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Growth and fibre yield of newly released genotypes of roselle (*Hibiscus sabdariffa* L.)

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Abstract
The field experiment was conducted during *kharif* 2019 at Farm of Jute and Allied Fibre crops at Rahuri, Maharashtra on medium black soil to evaluate the yield potential and economics of newly released genotypes of roselle (*Hibiscus sabdariffa* L.). The experiment was laid out in Factorial Randomized Block Design during *kharif* season in four replications. The factor A consist of three varieties *viz.*, V1-AHS 286, V_2- AMV-5 and V_3-HS-4288 and factor B consist of four fertilizer levels *viz*., F_0-Control, F_1-40:20:20, F_2- 60:30:30 and F_3-80:40:40; N:P_2O_5 :K_2O;kg ha^{-1}.This semi-arid tract with an annual rainfall received 693.8 mm and 43 rainy days during period experiment. The altitude varies from 495 to 569 m above mean sea-level. The results stated that, the variety AHS-286 recorded significantly higher growth and yield attributes *viz*., Plant height, number of functional leaves, fibre yield per plant than the variety AMV-5 and HS-4288. The variety AHS-286 recorded significantly higher green biomass and fibre yield (59.68 t/ ha, 23.79 q/ ha) than the variety HS-4288 (56.42 t/ha, 20.73 q/ha) and AMV-5 (51.15 t/ha, 20.01q/ha). Similarly, the variety AHS-286 recorded maximum gross (Rs.93962/ha), net (Rs.55921/ha) monetary returns and B:C ratio (2.45) than rest of all varieties. The application of fertilizer levels (N: P2O5:K2O) of 80:40:40 to the roselle crop recorded significantly higher green stalk and fibre yield (64.53 t/ha and 27.07 q/ ha) than fertilizer levels of control and 40:20:20 kg/ha but it was at par with fertilizer levels (N:P_2O_5:K_2O) of 60:30: 30 kg/ ha (63.29 t/ha and 26.03 q/ha). So, Its beneficial effects recorded to increase economic indices *viz*., net returns (Rs.66185/ha) and per rupee returns (2.64) of application of fertilizer levels (N:P_2O_5:K_2O) of 60:30: 30 kg/ ha than rest of all treatments. It is concluded that, performance of newly released genotype of AHS-286 with fertilizer level of 60:30:30 (N:P_2O_5:K_2O) kg/ha is beneficial for higher fibre yield and economic returns of roselle (*H. sabdariffa*) in kharif season.

Keywords: Growth attributes, varieties, fertilizer levels fibre yield and economics

Introduction
In twenty-first century, jute and allied fibres, once known as The Golden Fiber of India is becoming increasingly valuable not only as a natural alternative to petrochemical derived synthetic fibers, but also as a component of automobile interiors, fiber composites and other diversified products. In comparison to major crops like rice and wheat, jute is more energy efficient, producing more biomass and fixing higher carbon dioxide. Surely, demand for jute will increase in near future. Globally, India is the largest producer of both raw jute (jute and Mesta) and jute products with a shares of 53 per cent and 62 per cent respectively, in global production. Jute fiber contributes nearly 7000 core (0.4 per cent) to India's value of output from agriculture. India is the largest producer of jute and allied fibre (40% of world production) and jute and allied fibre goods (60% of global production) in the world with an average productivity of both Bangladesh and India (Pandey *et al.* 2020) [9]. China has also a dominating place in its cultivation. On small scale, Thailand, Myanmar, Pakistan, Nepal and Bhutan are also cultivating these crop. In India area under jute and mesta was 0.742 million ha and production 10.03 million Bales with productivity 2435 kg ha^{-1} during 2017-18 (Anonymous, 2018) [1]. Two botanical types of roselle, namely *H. sabdariffa* var. *altissima* and *H. sabdariffa* var. *sabdariffa*. The first grown for its phloem fibre and the second for its fleshy, shiny-red calyxes which are usually extracted in hot or cold water and consumed as a beverage. Area under cultivation of roselle in Maharashtra especially very low, but this crop is newly emerging and grown for seed production in Andhra Pradesh and Karnataka.

Roselle is highly responsive to chemical fertilizer and organic manures. The full expression of genetic potential of a crop could be attained with proper management practices including appropriate fertilizer management (Alam *et al*., 2002) [2].

Use of chemical fertilizers has positive effect on growth and yield of roselle, but imbalanced use of chemical fertilizers not only lowers productivity but also adversely affects soil health by decreasing soil organic carbon, microbial flora and hardening of soil. The newly released genotypes with improved agro-techniques play crucial role to increase the production and productivity of fibre crops (Singh *et al.* 2015) [10]. For this present study was undertaken for evaluation of newly released genotypes and fertilizer levels on growth, fibre yield and economics of roselle (*Hibiscus sabdariffa* L.).

Materials and Methods

The experiment was conducted during *kharif* 2019 on Farm of Jute and Allied Fibre crops, Mahatma Phule Krishi Vidyapeeth, Rahuri; Maharashtra (situated at lies between 19° 48' N and 19° 57' N latitude and 74° 32' E and 74° 19' E longitude). The altitude varies from 495 to 569 meter above mean sea level. The soil of the experimental site is clay loam in texture (Clay-53.18%, Silt-18.04% and Sand- 28.78%) with having pH 8.2 and EC 0.28 dS/m and organic carbon 0.46% in top of 15 cm soil. The soil available nitrogen, phosphorus and potassium were 279.88, 15.56, 313.78 kg/ ha. The field capacity, bulk density and permanent wilting point of the surface (0-15 cm) soil were 31.20% on volume basis, 1.17 Mg^{-3} and 16.42%, respectively. The average annual rainfall at Rahuri is 520 mm. The rainfall received from south-west monsoon from May to November was 693.8 mm and 43 rainy days during 2019, which is beneficial for crop growth and seed development. The average mean annual maximum and minimum temperature ranges from 33° to 43 °C and 6° to 18 °C, respectively. The average relative humidity during morning and evening hours are 59 and 35 per cent, respectively. The experiment was laid out in Factorial Randomized Block Design during *kharif* season in four replications. The factor A consist of three varieties *viz.,* V1-AHS 286, V_2-AMV-5 and V_3-HS-4288 and factor B consist of four fertilizer levels *viz.*, F_0-Control, F_1-40:20:20, F_2-60:30:30 and F_3-80:40:40; $N:P_2O_5:K_2O$;kg ha^{-1}. Fertilizer doses of N, P_2O_5 and K_2O were applied as per treatment wise fully of P_2O_5 and K_2O at the time of sowing and N was given in split application of 30% at sowing, 35% at 30 days after sowing and 35% at 65 days after sowing, respectively.

In experimental plot, 5 plants were selected randomly from the second row of each plot for measurement of growth and yield attributes. The crop was harvested at 50% flowering as per treatment wise and take weight of green biomass bundles and dipped in rating tank as per treatment-wise for 21 days and after washed in freely moveable water, dried and recorded yield of fibre from net plot and converted into t/ha. The gross returns were calculated by multiplying the prevalent market price of fibre with their respective yields, and net returns were calculated by subtracting cost of cultivation from the gross returns. Benefit: cost ratio was calculated by dividing the net returns with cost of cultivation under the respective treatment. Statistical analysis was done as per randomized block design (Gomez and Gomez, 1984) [5] and treatment means were compared at 5% level of significance.

Results and Discussion

The crop sown of different varieties and application of fertilizer levels were recorded significant effect in growth, fibre yield and economics of roselle in Table 1 and 2.

Performance of varieties on growth and yield of roselle

The growth, yield attributes and yield of roselle crop as influenced by different treatments are presented in Table 1. The variety AHS-286 recorded significantly higher growth and yield attributes *viz*., Plant height (241.36 cm), number of functional leaves (61.66), fibre yield (8.51 g) per plant than the variety AMV-5 and HS-4288. Similarly, higher growth and yield attributes resulted into significantly higher green biomass yield of roselle crop. The variety AHS-286 recorded significantly higher green biomass and fibre yield (59.68 t/ ha, 23.79 q/ha) than the variety HS-4288 (56.42 t/ha, 20.73 q/ha) and AMV-5 (51.15 t/ha, 20.01q/ha). It is recorded higher green biomass and fibre yield of 16.67 and 18.89% than AMV-5. These findings are in harmony with results of Ali *et al.*, 2017 and Islam 2019 [8, 7].

Performance of varieties on economics

The different varieties of roselle crop recorded significant differences in green biomass and fibre yield. It is responsible for converted to the higher economic indices. The variety AHS-286 recorded maximum gross (Rs.93962/ha), net (Rs.55921/ha) monetary returns and B:C ratio (2.45) than the variety HS-4288 and AMV-5. The lowest economic indices like gross (Rs.79056/ha), net (41057) monetary returns and B:C ratio (2.05) were recorded by the variety AMV-5. These results are in agreement with the results of Islam, (2019) [7] and Tripathi *et al.*, 2012 [11].

Performance of fertilizer levels on growth and yield

The application of fertilizer levels ($N:P_2O_5:K_2O$) of 80:40:40 to the roselle crop recorded significantly higher green stalk and fibre yield (64.53 t/ha and 27.07 q/ha) than fertilizer levels of control and 40:20:20 kg/ha but it was at par with fertilizer levels ($N:P_2O_5:K_2O$) of 60:30: 30 kg/ha (63.29 t/ha and 26.03 q/ha) during the period of experiment. So the optimum level of fertilizer in roselle of 60:30:30; $N:P_2O_5:K_2O$/ha is more beneficial to increase the fibre yield and it was 27.47% higher than 40:20:20 kg/ha and 51.86% higher than control treatment. The lowest green biomass (39.73 t/ha) and fibre yield (12.53 q/ha) of roselle crop was recorded by control treatments. The growth and yield attributes *viz.*, Plant height (242.78 cm), number of functional leaves (61.10), basal diameter (1.51 cm) and fibre yield (9.29 gm) per plant were recorded significantly higher with application of fertilizer levels ($N:P_2O_5:K_2O$) of 80:40:40 to the roselle crop than rest of all treatments but it was at par with fertilizer level of 60:30:30; $N:P_2O_5:K_2O$/ha. Similar results are registered by Egharevba and Law-ogboma (2007) [3] and Guha *et al*., (2008) [6].

Performance of fertilizer levels on economics

The application of different fertilizer levels to the roselle crop are recorded significant differences in economic indices and indicated in table 2. The application of fertilizer levels ($N:P_2O_5:K_2O$/ha) of 80:40:40 to the roselle crop recorded significantly higher gross and net monetary returns (Rs.106914/ha and Rs.66185/ha) than rest of all treatments but it was par with fertilizer level of 60:30:30; $N:P_2O_5:K_2O$/ha in net returns. Similarly, the per rupees returns (2.64) of roselle crop were recorded maximum in fertilizer level of 60:30:30; $N:P_2O_5:K_2O$/ha. So it is saving of 25% fertilizer dose in roselle fibre production. The lowest per rupees returns

(1.40) was recorded by control treatment. Similar line of work was recorded by Guha *et al*., (2008) [6], Getso *et al*., (2018) [4] and Singh *et al*., (2015) [10].

Interaction effects: The interaction effect between varieties and fertilizer levels were found to be significant in number of leaves, fibre yield per plant (g/plant), green stalk weight (t/ha) and fibre yield (q/ha) and presented in Table 1a and 1b. The combined interaction effect of variety AHS-286 and fertilizer level of 80:40:40; N:P_2O_5:K_2O/ha was recorded significantly higher number of leaves (63.47), fibre yield per plant (10.68 g), green stalk and fibre yield (68.29 t/ha and 29.85 q/ha) than rest of interaction combinations, but it was at par with combined effect on fertilizer level of 60:30:30;N:P_2O_5:K_2O/ha and the variety AHS-286. The lowest yield of green stalk (31.60 t/ha) and fibre yield (9.65 q/ha) was recorded by combined interaction effect control treatment with variety AMV-5.

On the basis of experiment, it could be concluded that, the performance of newly released genotype of AHS-286 with fertilizer level of 60:30:30 (N:P_2O_5:K_2O) kg/ha is beneficial for higher fibre yield and economic returns of roselle (*H. sabdariffa*) in kharif season.

Table 1: Growth and yield attributes of toss jute as influenced by different treatments

Treatment	Plant height (cm)	Number of functional leaves/plant	Basal diameter (cm)	Fibre yield/plant	Green wt. (t/ha)	Fibre yield (q/ha)
A. Varieties						
V_1: AHS 286	241.36	61.66	1.43	8.51	59.68	23.79
V_2: AMV 5	228.83	52.67	1.36	7.74	51.15	20.01
V_3: HS 4288	233.01	54.21	1.41	8.49	56.42	20.73
S. E. m ±	2.36	0.53	0.02	0.10	0.81	0.31
CD (P=0.05)	6.92	1.54	NS	0.30	2.37	0.90
B. Fertilizer levels (N:P_2O_5:K_2O kg/ha)						
F_0: Control	224.31	51.20	1.25	6.96	39.73	12.53
F_1: 40:20:20	229.60	52.34	1.35	7.63	55.44	20.42
F_2: 60:30:30	240.90	60.08	1.49	9.11	63.29	26.03
F_3: 80:40:40	242.78	61.10	1.51	9.29	64.53	27.07
S. E. m ±	2.72	0.61	0.02	0.12	0.93	0.35
CD (P=0.05)	7.99	1.78	0.07	0.35	2.74	1.04
C. Interaction (M x F)						
S.Em ±	4.72	1.05	0.04	0.21	1.62	0.61
CD (P=0.05)	NS	3.08	NS	0.61	4.75	1.80

Table 1a: Interaction effect between varieties and fertilizer levels on functional leaves and fibre yield per plant of roselle

Varieties	Number of leaves/plant			Fibre yield per plant (g $plant^{-1}$)		
Fertilizer levels (N:P_2O_5:K_2O kg ha^{-1})	V_1:AHS-286	V_2:AMV-5	V_3:HS-4288	V_1:AHS-286	V_2:AMV-5	V_3:HS-4288
F_0: Control	60.27	45.47	47.87	8.97	8.01	7.95
F_1: 40:20:20	60.00	47.71	49.32	9.35	8.15	8.72
F_2: 60:30:30	62.90	58.43	58.92	10.18	9.00	9.63
F_3: 80:40:40	63.47	59.09	60.73	10.68	9.37	9.97
Source S.Em. +	1.05			0.21		
CD at 5%	3.08			0.61		

Table 1b: Interaction effect between varieties and fertilizer levels on green stalk and fibre yield (q/ha) of roselle at harvest

Varieties	Green stalk weight (t ha^{-1})			Fibre yield (q ha^{-1})		
Fertilizer levels (N:P_2O_5:K_2O kg ha^{-1})	V_1:AHS-286	V_2:AMV-5	V_3:HS-4288	V_1:AHS-286	V_2:AMV-5	V_3:HS-4288
F_0: Control	44.50	31.60	43.11	14.06	9.65	13.86
F_1: 40:20:20	61.08	51.53	53.70	22.97	18.42	19.86
F_2: 60:30:30	64.84	60.86	64.44	28.27	25.32	24.49
F_3: 80:40:40	68.29	60.60	64.42	29.85	26.66	24.69
Source S.Em. +	1.62			0.61		
CD at 5%	4.74			1.79		

Table 2: Economics of Roselle as influenced by different treatments

Treatments	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
A) Varieties				
V_1-AHS-286	93962	38041	55921	2.45
V_2-AMV-5	79056	37999	41057	2.05
V_3-HS-4288	81867	38048	43819	2.13
S.Em +	1208	--	1208	--
CD at 5%	3543	--	3543	--
B) Fertilizer levels (N:P_20_5:K_20,Kg/ha)				
F_1 - Control	49475	35329	14146	1.40
F_2-40:20:20	80652	37129	43523	2.17
F_3-60:30:30	102806	38929	63877	2.64
F_4-80:40:40	106914	40729	66185	2.62

S.Em +	1395	--	1395	--
CD at 5%	4091	--	4091	--
C) Interaction effects (AXB)				
S.Em +	3416	--	3416	--
CD at 5%	N.S.	--	N.S.	--

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