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Effect of Plant Growth Regulators and Fertilizers on Growth and Yield of Sunflower (*Helianthus annuus* L.)

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ABSTRACT: A field experiment was conducted during *Zaid season of* 2021, at CRF (Crop Research Farm) of Agronomy Department at SHUATS, Prayagraj with the objective to study Performance of plant growth regulators and fertilizers effect on growth, yield and oil content of sunflower (*Helianthus annuus* L.) under Randomized block design comprising of 9 treatments, with 2 different plant growth regulators from 3 different fertilizers. And result showed the growth parameters viz. Plant height (128.60cm) at 80 DAS, number of leaves per plant (22.93 g) at 60 DAS and crop growth rate (2.24) at 60 DAS in (NPK 100:50:50 + GA_3 200 ppm). The Yield parameters viz. seeds per capitulum (370.00), Test weight (38.60), seed yield (1480 kg/ha), stover yield (2903.20 kg/ha), biological yield (4383.20 kg/ha), Gross returns (162800 INR/ha), Net returns (128252 INR/ha) and BC ratio (1.26) were recorded maximum with application of (NPK 100:50:50 + GA_3 200 ppm). Number of unfilled seeds per capitulum (21.63) are recorded maximum at application (NPK 80:40:40 + GA_3 100 ppm) and Harvest index (52.63%) were records maximum with application in (NPK 80:40:40 + GA_3 200 ppm). The oil and protein content of sunflower were significantly and synergistically improved by the application of NPK and GA_3.

Keywords: Sunflower, Nitrogen, Phosphorus and Potassium, GA_3, Ethrel.

INTRODUCTION

Helianthus annuus L. is an important wholesome oilseed crop of the country and its oil is considered as premium because of its high poly unsaturated fatty acid content with high quantity of linoleic acid and absence of linolenic acid. Sunflowers have a broad adaptation environment and require full sunlight areas, but in its growth are not influenced by photoperiodism. Total area of sunflower is cultivated in an area of 0.48 million hectares in India, with a total annual production of 0.32 million tonnes and productivity of 720 kg/ha, (Ministry of Agriculture, Govt. of India, 2019-20). It is generally adopted not to cultivate it on the slopes that are steeper than 3°. Besides, given the long sunflower return period, the possibilities of increasing its sown areas are quite limited. This problem is especially noticeable in regions of significant spread of soil erosion, the cause of which is the destruction of forests and the high Ploughing of the territory (Ahmad and Goparaju 2017). Inorganic fertilizer components such as N, P and K are essential nutrients for plant growth and the yield. Balanced fertilization of each played a significant role in supplying the nutrients needed, to attain maximum sunflower growth (Patil *et al.*, 2009). The level of NPK fertilizer affected the plant growth, and the grain yield of sunflower (Yuniza and Sitawati, 2018) and maximum grain resulted from 120-90-60 kg/ha of NPK application (Nawaz *et al.*, 2003). Another study in the field showed that the optimum grain yield was obtained in 90-60-60 kg/ha of NPK fertilizer (Kathuria *et al.*, 1996**)**. The amount of nitrogen and potassium had a significant effect on plant height, biological yield, seed yield and seed oil content (Mollashahi *et al.*, 2013). Nitrogen and phosphorus application also enhanced growth and yield. Contributing for "*Yellow revolution*" in oil seeds for self-support in the country is noteworthy (Mangala, 2002). Great promise because after sunflower crop contribute more due to short lived, high seed multiplication ratio, wider adaptability, photo-insensitivity, higher water uses efficiency and drought tolerance. GA_3 are a class of endogenous plant growth substances exerts pleiotropic effects on developmental processes (Tiwari *et al*., 2011). (GA_S) can stimulate stem and root elongation, flowering, fruit senescence, seed germination, and reduces dormancy of seeds (Hedden *et al.*, 2015). The application of exogenous gibberellic acid (GA_3) has gained a extend attentiveness with the aim to promote plant growth, enhance yield and increase tolerance to abiotic stresses (Manonmani 2002). Ethrel affects several cellular, developmental and stress-response processes related to photosynthesis (Balota *et al*., 2004). (Mir *et al*., 2009); (Lone *et al*., 2010) reported that ethephon enhanced photosynthesis under both irrigated and non-irrigated conditions.

Gibberellins and Ethrel may play a key role in various metabolic pathways affecting these characteristics, such as chlorophyll production and degradation, translocation of assimilates, nitrogen metabolism, and nitrogen reposition. Whereas Ethrel improves the marginal improvement in the vegetation growth (Gowda, 2014). The study was aimed to find out of the effect of different levels of N, P and K fertilizers, GA_3 and Ethrel on the growth and yield of sunflower. An intensive cropping system has depleted the inherent soil fertility, leading to deficiency of implementing plant nutrients which finally causes poor nutrition. Proficient use of inputs along with ample and impartial fertilizers use is mandatory for sustainable production. Global agriculture is facing a serious upshot of population pressure, climatic variations and determinantal environment impacts. To subsist on the earth, enlarged population needs more food. To warrant food security new-fangled methos should be initiated by sustainable crop production that contribute plenty nourishment, devoid of harming the agroecosystem (Panwar and Vijayaluxmi, 2005).

MATERIALS AND METHODS

The experiment carried out in the Zaid season in 2021 in the CRF, SHUATS, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. To assess the effect of different levels of NPK, GA_3 and Ethrel on Growth and Yield of Sunflower (*Helianthus annus* L.). The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Treatment combination consisted of two factors, one with two different plant growth regulators i.e., Gibberellic acid and Ethrel and the other with three fertilizers i.e., 1: Nitrogen 2: Phosphorus and 3: Potassium viz., The factors are combined to frame the 9 treatment combinations that are depicted in Table 1. The nutrient sources were Urea, SSP and MOP to fulfil the requirement of Nitrogen, Phosphorus and Potassium. Each treatment was given nitrogen, phosphorus and potassium (80:60:40 kg/ha) respectively as per calculation based on. Plant protection measures were followed as per recommendations for the region.

RESULTS AND DISCUSSIONS

A. Effect on Growth and Growth parameters of sunflower

Observations regarding the plant height (cm) of Sunflower were given in Table 2 and it clearly depicts an increasing trend in plant height during crop growing period from 20 DAS to 80 DAS. At 80 DAS significantly higher plant height was observed in treatment with the application of NPK 100:50:50 + GA_3 200 ppm (128.60cm) which is statistically at par to NPK 80:40:40 + Ethrel 500 ppm (125.63cm), NPK 100:50:50 + GA_3 100 ppm (127.73cm), NPK 100:50:50 + Ethrel 250 ppm (125.3cm) and NPK 100:50:50 + Ethrel 500 ppm (124.36cm) Dhaduk *et al.,* (2007) reported that due to promotive effect of gibberellins on growth may be increased by auxin level of tissue or enhancing the conversion of tryptophan to IAA, which causes cell division and cell elongation. At 80 DAS, NPK 100:50:50 + GA_3 200 ppm significantly highest number of leaves/plant (22.40) which is statistically at par to NPK 100:50:50 + Ethrel 250 ppm (21.77) and NPK 100:50:50 + GA_3 100 ppm (21.73). Cechin and Fumis (2004) observed that longer stem possess a greater number of nodes, which in turn results in a greater number of leaves, report suggest that gibberellins can enhance nitrogen absorption by plants and improves plant mineral concentration through nitrogen fixation which can lead to enhanced number of leaves.

Table 1: Effect of plant growth regulators and fertilizers on growth parameters of sunflower.

Sr. No.	Treatments	Plant height (cm)	No. of Leaves /Plant	Dry weight (g/plant)	Leaf area index
1.	NPK 80:40:40 + $GA_3$100 ppm	121.07	20.57	10.71	4.17
2.	NPK 80:40:40 + GA_3 200 ppm	120.97	20.30	10.91	4.12
3.	NPK 80:40:40 + Ethrel 250 ppm	121.10	20.23	10.16	4.03
4.	NPK 80:40:40 + Ethrel 500 ppm	125.63	21.07	10.55	4.11
5.	NPK 100:50:50 + GA_3 100 ppm	127.70	21.73	11.45	4.40
6.	NPK 100:50:50 + GA_3 200 ppm	128.60	22.40	11.23	4.23
7.	NPK 100:50:50 + Ethrel 250 ppm	125.13	21.77	10.47	4.21
8.	NPK 100:50:50 + Ethrel 500 ppm	124.63	20.97	10.54	4.06
9.	Control	120.03	19.33	9.92	3.80
	SEm (±)	1.35	0.33	0.54	0.30
	CD(P=0.05)	4.04	1.00	1.62	0.89

*S-Significant at $P < 0.05$; NS-Non-significant at $P > 0.05$

Observations regarding the dry weight are given in Table 1 there was dry weight (g/plant) had consecutively increased from 20 DAS to 80 DAS. At 80 DAS the highest dry weight was observed with the application of NPK 100:50:50 + GA_3 100 ppm (11.45 g/plant) and the lowest dry weight was observed with Application of NPK 80:40:40 + Ethrel 250 ppm (10.16 g/plant). Ethrel 250 ppm growth regulator plays many important roles in the plant physiological processes like transportation of solutes, stomatal movement, activation of enzymes, translocation of carbohydrates to the sink and finally, improving the dry matter production results were observed by Osman and Awed, (2010). Observations regarding the Leaf area index are given in

Table 1 Leaf area index had consecutively increased from 20 DAS to 60 DAS and slight reduction from 60DAS to 80DAS, at 60 DAS the highest value was recorded with the application of NPK 100:50:50 + GA_3 100 ppm (4.40) and the lowest value recorded with the application of NPK 80:40:40 + Ethrel 250 ppm (4.03) Kumar *et al.,* (2012) reported this might due to plants sprayed with 200ppm ethrel accumulated higher K concentration in the plant and in stomatal guard cells, which increases more number of leaves and leaf area index, which they believed provided sufficient osmotic potential to increase turgor and therefore stomatal opening for CO_2 and water vapour diffusion**.**

B. Effect on Yield and Yield Attributes of sunflower

The statistical data regarding yield and yield attributes were presented in Table 2.

Table 2: Effect of plant growth regulators and fertilizers on yield parameters of sunflower.

Sr. No.	Treatments	No. of seeds/Capitulum	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
1.	NPK 80:40:40 + $GA_3$100 ppm	331.67	35.83	1334.67	2720.00	4054.67	49.23
2.	NPK 80:40:40 + GA_3 200 ppm	333.33	36.07	1389.20	2643.33	4032.53	52.60
3.	NPK 80:40:40 + Ethrel 250 ppm	336.67	35.13	1377.33	2708.17	4085.50	50.89
4.	NPK 80:40:40 + Ethrel 500 ppm	346.67	37.43	1404.45	2810.00	4214.45	50.01
5.	NPK 100:50:50 + GA_3 100 ppm	353.33	37.97	1458.33	2860.00	4318.33	51.00
6.	NPK 100:50:50 + GA_3 200 ppm	370.00	38.60	148 0.00	2903.20	4383.20	50.99
7.	NPK 100:50:50 + Ethrel 250 ppm	341.67	38.10	1392.33	2813.50	4205.83	49.50
8.	NPK 100:50:50 + Ethrel 500 ppm	344.67	37.97	1356.33	2853.33	4209.67	47.55
9.	Control	311.67	33.83	1276.33	2285.33	3561.67	55.89
	SEm±	7.19	0.59	14.89	47.93	40.93	1.32
	CD (P=0.05)	21.56	1.79	44.65	143.69	122.71	3.95

*S-Significant at $P < 0.05$; NS-Non-significant at $P > 0.05$

The highest Number of seeds/capitulum was recorded with the application of NPK 100:50:50 + GA_3 200 ppm (370) which is superior over all treatments except with the application of NPK 100:50:50 + GA_3 100 ppm (353.33), The increase in the number of seeds per head might be due to an increase in translocation of assimilates from source to sink Shekhawat and Shivay (2009). The highest test weight was observed with the application NPK 100:50:50 + GA_3 200 ppm (38.60) of and lowest was observed with application of (control plot) 80:60:40 NPK/ha (33.83), Saini *et al*., (2017) reported that observations made by the increased nutrient uptake resulted at higher levels under recommended dose of N, P and K accompanied by root development and greater surface area for absorption of nutrients. The high yield of seed was recorded with the application of NPK 100:50:50 + GA_3 200 ppm (1480.00kg/ha) which is superior over all treatments except with the application of NPK 100:50:50 + GA_3 100 ppm (1458.33kg/ha) and the lowest seed yield was observed in NPK 80:40:40 + $GA_3$100 ppm (1334.67kg/ha) due to application of higher but optimum rate of nutrients might have associated with an increase in accumulation and distribution of assimilated in all plant parts from seedling to maturity stage, and thereby improved all growth such as seed yield, stover yield and as well as yield stages by Moitra *et al.*, (2012). The highest biological yield was recorded with the application of NPK 100:50:50 + GA_3 200 ppm (4383.20.20kg/ha) which is superior over all treatments except with the application of NPK 100:50:50 + GA_3 100ppm (4318.33 kg/ha) were statistically at par and the lowest Biological yield was observed in NPK 80:40:40 + GA_3 200 ppm (4032.53 kg/ha). The highest stover yield was recorded with the application NPK 100:50:50 + GA_3 200 ppm (2903.20 kg/ha) which is superior over all treatments except with the application of NPK 100:50:50 + GA_3 100 ppm (2860.00 kg/ha), NPK 80:40:40 + Ethrel 500 ppm (2810.00 kg/ha), NPK 100:50:50 + Ethrel 250 ppm (2813.50 kg/ha) and NPK 100:50:50 + Ethrel 500 ppm (2853.33 kg/ha) were statistically at par. It clearly indicates that residual effect of sunflower stover incorporation was significant on seed, stover, biological yield and harvest index which induces 25.9% increment in seed, 19.54% in stover, 21.80% in biological yields and 3.20% harvest index of sunflower, due to different levels of nutrients and mainly Nitrogen and Phosphorus, this finding were supported by Skarpa and Losak (2008).

Fig. 1. Research field and Spraying operation in sunflower crop at crop research farm, Department of Agronomy, SHUATS, Prayagraj, during Zaid, 2021.

The highest harvest index was recorded with the application of NPK 80:40:40 + GA_3 200 ppm (52.60%) and the lowest Harvest index was observed in NPK 100:50:50 + Ethrel 500 ppm (47.55%). Reddy and Babu (2003) stated that Maximum seed (2.85 and 2.57 tones/ha), also simultaneously biological yield and harvest index increased with the application of N, P and K nutrients to sunflower caused significant yield effects. This was probably due to the higher availability of N, P and K in the initial stage, which helped to acquire a definite advantage over control in respect of growth.

CONCLUSION AND FUTURE SCOPE

It may be concluded that application of NPK 100:50:50 kg/ha + Gibberellic acid 200 ppm was recorded higher Seed yield (1480 kg/ha). Since the findings were based on the research done in one season it may be repeated for further confirmation and recommendation, which may be more preferable for farmers since it is economically more profitable and hence, can be recommended to the farmers. As the monetary units is the supreme importance in the farmer perspective.

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Conflict of Interest. None.

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