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Correlation and Regression Studies of Growth, Yield Attributes, Yield and Equivalent Yield of Sesamum Based Intercropping System

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Authors' contributions

This work was the part of M.Sc. research. Author DK designed the study, performed the statistical analysis, wrote the first draft of the manuscript. Author RBA designed the study, improved and finalized the manuscript. Author RKM performed statistical analysis and draw figures for this manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at College Farm, Navsari Agricultural University, Navsari (India) to assess the association and interrelationship of various growth and yield attributing traits that determine seed yield of sesamum. The experiment was carried out in randomized block design with four replications and nine treatments viz., T_1: sole sesamum, T_2: sole sesamum (Paired rows at 30-60 cm), T_3: sole sesamum (Paired rows at 30-30-75 cm), T_4: sole green gram, T_5: sole cowpea, T_6: sesamum + green gram (paired 2:1), T_7: sesamum + green gram (paired 3:2), T_8: sesamum + cowpea (paired 2:1) and T_9: sesamum + cowpea (paired 3:2). Results showed that seed yield of sesamum was significantly affected and positively correlated with growth characters viz., number of branches/plants at 45 DAS (r=0.656**), harvest (r=0.545**), dry matter accumulation at 45 DAS (r=0.687**) and harvest (r=0.553**). Various yield attributing traits viz., number of capsules/plants (r=0.671**), capsule length (r=0.618**), number of seeds/capsules (r=0.672**) and test weight (r=0.704**) significantly influenced the seed yield of sesamum. Sesamum equivalent yield was also significantly and positively correlated with available N, P and K status of soil. Regression studies

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indicated that the yield variations in seed yield of sesamum due to yield attributes to a great extent (80 to 98%). Overall, it can be concluded that better growth and yield attributing traits caused significant and positive improvement in seed yield of sesamum as well as its equivalent yield.

Keywords: Correlation; intercrops; regression; seed yield; sesamum.

1. INTRODUCTION

Sesamum (*Sesamum indicum* L.) is one of the oldest oilseed crops and is popularly known as sesame, gingelly, etc. Sesamum is mainly cultivated in India, China, Turkey, Burma and Pakistan in Asia, Egypt and Sudan in Africa, Greece in Europe, Venezuela, Argentina and Columbia in South America, Nicaragua and El-Salvador in Central America and Mexico and U.S.A. in North America. In India, it is mainly grown in Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, West Bengal and Andhra Pradesh. It is generally grown year-round (*kharif*, semi *rabi* and summer) either as a sole or mixed/inter crop. Among oilseeds, sesamum is one of the most preferred crops during rainfed condition. As, it is very sensitive to biotic and abiotic stresses; hence, uncertainty prevails with sesamum cultivation especially during *kharif*. Lower seed yield of sesamum in *kharif* is due to lesser daily sunshine hours (average 4-5 hours). Its productivity is higher under summer season compared with *kharif* season [1]. Sesamum seeds are rich source of oil (46-52%), protein (18-20%) and several mineral elements viz., calcium, phosphorus, potassium, etc. Due to presence of antioxidants such as sesamin, sesamol and sesamolin [2], its oil can be preserved for long time and does not get rancid [3]. Its seed cake is edible and contains 42% protein, rich in tryptophan and methionine. Sesamum being a short duration crop, has the potential to enhance cropping systems intensification and diversification [4].

To enhance the oilseed productivity, an appropriate production-oriented cropping system and production technology are need to be developed and implemented properly. Intercropping is playing key role in sustaining the sesamum as well as pulse productivity because it can easily be adopted by small and marginal land holders. Intercropping has been recognized potentially beneficial system to increase crop productivity in both spatial and temporal dimension, which provides yield advantages over monoculture [5,6]. Inclusion of legumes in intercropping system improves the soil fertility which benefits the main crop [7,8]. The chief drawback associated with intercropping is the higher competition for water, light and nutrients that tend to diminish to a higher or lower the degree of profitability of each separate crop. However, intercropping may dominate benefits over drawback through the correct use and management of the soil, plant density and planting configuration [9]. Short duration and photo-insensitivity pulses might be the ideal candidates for inclusion in sesamum based intercropping systems [7,10,11,12]. Considering the above factual figures, the present was undertaken to identify the suitable intercropping system and interrelation of various growth and yield related parameters.

2. MATERIALS AND METHODS

2.1 Experimental Site and Climatic Condition

The experiment was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (India) during summer season of 2015-16. College Farm (Navsari) is located at 20º57' N latitude and 72º54' E longitude at an altitude of 10 meters above the mean sea level nearer to great historical place "Dandi" on Arabian Sea shore line. It falls under the agro-ecological situation-III of South Gujarat Heavy Rainfall Zone (Zone-I). Climate of this region is typically tropical, humid and warm monsoon with heavy rains, cold winter and fairly hot summer with an average annual rainfall of 1500 mm. The mean weekly meteorological data during experimentation depicted in Fig. 1 indicates that weather and climate conditions were normal and favourable for the cultivation of sesamum and pulse crops. Soil of the experimental field was clayey in texture, low, medium and high rated in terms of available nitrogen (197.26 kg/ha), phosphorus (30.93 kg/ha) and potassium (369.80 kg/ha), respectively. The soil was slightly alkaline (pH 7.6) with normal electric conductivity (0.32 dS/m).

2.2 Treatments and Design

A field experiment was carried out during summer season of 2016 in randomized block design with nine treatments viz., T_1: sole sesamum, T_2: sole sesamum (Paired rows at 30-60 cm), T_3: sole sesamum (Paired rows at 30-30-75 cm), T_4: sole green gram, T_5: sole cowpea, T_6: sesamum + green gram (paired 2:1), T_7: sesamum + green gram (paired 3:2), T_8: sesamum + cowpea (paired 2:1) and T_9: sesamum + cowpea (paired 3:2) and four replications.

2.3 Crop Management

A fine seed bed was prepared using cross cultivation followed by harrowing and planking for levelling. Layout was made by preparation of ridges by manual labourers. Sesamum cv. GT-3 at 3 kg seeds/ha were sown in additive series as sole crop and covered immediately. While, green gram cv. Meha and cowpea cv. GC-4 were sown as intercrops using seed rate based on their area proportion (standard seed rate used as 25 kg/ha). Recommended dose of fertilizers (N-P_2O_5-K_2O) for sesamum as 50-25-0 kg/ha and for pulse intercrop as 20-40-0 (on area basis) were used. Spacing for sole sesamum was 45 × 10-15 cm and for pulse intercrops was 30 × 10 cm maintained. One intercultural operation was carried out by using mechanical weeder at 20 days after sowing followed by two hand weeding at 25 and 40 days after sowing. Other standard agronomic practices were followed to grow sesamum and pulse intercrops.

2.4 Statistical Analysis

The statistical analysis of data recorded for different parameters during experimentation and analysed in laboratory was carried out through the procedure appropriate to the randomized block design of the experiment [13]. The significance of difference was tested using 'F' test at 5% probability level. Correlation and regression analysis were carried out using MS Excel-2019 and SPSS software.

3. RESULTS AND DISCUSSION

3.1 Correlations among Growth Attributes and Seed Yield

Correlation studies (Table 1) indicate that seed yield of sesamum showed significantly positive and moderate correlation with number of branches at 45 DAS (r= 0.656; *P*<0.01), harvest (r= 0.545; *P*<0.01), dry matter accumulation (DMA) at 45 DAS (r= 0.687; *P*<0.01) and harvest (r= 0.553; *P*<0.01). Though, negative correlation was noted with plant height 60 DAS (r= –0.563; *P*<0.01), harvest (r= –0.578; *P*<0.01). Relationship among growth attributes shows that plant height was negatively correlated with number of branches as well as DMA. Though, relationship between number of branches and DMA was found to be highly significant (*P*<0.01) and positive. It indicates that higher number of branches produces more DMA which might justify the higher seed yield of sesamum due to higher DMA. Similar results are also reported by Aye and Htwe [14]. Initial plant height (at 30 DAS) of sesamum was not significantly affected because of slow growth rate. At later stage of sesamum, the competition between plants for sunlight absorption as well as legumes improved nitrogen status of the soil which made available to sesamum; and thus, plant height is increased. Considerably higher plant height of sesamum under different intercropping treatments as compared to sole sesamum was also reported by Krishna and Reddy [15]. Inversely to plant height, number of branches per plant reduced significantly under intercropping might be due to more competition among plants for light, space, water and nutrients. These results corroborate the earlier findings of Kumar and Thakur [16]. Negative correlation between seed yield and plant height may be due to its relatively luxuriant vegetative growth of intercrop which supress the growth of sesamum, besides increasing plant height. Similar results are also in agreement with the findings of Bhatti et al*.* [17].

3.2 Correlations among Yield Attributes, Yield and Nutritional Value

Relationship among yield attributes, yield and nutritional value of sesamum (Table 2) shows that seed yield significantly and positively correlated with number of capsules/plant (r= 0.671; *P*<0.01), capule length (r= 0.618; *P*<0.01), number of seeds/capsule (r= 0.672; *P*<0.01), test weight (r= 0.704; *P*<0.01), protein content (r= 0.456; *P*<0.05), protein yield (r= 0.990; *P*<0.01), oil content (r= 0.446; *P*<0.05) and oil yield (r= 0.982; *P*<0.01). Significant and positive correlation between protein content and yield (r= 0.576; *P*<0.01) and oil content and yield (r= 0.606; *P*<0.01) were found. Higher protein and oil yield might be result of better yield attributes, protein, oil content and seed yield. Positive correlation between seed yield and yield attribute might be due to the fact that seed yield of sesamum under intercropping treatments reduced with lower values of yield attributes *viz*., number of capsules/plants, capsule length, number of seeds per capsule and test weight. Similar results were also reported by Parimala and Mathur [18], Navaneetha et al. [19], Umamaheswari et al. [20] and Taiwo et al. [21].

3.3 Correlations among Soil Available NPK and Sesamum Equivalent Yield

Correlation studies between sesamum equivalent yield and post-harvest soil fertility status (Fig. 2) reveals that sesamum equivalent yield was significantly and positively correlated with available N (r= 0.767; P<0.05), P (r= 0.715; P<0.05) and K (r= 0.718; P<0.05) status in soil. The N, P and K status were also showed significantly correlated with each other.

3.4 Regression between Yield Attributes and Seed Yield

Regression studies between yield attributes viz., capsules/plants, capsule length, number of seeds/capsule and test weight and seed yield of sesamum are depicted in Fig. 3. Polynomial equations of regression indicates that seed yield of sesamum was significantly influenced with number of capsules/plants, capsule length, number of seeds/capsule and test weight which was affected by various intercropping system. The number of capsules/plants explained the 98.1% variations in seed yield. Similarly, Capsule length and number of seeds/capsules explained the 92.8 and 80.0%, respectively variations in seed yield. Seed yield of sesamum was also affected by test weight which was explained by 89.9%. Our results are in line with the earlier findings of Emamgholizadeh et al. [22] and Ramazani [23].

Table 1. Correlation coefficient among growth characters, seed and stalk yield of sesamum grown under intercropping system

	PH30	PH60	PHH	NB45	NBH	DMA45	DMAH
PH60	0.165						
PHH	0.143	0.441*					
NB45	-0.199	-0.224	-0.506**				
NBH	-0.177	-0.149	-0.201	0.571**			
DMA45	-0.313	-0.530**	-0.444*	0.537**	0.492**		
DMAH	-0.414*	-0.528**	-0.252	0.491**	0.542**	0.579**	
Seed yield	0.009	-0.563**	-0.578**	0.656**	0.545**	0.687**	0.553**

*Note: PH30: Plant height at 30 DAS; PH60: Plant height at 60 DAS; PHH: Plant height at harvest; NB45: Number of branches at 45 DAS; NBH: Number of branches at harvest; DMA45: Dry matter accumulation at 45 DAS; DMAH: Dry matter accumulation at harvest; * and ** indicates the probability levels 5 and 1%, respectively of significant for Pearson correlation (2-tailed)*

Table 2. Correlation coefficient among yield attributes, quality characters and seed yield of sesamum grown under intercropping system

	Seed yield	NCPP	CL	NSPC	TW	Protein content	Protein yield	Oil content
NCPP	0.671**							
CL	0.618**	0.392*						
NSPC	0.672**	0.548**	0.422*					
TW	0.704**	0.606**	0.474*	0.488**				
Protein content	0.456*	0.429*	-0.036	0.342	0.705**			
Protein yield	0.990**	0.680**	0.568**	0.674**	0.759**	0.576**		
Oil content	0.446*	0.509**	0.145	0.180	0.449*	0.461*	0.476*	
Oil yield	0.982**	0.704**	0.581**	0.638**	0.714**	0.494**	0.978**	0.606**

*Note: NCPP: Number of capsules per plant; CL: Capule length; NSPC: Number of seeds per capsule; TW: Test weight; * and ** indicates the probability levels 5 and 1%, respectively of significant for Pearson correlation (2-tailed)*

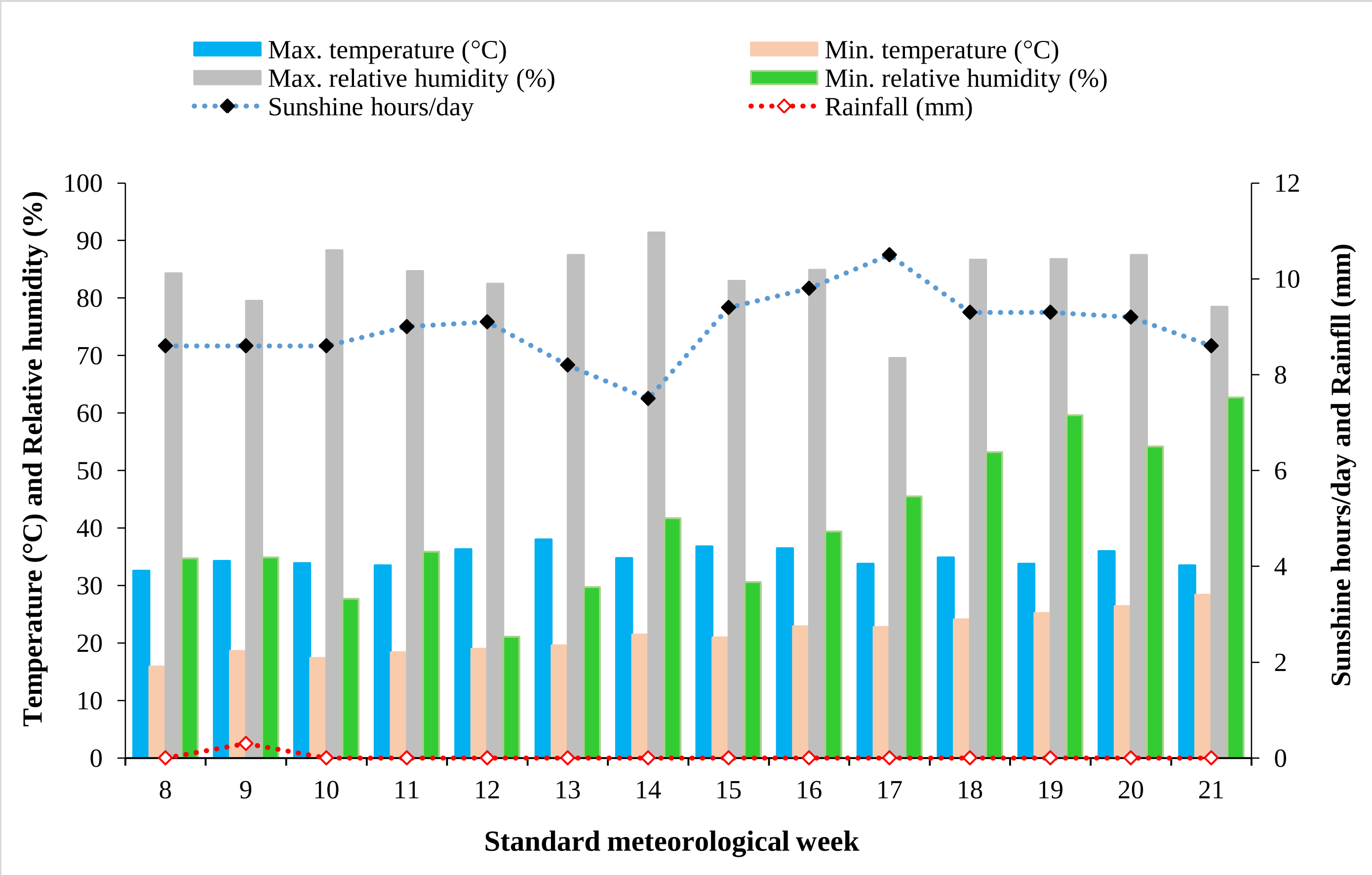

Fig. 1. Mean weekly meteorological data during crop season of the year 2016

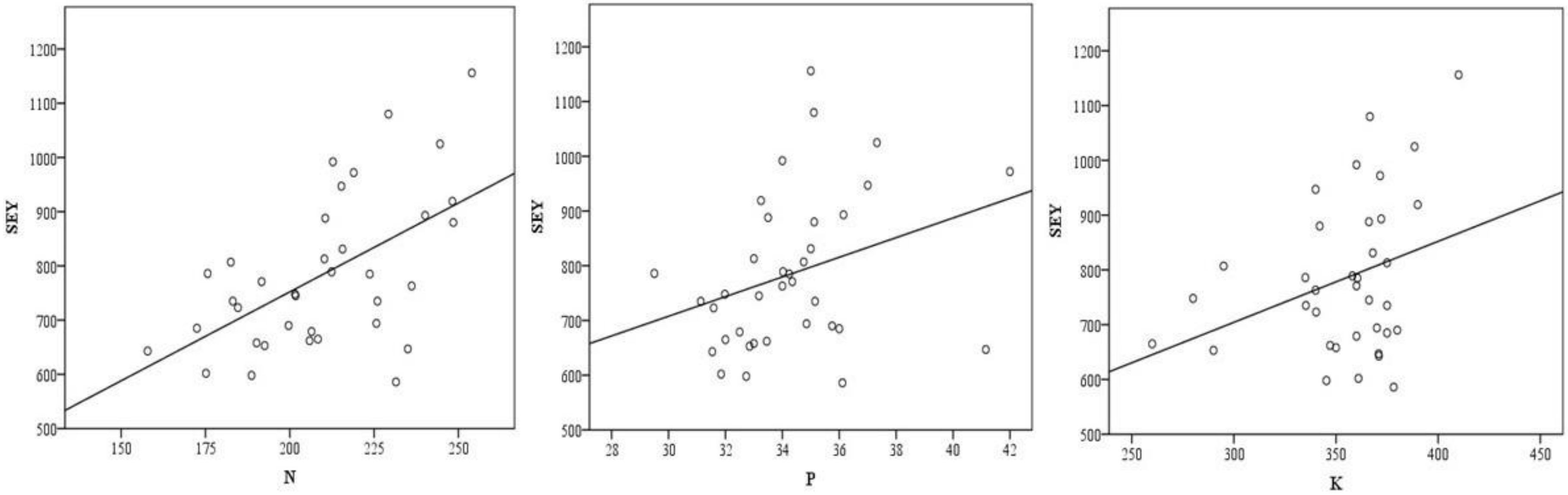

Fig. 2. Relationship (scatter diagram) between sesamum equivalent yield and available N, P and K status of soil

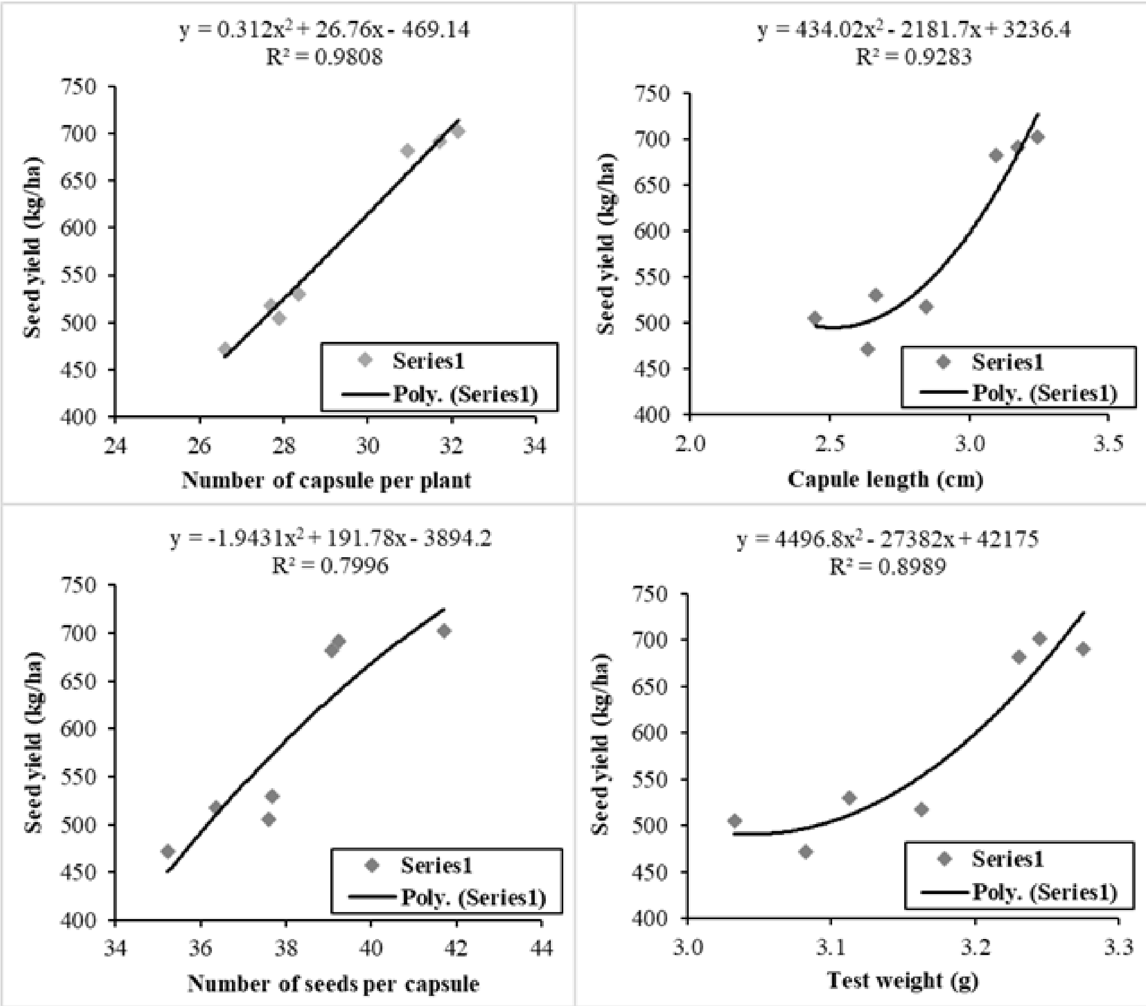

Fig. 3. Regression equation (polynomial) between seed yield and yield attributes of sesamum grown under intercropping system

4. CONCLUSION

Correlation studies revealed that seed yield of sesamum was significantly affected and positively correlated with growth characters viz., number of branches/plants, dry matter accumulation and yield attributes viz., number of capsules/plants, capsule length, number of seeds/capsules, test weight. Sesamum equivalent yield was also significantly and positively moderate correlated with available N, P and K status of soil. Regression equation indicated the 80 to 98% variations in sesamum seed yield due to various yield attributing traits. Overall, it can be concluded that seed yield of sesamum /or sesamum equivalent yield is significantly and positively correlated with growth and yield attributes; hence, better growth and yield attributes are pre-requisite for higher sesamum yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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