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Physiological responses of transplanted sesame to growth regulators

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Abstract
The field experiment has been conducted during 2020-2021 on the basis of Randomized plot design with three replication at Agricultural College & Research Institute, Madurai. Treatments consists of direct sowing, transplanted control, seedling root dipin IBA (50 ppm), seedling root dip in NAA (50 ppm), foliar spray of salicycilic acid (100 ppm), TIBA (50 ppm), PPFM (2 percent). Foliar spray has been imposed on 20 and 40 days after transplanting. The growth, total chlorophyll was taken on 55 days after transplanting. Comparing the seven treatments, foliar application of TIBA (50 ppm) recorded the highest value in plant morphological characters viz., root length (cm), number of branches, plant width at base (cm) and biochemical parameters of total chlorophyll content (mg g^{-1}), Soluble protein content (mg g^{-1}) and nitrate reductase enzyme activity (µg g^{-1}). Besides, the reduction in plant height (cm) was noticed by the foliar application of TIBA (50 ppm) than the other treatments. The yield and yield characters were recorded after harvest. Among the treatments, foliar application of TIBA (50 ppm) maintained its superiority in number of capsules $plant^{-1}$, 1000 seed weight and yield (kg ha^{-1}).

Keywords: Sesame, transplanted, growth regulators, yield

Introduction
Sesame (*Sesamum indicum* L.) is considered as important oil seed crops extensively cultivated in different parts of the world. Sesame seeds has rice source of oil, protein, vitamins, and minerals for maintaining the nutrient balance of human and animals (Weiss, 2000) [11]. The oil of the sesame is very stable one owing to its content of such antioxidants as sesamin, sesamolin, and sesamol (Suja *et al*., 2004) [9]. The seed consist of 42-45% oil, 20% proteins and 14-20% carbohydrates. Besides, the sesame seeds also contains rice source of micro nutrients particularly more in Fe, followed by Cu, Zn and Mn (Suresh *et al*., 2013) [10]. Sesame is one of the oldest queens of oilseed crop cultivated in India. It is very drought tolerant crop of semiarid regions. It is highly adaptability to varied agro-climatic condition. Sesame oil has a excellent stability due to the presence of natural antioxidants such as sesamin, sesamolin and sesamol (Brar and Ahuja, 1979) [12]. 70% of the world sesame is processed into oil and meal and the remaining is used for the production of food and confectionary industries, Morris (2002) [6]. Sesame oil is highly beneficial and also lowering the cholesterol level and incidences of certain cancers (Frank, 2005) [13]. As compared to the other oilseeds crops, higher amount of health benefits are present in sesame oil and hence it is also known as "Queen of Oilseeds".

Normally, the sesame sowing was taken by direct sown method either in line sowing or broadcasting. The maintenance of optimum population by thinning and gapfilling demands huge number of labourers leads to higher cost of cultivation. Further, excess or less population than the required resulted with less yield and may be due to higher competition between plants for resources or less utilization and higher pest and disease incidence etc. Under these circumstances, transplanting is seems to be an alternate method of establishment for sesame. Earlier findings also proved that sesame is amenable for transplanting especially in light textured soil. In addition to that it also offers many advantages like reduction of duration in the main field, flexible to manage the required population, easy management, possibility to introduce mechanization and ultimately enhancement of yield. The soil and optimum moisture content also plays an vital role in transplanted crops as it helps the roots to put forth the growth and establishment of the crop. Since transplanting in sesame is an innovative methodology, the initial establishment of crop and further growth and development is found to be very important.

Plant growth regulators promote cell division, cell enlargement, rooting, flowering, fruiting and seed formation and stimulate or inhibit specific enzymes or enzyme systems and help to regulate plant metabolism. It plays an important role in improving the growth, yield and quality attributes by improving the source sink relationship, promotion of photosynthesis, translocation of photo assimilates, and delayed senescence in plant system. Plant growth regulators (PGRs) have been successfully employed in many plant species to improve the root ability of stem cuttings (Sağlam *et al*., 2014) [14]. These include indole-3-acetic acid (IAA), naphthalene acetic acid (NAA) and indole-3-butyric acid (IBA) (Sardoei *et al.*, 2013) [15]. Sambasiva Rao *et al*. (1980) [16] recorded dipping of brinjal seedling roots in NAA at 0.1 or 0.2 ppm for 24 hours influenced growth and development. Better rooting results in better yield due to proper nutrients and water uptake whereas reduced root growth limits shoot growth that never results in healthy plant. Further, roots sense various types of environmental or hormonal stresses and respond by communicating with shoot through signaling pathways. Hormones playkey role in these communications (Bano *et al.*, 1993) [17]. IBA (Indole-3- butyric acid) is another major auxin for root growth (Singh *et al.*, 2014) and has extensively been explored to induce roots on in vitro grown shoots.

Foliar application of salicylic acid registered 14 percent increased the number of capsules per plant as compared to untreated plants (Vasanthan, *et al.* 2018) [19]. Vekaria *et al*. 2017 [20] reported that highest seed (947 kg ha^{-1}), stalk (2810 kg ha^{-1}) and biological yield (3757 kg ha^{-1}) were obtained due to foliar spraying of IAA @ 100 ppm at flowering and capsule formation stage in sesamum. Application of Azospirillum as seed treatment, recommended dose of NPK, soil application of $MnSO_4$ @ 5 kg ha^{-1}, clipping at 0 + 2 leaf stage and planofix spraying of 30 ppm at 45 DAS and at 55 DAS found to be the best production technologies to improve sesamum yield (Bharathi *et al.*, 2014) [21]. In this context, a study was conducted to increase yield in sesame by transplanting instead of direct sown with root dip and foliar spray of growth regulators

Materials and Methods

An experiment was carried out to study the growth and biochemical responses of sesame to transplanting and growth regulators. The field experiment has been conducted during 2020-2021 on the basis of Randomized plot design with three replication at Agricultural College & Research Institute, Madurai. Treatments consists of direct sowing, transplanted control, seedling root dipin IBA (50 ppm),seedling root dip in NAA (50 ppm), foliar spray of salicycilic acid (100 ppm), TIBA (50 ppm), PPFM, (2 percent). Foliar spray has been imposed on 20 and 40 days after transplanting. The growth and physiological parameters were measured at 55 days after transplanting. The yield and yield attributes characters were measured during harvest stage. Statically analysis was done and mean compared at 5% probability level for significant results.

Result and Discussion

The growth parameters like plant height (cm), root length (cm), number of branches and plant width at base (cm) were significantly varied among all the treatments by the transplanting method and application of growth regulators and presented in table 1.

Plant height (cm)

The results on plant height (cm) of sesame influenced by growth regulators treatment significantly. Comparing the seven treatments, seedling root dip with NAA 50 ppm (T_4) recorded highest plant height (91.2cm); whereas, foliar application of TIBA 50 ppm (T_6) registered minimum plant height of about 63.3 cm which was followed by foliar application of PPFM 2% (T_7) 63.1cm. The treatment T_6 and T_7both are on par with each other (Table 1).

Root length (cm)

Significant differences were observed in all the treatments with respects to root length. The transplanting method and application of plant growth regulators showed an intense effect on root length. The maximum root length was recorded in foliar application of TIBA50 ppm (T_6-14.8cm) and the minimum root length was recorded in direct sown (T_1) treatment (10.4 cm). (Table 1).

Number of branches

Measurement of number of branches revealed that there was a significant difference in all the treatments. Comparing the seven treatments, foliar application of TIBA50 ppm (T_6) recorded the more number of branches of about 4.9, which was followed by foliar application of PPFM 2% (T_7) 4.5 branches. The lesser number of branches were noticed in T_1 (direct sown) treatment (3.2 branches) and presented in (Table 1).

Plant width at base (cm)

The data on Plant width at base (cm) varied significantly and presented in table 1. Among the various treatments, foliar application of TIBA50 ppm (T_6) recorded the more plant width at base of about 3.6cm, which was followed by seedling root dip with NAA 50 ppm (T_4)2.9cm. The treatment T_1 (direct sown) recorded minimum value in plant width at base (2.5 cm).

According to Shimizu-Sato *et al*., (2009) [22] reported that TIBA is auxin transport inhibitor that inhibits polar auxin transport inside the plant. Besides, the exogenous application of TIBA can induce axillary bud outgrowth, increase branch number, and inhibit the increase of plant height. These evidences are in accordance with the support of Wu, (2006) [23] in hemp (*Cannabis sativa* L.). Wu, (2006) [23] found that the TIBA (100 mg L^{-1}) treated plants had the effect of promote dwarfing, and formation of effective lateral branches, and spring tea yield. Sivakumar *et al*., (2022) [8] noticed that application of TIBA decreased the plant height up to 31.8% might be due to its anti-auxin task also might be due to arresting the apical dominance in horse gram.

Table 1: Effect of plant growth regulators on plant morphology and physiology of sesame

Treatments	2020-2022					
	Plant height (cm)	Root length (cm)	No. of branches	Plant width at base (cm)	Total chlorophyll (mg g^{-1})	Soluble protein (mg g^{-1})
T_1	82.4	10.4	3.2	2.5	1.67	9.89
T_2	82.7	12.2	3.9	2.7	1.98	9.99
T_3	70.1	13.3	3.9	2.7	1.90	11.07
T_4	91.2	13.4	4.2	2.9	1.82	11.35
T_5	81.7	14.2	4.4	2.6	2.18	11.29
T_6	63.3	14.8	4.9	3.6	2.88	12.08
T_7	63.1	11.2	4.5	2.6	2.34	11.60
SE (d)	6.54	0.20	0.07	0.05	0.05	0.17
CD	11.98	0.41	0.1	0.11	0.12	0.37

T_1 – Direct sown
T_2 – Transplanted (Control)
T_3 – IBA (50 ppm) (seedling root dip)
T_4 – NAA (50 ppm) (seedling root dip)
T_5 – Salicylic acid (100 ppm) (Foliar spray)
T_6 – TIBA (50 ppm) (Foliar spray)
T_7 – PPFM (2 %) (Foliar spray)

Total chlorophyll and soluble protein content (mg g^{-1})

Significant difference was noticed in all treatments with respect to chlorophyll and soluble protein content under direct sown and transplanted sesame. The data showed that, higher quantity of chlorophyll and soluble protein content were observed in foliar application of TIBA 50 ppm (T_6) (2.88 mg g^{-1}) and 12.08 mg g^{-1}respectively.Direct sown treatment recorded the lowest chlorophyll (1.676 mg g^{-1}) and soluble protein content (9.89 mg g^{-1}).

Table 2: Effect of plant growth regulators on yield and yield attributes

Treatments	2020-2022					
	N Rase activity (µg g^{-1})	No. of capsules $plant^{-1}$	No. of capsules on main branch	No of $seedcapsule^{-1}$	No of chaffy $seedcapsule^{-1}$	No of healthy $seedcapsule^{-1}$
T_1	79.5	21.01	13.24	33.8	7.8	25.9
T_2	93.1	38.80	9.92	35.2	7.7	27.5
T_3	91.2	34.81	9.38	36.4	6.3	30.2
T_4	89.2	36.68	13.46	37.7	6.0	31.7
T_5	86.3	22.85	9.64	38.1	4.8	33.3
T_6	98.9	51.36	13.54	41.6	4.6	37.1
T_7	94.1	27.02	9.06	38.9	3.9	35.0
SE (d)	6.89	4.32	0.24	3.77	0.15	2.84
CD	13.07	7.88	0.48	6.67	0.34	4.75

T_1 – Direct sown
T_2 – Transplanted (Control)
T_3 – IBA (50 ppm) (seedling root dip)
T_4 – NAA (50 ppm) (seedling root dip)
T_5 – Salicylic acid (100 ppm) (Foliar spray)
T_6 – TIBA (50 ppm) (Foliar spray)
T_7 – PPFM (2 %) (Foliar spray)

Yield attributes

The data on yield attributes viz., No. of capsules $plant^{-1}$, No. of capsules on main branch, No of $seedcapsule^{-1}$,No of chaffy $seedcapsule^{-1}$, No of healthy $seedcapsule^{-1}$, 1000 seed weight were differed significantly in all the treatments. Comparing the seven treatments, foliar application of TIBA 50 ppm (T_6) maintained its superiority in yield attributes characters of No. of capsules $plant^{-1}$ (51.36), Number of capsules on main branch (13.54), number of seed $capsule^{-1}$ (41.6), number of chaffy seed $capsule^{-1}$ (4.6), No of healthy seed $capsule^{-1}$ (37.1) and 1000 seed weight (3.11g). The lesser Yield attributes characters were noticed in direct sown treated plants (T_2).

Yield

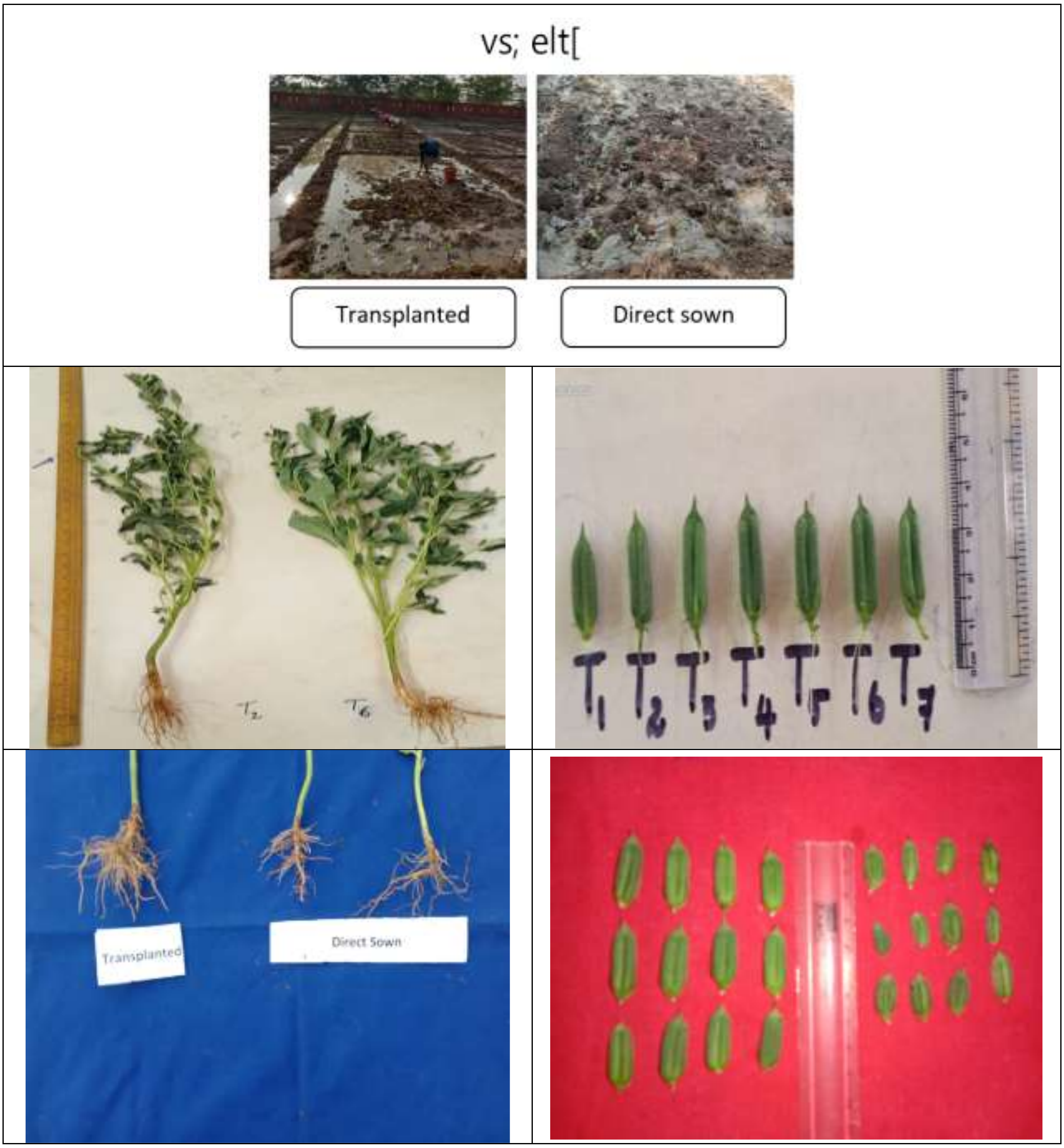
The result on yield per hectare was recorded during harvest stage. Among the treatments, foliar application of TIBA 50 ppm (T_6) recorded maximum yield per hectare of about 703.19 kg ha^{-1}; whereas direct sown plants had lesser yield (491.87 kg ha^{-1}) Table 3.

These results were in accordance with the support of Noodén & Nooden, (1985) [7] opined that the foliar application of Tri-iodo benzoic acid (TIBA) enhanced pod number per node. According to Kumar *et al.* (2002) [3] reported that the increase in the pod and seed number per plant when the plants are treated with the 50 ppm of TIBA and therefore increased the grain yield in soybean. Treatment with 15 to 120 ppm TIBA facilitated fruit development and better conditions for podding and also increased seed yield.

Table 3: Effect of plant growth regulators on Yield and yield attributes

Treatments	2020-2022		
	1000 seed weight	Yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1	2.18	491.87	1942.89
T_2	2.31	520.95	2057.73
T_3	2.53	571.44	2257.18
T_4	2.67	601.65	2376.53
T_5	2.79	631.50	2494.43
T_6	3.11	703.19	2777.61
T_7	2.94	663.60	2621.19
SE (d)	0.07	45.25	81.42
CD	0.13	117.84	177.41

T_1 – Direct sown
T_2 – Transplanted (Control)
T_3 – IBA (50 ppm) (seedling root dip)
T_4 – NAA (50 ppm) (seedling root dip)
T_5 – Salicylic acid (100 ppm) (Foliar spray)
T_6 – TIBA (50 ppm) (Foliar spray)
T_7 – PPFM (2 %) (Foliar spray)



Conclusion

Foliar application of TIBA 50 ppm at 20 and 40 DAT in transplanted sesame reduces the plant height and increases the number of lateral branches and increased the yield by 21 percent over transplanted alone.

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