International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 3330-3332

Received: 08-10-2020
Accepted: 19-11-2020

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Effect of spacing and plant growth regulators on yield and economic of *Zaid* sesame (*Sesamum indicum* L.)

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DOI: https://doi.org/10.22271/chemi.2021.v9.i1au.11747

Abstract
The field experiment was conducted during *Zaid* season, 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP) On sandy loam soil to investigate the Effect of Spacing and Plant Growth Regulators on Yield and Economic of *Zaid* Sesame (*Sesamum indicum* L.). The experiment was laid out in Randomized Block Design with nine treatments replicated thrice with the different spacing (30cm x 10cm and 45cm x 10cm) and different levels of NAA (10 ppm & 20 ppm), GA_3 (10 ppm & 20 ppm), IAA (10 ppm & 20 ppm) and salicylic acid (10 ppm & 20 ppm) as foliar spray. Study revealed that Spacing 45cm x 10cm + GA_3 10 ppm foliar spray at 30 and 45 DAS was recorded significantly higher Seed yield (8.27 q/ha), Stover yield (27.84 q/ha) as compared to all the treatment combinations. The economic analysis clearly indicates that higher B:C ratio (2.10) recorded with treatment of spacing 45cm x 10cm + GA_3 10 ppm foliar spray at 30 and 45 DAS as compared to all treatment combinations.

Keywords: Spacing, NAA, GA_3, IAA, salicylic acid

Introduction
Sesame (*Sesamum indicum* L.) Adomed as "Queen of oil seed crop". It is commonly known as Til, Gingeli, Sim and it is the oldest important oil seed crop in the tropics. It has been believed as sesame probably originated in Africa. It belonging to the order Tubiflorae, family Pedaliaceae an important oil seed crop being cultivated in the tropics as well as in the temperate zone of the world and cultivated for its high-quality oil (Chung *et al.* 2003) [2]. Sesame is one of the oldest oilseed crop cultivated in India. It is called as by virtue of its excellent quality. Sesame is very drought-tolerant crop of semiarid regions. It is superior to other oilseed crop due to adaptability to varied agro-climatic condition and high degree of drought tolerance. Among the cultural practices, row spacing is one of the important components, manipulation of which could lead for optimizing yield. Population density has profound influence on grain yield. The plant density can be adjusted by the use of either different seed rates or different row spacing. Optimum planting density enables the sesame plant to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, space and water which ultimately leads to boost crop production (Shinde *et al*, 2011) [11].

GA_3 accelerated stem elongation and bud development (Kabar *et al.* 1990) [4]. Gibberellins (GA_3) constitute a group of tetracyclic diterpenoids, involved in plant growth and development. Gibberellic acid (GA_3) a well-known phytohormone, has numerous physiological effects on plants including seed germination, growth, stem elongation, leaf expansion, photosynthesis, flowering and cell expansion (Taiz and Zeiger, 2010; Yuan and Xu, 2001) [9, 10]. Naphthalene acetic acid is the growth promoting substance, which may play a significant role to change growth characters and yield of sesame. Foliar application of growth regulator-NAA produces more fertile grain. NAA has a positive effect on growth and higher dry matter production. Foliar spray of NAA (15 ppm) at 15, 30 and 45 days after sowing increased fruit set and productivity (Siddik *et al*. 2016) [8].

IAA has been found to increase the plant height, number of leaves per plant, pod size with consequent enhancement of yield. It also increases the flowering, fruit set, the total dry matter of crops. It is also known that auxin suppresses axillary bud outgrowth (Shimuzu-Sato *et al*. 2009) [6].

Salicylic acid (SA) belongs to a group of phenolic compounds, which is widely in plants and is now known as a hormone-like substance (Levent Tuna *et al*. 2007) [5]. SA acts as a potential non-enzymatic antioxidant as well as a plant growth regulator, which play an important role in regulation of plant physiological stages, including photosynthesis, growth, nitrate metabolism, heat production (Joseph *et al*., 2010) [3], flowering, the effect on the germination of seeds, maturity and response to stress.

Materials and Methods

An experiment was carried out to study the "Effect of Spacing and Plant Growth Regulators on Yield and Economic of *Zaid* Sesame (*Sesamum indicum* L.) during *Zaid* season of 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Naini Agricultural Institute, Prayagraj (U.P), which is located at 25º 24' 42" N latitude, 81º 50' 56" E longitude and 98 m altitude above the mean sea level. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.28%), medium in available N (225 Kg/ha), high in available P (19.60 Kg/ha) and available K (92.00 Kg/ha). The experiment was laid out in Randomized Block Design with consisted of nine treatments replicated thrice viz. T_1: Control Spacing 30cm x 10cm + Water spray at 30 & 45 DAS, T_2 Spacing 30cm × 10cm + NAA 20 ppm Foliar spray at 30 DAS, T_3: Spacing 45cm × 10cm + NAA 10 ppm Foliar spray at 30 and 45 DAS, T_4: Spacing 30cm × 10cm + GA_3 20 ppm Foliar spray at 30 DAS, T_5: Spacing 45cm × 10cm + GA_3 10 ppm Foliar spray at 30 and 45 DAS, T_6: Spacing 30cm × 10cm + IAA 20 ppm Foliar spray at 30 DAS, T_7: Spacing 45cm × 10cm + IAA 10 ppm Foliar spray at 30 and 45 DAS, T_8: Spacing 30cm × 10cm + Salicylic acid 20 ppm Foliar spray at 30 DAS, T_9: Spacing 45cm × 10cm + Salicylic acid 10 ppm Foliar spray at 30 and 45 DAS. Foliar application of these plant growth regulators was made at 30 and 45 days after sowing. The growth parameters were recorded at periodical intervals of 20, 40, 60, 80 from randomly selected five plants in each plot were collected. Statically analysis was done and mean compared at 5% probability level for significant results.

Results and Discussion

Seed yield (q/ha), Stover Yield (q/ha), Harvest Index (%)

Data pertaining to Seed yield (q/ha), Stover yield (q/ha), Harvest Index (%) is presented in Table 1. The treatment with Spacing 45cm × 10cm + GA_3 10 ppm Foliar spray at 30 and 45 DAS were recorded maximum seed yield (8.27 q/ha) and stover yield (27.84 q/ha) which which was significantly superior over all the treatments. However, in case of seed yield and stover yield treatment with spacing 45cm×10cm + NAA 10 ppm Foliar spray at 30 and 45 DAS and Spacing 45cm×10cm + IAA 10 ppm Foliar spray at 30 and 45 DAS were statistically on par with treatment of spacing 45cm × 10cm + GA_3 10 ppm Foliar spray at 30 and 45 DAS. Harvest index (%) shows non-significant result among different treatments but it found maximum (23.53%) in Spacing 45cm×10cm + Salicylic acid 10 ppm Foliar spray at 30 and 45 DAS.

It might due to better utilization of available resources viz. mineral, nutrients, water, sunlight and the optimum plant population. Shinde *et al.* (2011) [11] also reported that GA_3 treated plots showed highest yield compared to control.

Economics

Economics of crop production is dependent on market price of inputs and quantity of output produced and price in the market (Aparna *et al*., 2020) [1]. As result found seed and stover yield varies from treatment to treatment. The maximum gross return and net return was observed in high yield producing treatment, i.e., Spacing 45cm × 10cm + GA_3 10 ppm Foliar spray at 30 and 45 DAS. The maximum gross return (₹89837.7/ha), net return (₹60887.7/ha) and B:C ratio (2.10) were found under treatment of spacing 45cm × 10cm + GA_3 10 ppm Foliar spray at 30 and 45 DAS.

Table 1: Effect of Spacing and Plant growth regulators on Seed yield, Stover yield and Harvest index of *Zaid* Sesame.

	Treatments	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1	Control- Spacing 30cm×10cm + Foliar Spray with Water at 30 and 45 DAS	4.50	24.56	20.36
2	Spacing 30cm×10cm + NAA 20 ppm Foliar spray at 30 DAS	5.24	23.62	18.59
3	Spacing 45cm×10cm + NAA 10 ppm Foliar spray at 30 and 45 DAS	7.17	26.32	21.56
4	Spacing 30cm×10cm + GA3 20 ppm Foliar spray at 30 DAS	5.14	25.64	20.82
5	Spacing 45cm×10cm + GA3 10 ppm Foliar spray at 30 and 45 DAS	8.27	27.84	19.89
6	Spacing 30cm×10cm + IAA 20 ppm Foliar spray at 30 DAS	5.27	24.24	21.92
7	Spacing 45cm×10cm + IAA 10 ppm Foliar spray at 30 and 45 DAS	7.24	26.09	21.31
8	Spacing 30cm×10cm + Salicylic acid 20 ppm Foliar spray at 30 DAS	5.61	24.63	22.53
9	Spacing 45cm×10cm + Salicylic acid 10 ppm Foliar spray at 30 and 45 DAS	4.48	24.28	23.53
	S.Em(±)	0.7703	0.8067	0.9195
	CD (p=0.05)	2.3094	2.4184	-

Table 2: Effect of Spacing and Plant growth regulators on Total Cost of Cultivation, Gross Return, Net Return and B:C of *Zaid* Sesame

	Treatments	Total cost of cultivation	Gross return	Net return	B: C ratio
1	Control- Spacing 30cm×10cm + Foliar Spray with Water at 30 and 45 DAS	28980	58335.4	29355.4	1.01
2	Spacing 30cm×10cm + NAA 20 ppm Foliar spray at 30 DAS	29120	62915.9	33795.9	1.16
3	Spacing 45cm×10cm + NAA 10 ppm Foliar spray at 30 and 45 DAS	28970	80116.8	51146.8	1.77
4	Spacing 30cm×10cm + GA3 20 ppm Foliar spray at 30 DAS	29080	64191.9	35111.9	1.21
5	Spacing 45cm×10cm + GA3 10 ppm Foliar spray at 30 and 45 DAS	28950	89837.7	60887.7	2.10
6	Spacing 30cm×10cm + IAA 20 ppm Foliar spray at 30 DAS	29160	63793.7	34633.7	1.19
7	Spacing 45cm×10cm + IAA 10 ppm Foliar spray at 30 and 45 DAS	28990	80389.5	51399.5	1.77
8	Spacing 30cm×10cm + Salicylic acid 20 ppm Foliar spray at 30 DAS	29180	66680.4	37500.4	1.29
9	Spacing 45cm×10cm + Salicylic acid 10 ppm Foliar spray at 30 and 45 DAS	29000	57883.7	28883.7	1.00

Conclusion

It can be inferred from the above experiment that Spacing 45cm x 10cm + GA_3 10 ppm foliar spray at 30 and 45 DAS was recorded higher yield and found to be economically beneficial for the farmers.

Acknowledgement

I express gratitude to my advisor Dr. Rajesh Singh for constant support and guidance. I am indebted to Prof. (Dr.) Joy Dawson, Dr. Vikram Singh, Dr. Umesha. C and Dr. Shikha Singh, Department of Agronomy

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