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Assessing effect foliar application of nutrients and growth regulators on sesame (*Sesamum indicum* L.) in the old alluvial zone of West Bengal

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Abstract
India is one of the largest producers of oilseeds in the world. Its share in world production is as high as 27 percent for groundnut, 23 percent for sesame, 16 percent for rapeseed and mustard and 66 percent for the castor seed. Groundnuts in shell form 11% of world exports and sesame forms 17%. Groundnut, rapeseed-mustard, sesame and safflower are the traditionally cultivated oilseeds. Now-a-days soybean and sunflower have gained importance. To increase domestic production of oilseeds and reduce import bill and make country self-reliant in vegetable oils, the Government of India had launched a Technology Mission on Oilseeds (TMO) in 1986. In recent time however, there is stagnation in both area and production. The field experiment on evaluation of pre and post emergence herbicide for chemical weed management in sesame over summer season of 2020 was conducted at Malda Krishi Vigyan Kendra, Old Alluvial Zone, Uttar Banga Krishi Viswavidyalaya, Malda, West Bengal. The experimental site is situated at 26º8'N latitude and 78ºE longitude having an average altitude of 8.75m above mean sea level. There were altogether ten treatments. The experiment was laid out in a RBD with three replications. Among the different foliar nutrient treatments *viz* N:P:K 19:19:19, N:P:K 10:26:26 and KNO_3, have shown significantly, higher magnitude of dry matter production than growth regulators at all the growth stages of the crop having maximum number of capsules / plant was obtained under the treatment of foliar spray of N:P:K 19:19:19 at 0.5% followed by N:P:K 10:26:26 at 2%. In this experiment all foliar sprays, had an increasing effect on number of capsule /plant over control and clipping treatments. It was very noteworthy to mention that in general, foliar nutrients showed the better performance than growth regulators. The test weight was increased significantly with application of the growth regulators and foliar nutrients and the trend was like number capsules per plant. Based on one year results, it may be concluded that application of the foliar spray of growth regulators as well as foliar nutrients significantly increased grain yield over only water spray control treatment. Among the foliar nutrients, N:P:K 19:19:19 (0.50%), N:P:K 10:26:26 and KNO, (0.50%) recorded significantly higher seed yield than KCI (0.50%) while, among the growth regulators, Triacontanol 500 ppm recorded more yield than other growth regulators. The finding indicated that clipping at 35 days after sowing is comparatively better than only water sprays treatment. Hence, present study was undertaken.

Keywords: Crop growth rate, foliar spray, dry matter of plant, leaf area index, test weight

Introduction
India is one of the largest producers of oilseeds in the world. Its share in world production is high about 27 percent for groundnut, 23 percent for sesame, 16 percent for rapeseed & mustard and 66 percent for castor seed. Groundnuts in shell form 11% of world exports and sesame forms 17%. Groundnut, rapeseed-mustard, sesame and safflower are the traditionally cultivated oilseeds. In the recent years however, soybean and sunflower have gained the importance. To increase domestic production of oilseeds and reduce import bill and make the country self-reliant in vegetable oils, the Government of India had launched a Technology Mission on oilseeds (TMO) in 1986. In the recent years however, there is stagnation in both area and production. Edible oil consumption in India has been growing rapidly over the years. Aggregate consumption increased from around six million tons in the early nineties to around than 11 million tons in recent years. However, per capita consumption of fats and oils in India is far below the world average. India's productivity is however, quite low, around fifty percent of the world average and even less in the case of soybean. The comparatively, lower yields are mainly due to the fact that the quality of the seed varieties is generally poor and oilseeds crops in India are mostly cultivated in the unirrigated areas. Madhya Pradesh, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, Tamilnadu, and Uttar Pradesh account for nearly 89% of the oilseeds area and production in the country.

Sesame is one of the important oilseed crops in India, ranking after groundnut and mustard-rapeseed. Even though it is a major oilseed crop, its average yield is very low when compared to other oilseed crops. Although many reasons have been attributed to explain such low productivity, the main problem is the physiological problems associated with micro nutrient deficiencies, resulting in a hormonal imbalance which brings results like low productivity of the crop. Since the area for sesame cultivation cannot be increased, the only way to increase production is by increasing the productivity of sesame. In West Bengal there is a huge shortfall of production of oilseeds to the demand in the State. The State is now producing approximately 43% of the oilseeds over total requirement of the State is about 57% of the total requirement of oil has to import from other states and countries. So there is an urgent need of increasing oilseed production. Rapeseed-Mustard and sesame are common oilseed crops of West Bengal. However, since last 5 years, groundnut, sunflower also being grown and these two crops of late have become important oilseed crops in the state. Sesame occupies a prominent place in the oilseed map of West Bengal. It is the second largest oilseed crop next only to rapeseed-mustard contributing around 20% to the state oilseed basket. The crop thus plays the pivotal role in the state's endeavor to reach the oilseed production target during the last 10 year although the area has virtually remained stagnant; the production has gone up substantially as a result of phenomenal increase in the productivity level. The states average productivity was around 843 kg/ha in 2004-2005. In West Bengal, it is grown over an area of 195340 ha and produce about 180484 tones (Department. of Agriculture, Government of West Bengal) In West Bengal sesame is generally grown in summer season after harvesting of potato with high residual fertility. More than 98 % of the crops are cultivated in this season and production in summer crop is also high as compared to kharif and winter crop. Highest sesame production in West Bengal is obtained in the district of West Medinipur. Due to high residual fertility with frequent rains during summer and kharif season, sesame plant generally attains excessive vegetative growth resulting in lower reproductive growth and lower yield. There is a tremendous scope for improving sesame productivity by agronomic manipulation. Hence, present study was under taken.

Materials and Methods

The field experiment on evaluation of pre and post emergence herbicide for chemical weed management in sesame over in the summer season of 2020 was conducted at Malda Krishi Vigyan Kendra, Old Alluvial Zone, Uttar Banga Krishi Viswavidyalaya, Malda, West Bengal. The experimental site is situated at 26º8´N latitude and 78ºE longitude having an average altitude of 8.75 m above mean sea level. The soil of the experimental site was Gangetic alluvial with sandy clay loam texture, good water holding capacity, well drained and moderate fertility status. The experimental site located in sub-humid, subtropical zone and lies in Indo-Gangetic old alluvial agro-ecological zone. The average annual rainfall ranged from 1545 to 2050 mm and major portion of rainfall is generally received during the month of June to middle of October. The mean monthly temperature ranged from 8 ºC to 40 ºC.

The experimental plot land topography was medium low soil, more or less uniform with a good drainage system. The soil has been of medium fertility, clay loam in nature, mildly acidic in reaction (pH 6.6) and indicative of West Bengal's new gangetic alluvial soil. Before sowing the crop the soil samples from the experimental plots were collected from a depth of 25 cm. The land was prepared by tractor followed by harrowing and then the soil was pulverized with the help of power tiller made soil loose and friable. The leveling was properly done by ladder.

Chemical analysis of soil

The methods adopted for the analysis of the soil samples of the experimental field are

Placed in the Table no. 1

Table 1: Methods of Chemical Analysis of Soil

Sl No.	Particulars	Methods
1.	Mechanical Analysis	International Pipette Method (Piper, 1942) [21]
2.	Organic carbon	Volumetric Method (Walkley & Black, 1947) [22]
3.	Soil pH	1:2.5 soil water suspension by the P^H meter (Jackson, 1973) [23].
4.	Available Nitrogen	Alkaline Permanganate Method (Jackson, 1973) [23]
5.	Available phosphate	Olsen's method (1954) [13]
6.	Available Potassium	Flame Photometer Method (Jackson, 1973) [23]

Experimental materials

The experiment was laid out in a Randomized Block Design with 3 replications. The experimental factor includes 10 different treatments on growth regulators and foliar nutrition in 3 replications.

The detail descriptions of the treatments are as follows:

Layout of the experiment

Treatment	Details
T_1	Water spray at 35 DAS & 50 DAS
T_2	0.50% NPK19:19:19 at 35 DAS & 50 DAS
T_3	0.50% KNO_3 at 35 DAS & 50 DAS
T_4	Cycocel 1500 ppm at 35 DAS & 50 DAS
T_5	Cycocel 2000ppm, at 35 DAS & 50 DAS
T_6	0.50% Potassium chloride at 35 DAS & 50 DAS
T_7	Ethepan500 ppm, at 35 DAS & 50 DAS
T_8	Triacontanol 500 ppm at 35 DAS & 50 DAS
T_9	Clipping once at 35 DAS
T_{10}	2% NPK 10:26:26 at 35 DAS & 50 DAS

Result and Discussion

Plant height (cm)

The data on periodic the plant height have been presented in (Table 1 and figure no.1). The result shows significant effect on the stem elongation and hardiness of the sesame crop due to application of foliar spray nutrients and growth regulators.

In general, irrespective of treatments the plant height has increase progressively with the advancement in age of plants; maximum rate of increase in plant height has been recorded during the period of 30-60 days after sowing. The rate of increase in plant height has been sown a declining trend onwards 60 days of growth, although plant height has attained the maximum at harvest.

Among the foliar nutrient treatments, N:P:K 19:19:19, N:P:K 10:26:26 had given significantly higher plant height over other plant nutrient treatments. While in case of growth regulators, cycocel 2000 ppm produced significantly, higher plant height over other growth regulators.

There was significant effect of growth regulators and foliar nutrients on plant height on 35, 60 and 90 days after sowing. However, the differences in plant height due to different foliar application of growth regulators are not significant.

Table 2: Effect of growth regulators, foliar nutrient and clipping on the plant height of sesame in summer season

Treatment	Plant height (cm)		
	35 DAS	60 DAS	90 DAS
T1-waterspray	31.50	69.87	71.00
T2- NPK19:19:19@0.5%	31.46	74.44	74.27
T3-KNO_3:@0.5%;	31.61	70.54	73.68
T4-Cycocel@1500ppm	29.24	64.52	66.39
T5-Cycocel@2000ppm	32.27	67.66	70.57
T6-KCL@0.5%	28.16	63.99	68.39
T7-Ethephon@500ppm	35.42	66.94	69.33
T8-Triacontanol@500ppm	29.37	71.01	60.58
T9-Clipping	23.68	44.98	48.42
T10-NPK10:26:26@2%	29.42	71.37	74.47
CD (0.05)	2.81	3.47	1.76

Dry matter per plant

The data are presented in (Table 2 and figure 2) reveal that there was a corresponding increase in dry matter production with the increasing age of the plant. At the initial growth during 30 days after sowing, the rate of dry mater accumulation was rather slow under all the treatments. The rate of dry matter production had taken a momentum from 30 days onwards.

The trend of dry matter accumulation persisted up to 90 days, when the crop matures. Among the foliar nutrient treatments, N:P:K 19:19:19 and N:P:K 10:26:26 had given significantly, higher magnitude of dry matter production over KNO_3, and KCL. Among the growth regulators, cycocel 2000 ppm produced significantly higher dry matter production over the other growth regulators. At harvest significantly, maximum dry matter accumulation per plant had been recorded with foliar spray at the rate of N: P: K 19:19:19 which is followed by foliar spray of N:P:K 10:26:26 and KNO_3.

Table 2: Effect of growth regulators, foliar application and clipping on periodic dry matter production (g/plant) of sesame

Treatment	Dry matter (g/plant)		
	30 DAS	60 DAS	90 DAS
T1-waterspray	0.36	5.40	32.25
T2- NPK19:19:19@0.5%	0.49	7.67	44.00
T3-KNO_3:@0.5%;	0.21	7.10	41.77
T4-Cycocel@1500ppm	0.27	7.22	41.49
T5-Cycocel@2000ppm	0.29	7.95	39.38
T6-KCL@0.5%	0.42	6.98	41.56
T7-Ethephon@500ppm	0.26	7.46	39.18
T8-Triacontanol@500ppm	0.31	6.76	41.46
T9-Clipping	0.22	6.33	37.42
T10-NPK10:26:26@2%	0.42	7.55	42.66
CD (0.05)	0.37	0.94	3.54

Physiological growth parameters

Leaf area index (LAI)

The data of Leaf Area Index has been presented in (Table no 3).

Leaf area index of the sesame crop had been increased progressively up to t 60 days of growth and onwards it has shown a declining trend irrespective of treatments at 30 DAS, there is no significant differences among the treatments because foliar application of nutrients and growth regulators applied at 35 DAS AND 50 DAS.

Among the foliar application treatments, application of N.P.K 19:19:19 increased significantly, leaf area index over other foliar nutrient treatments. Among the growth regulators, Triacontanol produced higher leaf area index over other growth regulators. But both at 60 DAS and 90 DAS NPK 19:19:19 have shown one of the best effects on LAI.

Table 3: periodic Leaf Area Index (LAI) of sesame as by growth regulators, foliar nutrients and clipping.

Treatment	Leaf area index (LAI)		
	30 DAS	60 DAS	90 DAS
T1-waterspray	0.15	0.65	0.66
T2- NPK19:19:19@0.5%	1.15	1.85	1.60
T3-KNO_3:@0.5%;	0.83	0.52	0.42
T4-Cycocel@1500ppm	0.42	0.92	1.30
T5-Cycocel@2000ppm	0.81	0.61	0.83
T6-KCL@0.5%	0.90	0.44	0.32
T7-Ethephon@500ppm	0.82	0.86	1.57
T8-Triacontanol@500ppm	1.27	1.24	1.42
T9-Clipping	0.92	0.72	1.09
T10-NPK10:26:26@2%	1.05	1.43	1.27
CD (0.05)	0.81	0.45	0.71

Crop growth rate (CGR)

The increase in dry matter per unit time under different treatments has been shown in (table no 4).the crop growth rate progressively, increased up to 60-90 days of growth under all the treatments. There was no significant difference between foliar nutrients in respect of crop growth rate.

Foliar spray of N: P: K 19:19:19 showed pronounced effect on the crop growth rate. But, control treatment of foliar spray had recorded lower CGR values during most of the growth stages. No distinct effect of different foliar nutrients and growth regulators was discernible in respect of CGR of sesame except ethephon.

Table 4: Periodic crop growth rate (CGR) of sesame as by growth regulators, foliar nutrients and clipping

Treatment	Crop growth rate (C.G.R)	
	30-60 DAS	60-90 DAS
T1-waterspray	0.17	1.06
T2- NPK19:19:19@0.5%	0.31	1.22
T3-KNO_3:@0.5%;	0.27	0.97
T4-Cycocel@1500ppm	0.23	1.10
T5-Cycocel@2000ppm	0.29	1.02
T6-KCL@0.5%	0.25	1.15
T7-Ethephon@500ppm	0.26	1.06
T8-Triacontanol@500ppm	0.26	1.15
T9-Clipping	0.27	1.06
T10-NPK10:26:26@2%	0.24	1.20
CD (0.05)	0.06	0.21

Yield attributes

Number of capsules per plant

Capsule number per plant is the major component of yield in sesame crop. The data presented in (table no 5 and figure no 3) reveals that maximum number of capsules / plant was obtained under the treatment of foliar spray of N:P:K 19:19:19(0.50%) which was closely followed by N:P:K 10:26:26 at 2% and KNO_3, 0.50%. All these three treatments were statistically at par and found to be significantly superior to all the tested growth regulators. In this experiment all foliar spray of nutrients, growth regulators and clipping treatment had an increasing effect on number of capsules / plant over control. Lowest number of capsules/plant lowest number of was recorded under control treatment where only water was sprayed.

Table 5: Yield and yield attribute of sesame

Treatment	No of capsules/plant	No of seed /capsule	Test weight (g)	Yield kg/ha
T1-waterspray	39.58	60.50	3.13	850.33
T2- NPK19:19:19@0.5%	47.61	67.41	4.32	1174.00
T3-KNO_3:@0.5%;	47.99	63.50	3.98	1132.67
T4-Cycocel@1500ppm	41.51	66.39	4.15	935.33
T5-Cycocel@2000ppm	43.27	65.51	4.30	1053.68
T6-KCL@0.5%	46.58	64.43	3.94	1072.49
T7-Ethephon@500ppm	39.36	65.25	3.54	913.67
T8-Triacontanol@500ppm	43.66	65.50	3.93	1072.67
T9-Clipping	43.52	65.64	3.91	886.00
T10-NPK10:26:26@2%	47.58	66.93	4.33	1147.00
CD (0.05)	3.15	1.79	0.81	69.35

Conclusion

The experiment was conducted to study the “Effect of foliar application of nutrient and growth regulators on sesame (*Sesamum indicum* L.) in the old gangetic zone alluvial zone of west Bengal” at the Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vishwavidyalaya, Malda, West Bengal during summer season of 2020.

There were total ten treatments. The experiment was laid out in RBD with three replications.

Among three different foliar nutrient treatments i.e. N:P:K 19:19:19 and N:P:K 10:26:26 and KNO_3 have shown significantly, higher dry matter production than growth regulators at all the growth stages of the crop.

Maximum number of capsules/ plant was obtained under the treatment of foliar spray of NPK 19:19:19 at 0.5% followed by N:P:K 10:26:26 at 2%. In this experiment all foliar sprays had an increasing effect on number of capsule/plant over control and clipping treatments. It is very worthy to mention that in general, foliar nutrients showed better performance than growth regulators. The test weight was increased significantly, with application of growth regulators and foliar nutrients and the trend was like number of capsule per plant.

Among the all foliar nutrients NPK 19:19:19 p[produced proper plant growth which leads to maximum number of seeds per capsule which was closely followed by N:P:K 10:26:26 @ 2%. Among the growth regulators, the number of seeds/capsule found to be higher in cycocel 2000ppm.

All the nutrients as well as growth regulators recorded significantly higher grain yield over control treatment among the foliar nutrients. N:P:K 19:19:19 (0.50%) and NPK 10:26:26 recorded significantly, higher seed yied than KNO_3 (0.50%). On the other hand among the growth regulators, triacontanol 500ppm recorded higher yield higher than other growth regulators.

On the basis of one year results, it may be concluded that application of foliar spray of growth regulators as well foliar nutrients significantly, increases grain yield over only water spray control treatment. Among the foliar nutrients, NPK 19:19:19 (0.50%), N:P:K 10:26:26 and KNO_3 (0.50%) recorded higher yield than KCL(0.50%) while among the growth regulators, Triacontanol 500pmm recorded higher yield than other growth regulators. The findings also indicated that clipping at 35 days after sowing is comparatively better than only water sprays treatment. This results in immense growth of plants also leads to a desirable higher yield of the crop.

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