yields, including sunflowers [15]. The quantity of farmyard manure to be applied is determined by the nutrient needs of the crop, soil type, and other factors. Generally, soils deficient in essential nutrients and with inadequate structure can significantly

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benefit from an elevated application of farmyard manure. However, it is crucial to be mindful that an excessive use of farmyard manure may result in nutrient imbalances and give rise to various associated problems [16]. The utilization of potassium (K) has demonstrated effectiveness in alleviating the negative impacts of drought on sunflower plants, fostering their continuous growth and yield, irrespective of the crop development stage [17]. The notable effect is ascribed to a significant rise in potassium levels observed in the stems, leaves, and achenes of sunflower plants. This elevation substantially contributes to improved growth and productivity, particularly in times of drought [18]. Potassium functions as a compatible solute, facilitating enhanced water absorption and its effective utilization by regulating stomatal activity [19]. As a result, the externally applied potassium might have caused a partial closure of stomata, facilitated increased root penetration, and enhanced moisture retention within plant tissues [1]. In conditions of drought, potassium enhances the rate of photosynthesis, plant development, and crop yield [20]. The increase in yield-contributing traits, such as straw yield, harvest index, capitulum diameter, percentage of filled seeds, total number of seeds, and 1000-seed weight, may be responsible for this rise in yield [21]. Similarly, the results on sunflower growth and seed yield were significantly impacted by potassium levels application as compared to control (no fertilizer). Shahid *et al.*, also examined that the application of potassium significantly improved growth and seed yield if applied in the right time and quantity [22]. Therefore, Farmers are encouraged to utilize the mineral in their agricultural practices right proportion of at least 80 to 100 kg ha^{-1} to their plants for improved yield and growth. However, with an increase in the dosage of potassium, there is a corresponding rise in the yield of seeds. Similar to this, increasing the potassium dosages led to an increase in achene production [23]. The plot that received a potassium treatment of 100 kg ha^{-1} demonstrated the most favourable outcome in terms of sunflower seed production. Hence, it is highly recommended to apply 80 kg ha^{-1} of potassium for attaining exceptional growth and maximizing seed yield in sunflowers [24, 25]. Additionally, Mehrparvar *et al.*, also support the utilization of 80 kg ha^{-1} of potassium fertilizer, emphasizing its significant contribution in enhancing growth and increasing seed yield in sunflowers [26]. This endorsement makes it an extremely beneficial practice for local farmers.

CONCLUSIONS

It is determined that the sunflower growth and seed yield were significantly affected by Farmyard Manure and potassium levels as Linked to supervision (excluding fertilization). When Farmyard Manure and potassium levels increased, the seed yield increased linearly. However, the plot received fertilizer application ofFarmyard Manure@ 5 ton + potash @ 120 kg ha^{-1} produced the largest (2725.7kg ha^{-1}) sunflower seed yield followed by Farmyard Manure@ 5 ton + potash @ 80 kg ha^{-1} with 2556.7kg ha^{-1}. Hence, the divergence amidst the various treatments was inconsequential.

Authors Contribution

Conceptualization: RL, ZAS
Methodology: GML, MKS
Formal analysis: AAK, MMS, SS
Writing-review and editing: DM, MML, MHA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The author declares no conflict of interest.

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