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CORRELATION STUDIES ON DIFFERENT BANANA GENOTYPES BETWEEN GROWTH AND YIELD ATTRIBUTES

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ABSTRACT
The present study was undertaken to find the best banana genotypes under northern dry zone of Karnataka. The study was undertaken with twenty three genotypes. Among which, the genotype Hanuman recorded the maximum finger length (22.43 cm), number of fingers per hand (24.62) and yield (43.07 t ha^{-1}). The genotype mitli performed poor with the minimum finger girth (8.87 cm) bunch length (38.80 cm) and the lowest yield (3.84 tha^{-1}). The maximum finger girth (17.53 cm) and finger weight (243.27g) in Robusta. The minimum finger weight (43.20g) was recorded in the Pisanglilin. The highest number of hands per bunch (18.00), bunch length (119.40 cm) and fingers per bunch (276.33) were obtained in the genotype FHIA-3. The genotype Karibale showed the minimum number of fingers per hand (9.67) and fingers per bunch (50.33). However, the minimum number of hands per bunch was observed in the genotype Sakkarebale (4.00). Among the genotypes evaluated, the genotype hanuman was found the best with respect to yield and their economics under Northern Dry Zone of Karnataka.

INTRODUCTION

Banana is one of the most important commercial tropical fruits traded. Eve was said to have used banana leaves to cover he modesty in the *Garden of Paradise* as revealed from antiquity. Banana is thus called "*Apple of Paradise*". It is also known as "*Adam Fig*". Banana is a type of fruit from herbaceous plants of the genus *Musa*. The edible banana has been evolved by two wild progenators *viz*. *Musa acuminata* and *Musa balbisiana* (Simmonds and Shaphered 1955). In order to have better knowledge of crops' responses to their environment, statistical models are used as tools of great importance for analyzing cultivated systems,

allowing for the study and understanding of the set, estimating the performance of crops in different areas and situations and describing the behaviour of different types of traits in relation to the plant of interest (Silva *et al.,* 2002).

Identifying, describing and predicting the relationships between processes involved in the development of the banana plant is of fundamental importance. One way of doing these is to find out models that correlate the variables which describe the reality, assessing the possible relationship between a dependent variable with one or more independent variables. Although several studies have been conducted on banana plant mainly in Brazil in recent years, technical information needed for the understanding of the impact of its vegetative characteristics on final yield is still lacking (Rahman and Bala, 2010).

Predicting the development of a particular cultivar based on vegetative and yield characteristics is a common practice (Jame and Cutforth, 1996). Statistical modeling is used to estimate the duration of stages of plant development, choose the time of planting, determine the probable dates of harvest, predict an abnormal production, thus, providing data that could be used in breeding programs and offering the producer a tool that will assist in developing management plans (Roberto *et al*., 2005; Stenzel *et al*., 2006).

Its versatility in terms of modes of consumption (processed, fried, cooked, fresh) and its characteristic flavour, aroma, natural hygienic packaging and the fact that it could be eaten fresh (Silva *et al*., 2002).

However, most of the cultivars grown particularly the local ones are low yielders and are thus not very suitable for commercial production. To address this constraint, a study was conducted under northern dry zone of Karnataka with an objective to evaluate banana genotypes for growth and yield and how growth is correlated to yield.

MATERIALS AND METHODS

A field study was conducted with twenty three genotypes *viz.,* Karibale, Kayipallebale, Rajapuri, Red banana, Rasabale, Elakkibale, Kanayibanasi, Mitli, Bargibale, YangaviKM-5, Sakkarebale, Karpuravalli, Poovan, Pisangawak and Hanuman. Bagalkot is located in Northern Dry Zone (Zone-3) of Karnataka State at 16º10^{1} North latitude, 75º42^{1} East longitudes and at an altitude of 542.0m above the mean sea level. Bagalkot which comes under zone-3 of region-2 among the agro climatic zone of Karnataka has benefited by both South-West and North-East Monsoons. The observations on yield parameters of different genotypes were recorded after harvesting the crop. Banana bunches were harvested with a

curved knife when fingers were fully developed and devoid of any ridges on its surface and fingers started to change their colour from dark green to light green. The length of bunch was recorded by using measuring tape from peduncle to tip of the bunch in the tagged plants and the average was worked out and expressed in centimetre. The middle fingers in the top and bottom rows of the second hand were selected as representative fingers for recording the average length, girth and weight of finger. The length of finger was measured from base of the finger to the tip where it is attached to the stalk and expressed in centimetre. The girth of finger was measured at the middle portion of the finger by using a thread and expressed in centimetre. The weight of finger was recorded immediately after harvest of the bunch and expressed in gram. The number of fingers in a hand, fingers in a bunch and hands in a bunch, were counted and recorded. The yield was calculated by multiplying the yield per plant with the total number of plants per hectare and expressed in tonnes per hectare. The data in respect of all the above parameters were tabulated and subjected to the statistical analysis (ANOVA) for Randomized Complete Block Design and results were tested at 5 per cent level of significance by using Fischer's method of analysis of variance as suggested by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Correlation studies

Results obtained from the correlation studies have revealed that plant height (0.505) was significantly contributing to the plant girth. Similarly Plant height (0.500), plant girth (0.724), leaf length (0.753) and leaf girth (0.842) was significantly contributing to the leaf area. Finger length was significantly contributed by plant girth (0.568), leaf girth (0.605), leaf area (0.547) and number of leaves (0.546) whereas, plant girth (0.642), leaf girth (0.760), leaf area (0.716) and finger length (0.700) were significantly contributing to increasing the finger girth. Finger weight was significantly contributed by leaf girth (0.556), leaf area (0.576), finger length (0.668) and finger girth (0.866) however, number of fingers per hand (0.705) and number of hands per bunch (0.914) was significantly contributing to increasing the number of fingers per bunch. Finally, plant girth (0.588), number of leaves per plant (0.683), finger length (0.701), number of fingers per hand (0.696), number of hands per bunch (0.521) and number of fingers per bunch (0.712) was significantly correlated with the bunch weight (yield per plant) and helps in increasing the yield per hectare. This is because *acuminata* group genotypes having compact bunches. These results are in line with Baiyeri *et al.* (2000).

Vegetative parameters

Table-2 depicts that there was a significant differences among the genotypes and there were linear increase in plant vegetative characteristics in all the genotypes with the advancement of age.

At 240th day the genotype Monthon recorded the maximum plant height (305.00 cm). the minimum plant height (147.81 cm) was recorded in the genotype Saba. This might be due to its genetical characters and due to its vigorous growth. Similar findings were obtained by Devi *et al*. (2011). Medhi (1994) found that pseudostem height was significantly more in Athiakal.

The genotype YangaviKM-5 recorded the maximum plant girth (76.27 cm). Whereas, the minimum plant girth (46.44 cm) was recorded in the genotype Pisanglilin. Usually cooking bananas are vigorous in growth and size of the plant is also more. The plant height was contributed to the plant girth. These results are in line with Devi *et al*. (2011). Biswal*et al.* (2004) observed that girth of the pseudostem at the base was greatest (88.66 cm) in BatishaBantala and MendhiBantala under Orissa condition.

The genotype Robusta recorded the maximum leaf length (166.67 cm) and it was recorded minimum in the genotype Mitli (123.63 cm), this might be due to its genetical characters and vigorous growth of the plant and adoptability to the experimental condition. These results are in line with Biswal *et al.* (2004).

Table1: Correlation study

	Bunch wt(Y)	Plt ht (X1)	Plt grth (X2)	lf brdth (X3)	lf lth (X4)	lf area (X5)	No. of lvs (X6)	Finger lth (X7)	Fngr grth (X8)	Fngr wt (X9)	Fngrs /hand (X10)	Hands /bunch (X11)	Fngrs /bunch (X12)
Bunch wt (Y)	1												
Plt ht (X1)	0.155	1											
Plt grth (X2)	0.588*	0.505*	1										
lf lgth (X3)	0.004	0.358	0.449	1									
lf lth (X4)	0.371	0.385	0.652*	0.343	1								
lf area (X5)	0.256	0.5	0.724*	0.753*	0.842*	1							
No. of lvs(X6)	0.683*	-0.181	0.422	0.013	0.375	0.237	1						
finger lth (X7)	0.701*	0.312	0.568*	0.26	0.605*	0.547*	0.546*	1					
Fngr grth (X8)	0.345	0.325	0.642*	0.4	0.760*	0.716*	0.38	0.700*	1				
Fngr wt (X9)	0.442	0.412	0.552*	0.232	0.720*	0.576*	0.334	0.668*	0.866*	1			
Fngrs/hand (X10)	0.696*	0.022	0.204	-0.173	-0.038	-0.077	0.404	0.437	-0.069	-0.032	1		
Hands/bunch (X11)	0.521*	0.043	0.22	-0.024	-0.136	-0.059	0.194	0.067	-0.354	-0.333	0.375	1	
Fngrs/bunch (X12)	0.712*	0.024	0.256	-0.0988	-0.127	-0.091	0.361	0.279	-0.271	-0.245	0.705*	0.914*	1

Table t value at 5 % = 2.518

*Significant at 5 %

Plt: plant No: number fngr: finger
wt :weight lvs: leaves lf: leaf
grth: girth lth: length brdth : breadth

Table2: Performance of banana genotypes in respect of vegetative characteristics

Treatments	Vegetative characteristics Plant height (cm)	Plant Girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaf area (m^2)	Number of leaves per plant
T_1–Karibale (AAA)	169.24	59.91	139.73	61.99	0.64	14.33
T_2 - Kayipalle bale (ABB)	147.81	61.54	132.07	58.08	0.62	13.33
T_3 –Rajapuri (AAB)	154.38	62.76	127.00	49.87	0.50	11.67
T_4 - Red banana(AAA)	181.27	62.23	148.33	59.03	0.69	11.67
T_5 – Rasabale (AAB)	154.14	59.11	153.67	58.52	0.71	13.33
T_6 – Elakkibale (AB)	252.33	66.75	143.40	60.03	0.69	10.67
T_7–Kanayibanasi (AAA)	219.00	60.08	138.63	62.77	0.69	11.00
T_8–Mitli (AB)	201.15	49.20	123.63	43.62	0.45	11.33
T_9–Bargibale (AAB)	161.65	61.28	127.30	61.59	0.63	13.67
T_{10} -Balbisiana(BB)	186.33	52.53	135.00	50.81	0.54	12.67
T_{11}–Pisanglilin (AA)	161.00	46.45	141.97	50.72	0.57	10.67
T_{12} -FHIA 3 (AABB)	265.00	69.34	154.77	52.28	0.65	12.33
T_{13} –Lalchakrakeli (AAA)	206.33	68.25	139.33	65.44	0.72	15.00
T_{14} -Basrai Dwarf (AAA)	173.00	72.31	155.30	62.43	0.77	13.67
T_{15} –Monthon (ABB)	305.00	62.95	132.03	65.18	0.68	12.33
T_{16} –Robusta (AAA)	224.00	66.97	166.67	61.75	0.82	13.67
T_{17} -Kadali (AA)	254.33	75.34	150.43	62.07	0.75	12.67
T_{18} -Yangavi KM-5(AAA)	261.00	76.28	148.00	66.65	0.78	14.33
T_{19} - Sakkarebale (AB)	293.67	71.45	160.20	59.83	0.77	12.67
T_{20}–Karpuravalli (AAB)	212.67	65.38	129.00	59.93	0.69	13.00
T_{21} - Poovan (AAB)	273.67	72.86	148.00	66.86	0.80	12.33
T_{22}– Pisangawak (ABB)	220.00	60.08	148.33	62.13	0.73	13.00
T_{23} - Hanuman (AAA)	173.33	70.27	131.67	58.48	0.62	17.33
F- test	**	**	**	**	**	**
SEm ±	8.63	2.46	4.66	2.72	0.04	0.47
CD (0.05)	24.62	7.01	13.29	7.77	0.12	1.34

Table 3: Performance of banana genotypes in respect of finger parameters

Treatments	Finger parameters Finger length (cm)	Finger girth (cm)	Finger weight(g)	No. of fingers per hand
T_1 – Karibale (AAA)	17.03	13.37	140.17	9.67
T_2 – Kayipalle bale (ABB)	13.20	11.87	76.63	12.33
T_3 – Rajapuri (AAB)	13.40	12.40	108.90	12.67
T_4 – Red banana(AAA)	12.63	11.93	88.00	15.67
T_5 – Rasabale (AAB)	13.27	12.77	69.51	11.67
T_6 – Elakkibale (AB)	13.43	11.10	62.97	16.33
T_7 – Kanayibanasi (AAA)	17.10	12.40	118.60	13.33
T_8 – Mitli (AB)	8.50	8.87	46.00	12.67
T_9 – Bargibale (AAB)	12.63	10.47	119.37	13.33
T_{10} – Balbisiana (BB)	10.70	9.57	43.90	14.33
T_{11} – Pisanglilin (AA)	12.60	10.57	43.20	11.67
T_{12} – FHIA 3 (AABB)	15.10	9.80	71.33	15.33
T_{13} – Lalchakrakeli (AAA)	16.67	14.27	159.87	14.00
T_{14} – Basrai Dwarf (AAA)	15.60	14.57	173.90	13.67
T_{15} – Monthon (ABB)	16.90	14.20	214.13	14.00
T_{16} – Robusta (AAA)	19.77	17.53	243.27	12.67
T_{17} – Kadali (AA)	12.93	12.17	108.23	10.67
T_{18} – Yangavi KM -5 (AAA)	14.87	15.30	136.40	12.33
T_{19} – Sakkarebale (AB)	17.87	13.53	129.67	14.33
T_{20} – Karpuravalli (AAB)	16.17	11.43	53.53	15.33
T_{21} – Poovan (AAB)	17.73	14.63	152.33	12.33
T_{22} – Pisangawak (ABB)	15.30	11.73	119.53	14.00
T_{23} – Hanuman (AAA)	22.43	13.23	130.47	24.67
F- test	**	**	**	**
SEm ±	0.45	0.21	6.18	0.49
CD (0.05)	1.29	0.59	17.63	1.41

* - Significant at 0.05 % ** - Significant at 0.01 % and 0.05 %

The Maximum leaf breadth (66.86 cm) was observed in the genotype Poovan whereas, the minimum (43.62 cm) was recorded in the genotype Mitli. This might be due to its genetical characters. These results are in conformity with Devi

Table4: Performance of banana genotypes in respect of bunch parameters and yield

Treatments	Bunch parameters and yield (t/ ha)					
	Internodal length (cm)	Bunch length (cm)	No. of hands per bunch	No. of fingers per bunch	Bunch yield/ plant (Kg)	Yield (t/ ha)
T_1 – Karibale (AAA)	8.87	63.60	5.00	50.33	10.04	11.09
T_2 – Kayipalle bale (ABB)	7.47	61.33	6.67	83.33	9.42	10.46
T_3 – Rajapuri (AAB)	9.37	55.67	4.67	60.67	9.39	10.43
T_4 – Red banana(AAA)	6.57	49.83	4.67	72.67	8.31	9.26
T_5 – Rasabale (AAB)	10.77	65.00	6.00	67.67	7.37	8.19
T_6 – Elakkibale (AB)	8.57	90.37	8.00	132.00	11.97	13.29
T_7 – Kanayibanasi (AAA)	10.56	71.27	6.00	79.33	12.13	13.47
T_8 – Mitli (AB)	6.43	38.80	4.33	56.00	3.46	3.84
T_9 – Bargibale (AAB)	7.50	73.07	8.67	112.67	17.10	18.99
T_{10} – Balbisiana (BB)	5.07	55.83	7.67	106.33	6.90	7.66
T_{11} – Pisanglilin (AA)	10.33	97.40	8.67	102.00	7.36	8.17
T_{12} – FHIA 3 (AABB)	5.83	119.40	18.00	276.33	22.93	25.47
T_{13} – Lalchakrakeli (AAA)	7.13	68.30	8.33	119.67	22.02	24.46
T_{14} – Basrai Dwarf (AAA)	5.33	49.33	7.33	99.00	20.50	22.77
T_{15} – Monthon (ABB)	8.73	62.67	4.66	63.66	17.27	19.18
T_{16} – Robusta (AAA)	8.83	61.00	4.67	61.33	17.89	19.88
T_{17} – Kadali (AA)	6.30	77.67	10.00	109.66	14.42	16.02
T_{18} – Yangavi KM -5 (AAA)	7.53	77.67	7.33	90.67	15.60	17.16
T_{19} – Sakkarebale (AB)	6.37	41.27	4.00	56.67	10.79	11.98
T_{20} – Karpuravalli (AAB)	6.33	91.97	12.33	189.33	13.54	15.04
T_{21} – Poovan (AAB)	6.26	49.23	4.67	59.67	11.54	12.81
T_{22} – Pisangawak (ABB)	5.73	47.17	5.33	75.67	11.29	12.53
T_{23} – Hanuman (AAA)	5.27	78.53	11.33	273.67	38.77	43.07
F- test	**	**	**	**	**	**
SEm ±	0.31	5.56	0.57	9.55	1.03	1.16
CD (0.05)	0.91	15.85	1.64	27.23	2.97	3.32

* - Significant at 0.05 %;** - Significant at 0.01 % and 0.05 %

et al. (2011).

The genotype Robusta recorded the maximum leaf area (0.82 m^2). Whereas, the minimum leaf area (0.45 m^2) was recorded in the genotype Mitli. This might be due to maintenance of upright growth habit which allowed the maximum light interception, leaf length also contributed to increase the area of leaves. These findings are in line with Biswal *et al*. (2004).

The maximum number of leaves per plant (17.33) was recorded in the genotype Hanuman. Whereas, the minimum number of leaves per plant (10.66) was recorded in the genotype Elakkibale. This might be due to its genetical character. These results are in accordance with Biswal *et al*. (2004).

Finger parameters

Finger characters was significantly differed among the genotypes and the data is presented in the Table 3, the maximum finger length (22.43 cm) was found in the genotype Hanuman. The minimum finger length (8.50 cm) was recorded in the genotype Mitli. This might be due to the reason that *acuminata* group has longer fingers and its genetical characters. Similar findings were obtained by Syamal and Mishra (1989) observed length of fingers was maximum in Kanthali cultivar. Biswal *et al*. (2004).

The maximum finger girth was recorded in the genotype Robusta (17.53 cm). Whereas, the minimum finger girth was observed in the genotype Mitli (8.87 cm). This might be due to the reason that *acuminata* genotypes are having larger finger size and their genetical characters responsible to increasing the girth of finger. Similar findings were observed by Biswal *et al*. (2004). Syamal and Mishra (1989).

The maximum finger weight (243.27g) was recorded in the genotype Robusta and the minimum (43.20g) was recorded in the Pisanglilin. This might be due to the more fibre content and peel was very thick compared to other genotypes, this is a dessert genotype, usually dessert genotypes are larger in finger size (finger length and girth) which lead to increase in fruit weight. These results are in line with Biswal *et al*. (2004). Devi *et al*. (2011) observed that Myndoli having highest finger weight.

The maximum total number of fingers per hand (24.67) was recorded in the genotype Hanuman. The minimum number of fingers per hand (9.67) was recorded in the genotype Karibale. Usually *acuminate* group having more number of fingers per hand and due to the genetical characters of the genotype. These results are in contrast with Devi *et al*. (2011) reported that genotypes Sugandi recorded the highest number of fingers per hand and Ravi *et al*. (2014)

Bunch parameters

The data of bunch parameters showed in table 2, the highest bunch length (119.40 cm) was recorded in the genotype FHIA-3.However, the lowest bunch length (38.80 cm) was recorded in Mitli. This might be due to more number of fingers in the bunch, number of hands and its genetical characters led to increased bunch length. These results are in contrast with Syamal and Mishra (1989).

The maximum internodal length between hands (10.77 cm) was noticed in the genotype Rasabale and minimum (5.07 cm) was noticed in the genotype Balbisiana. This might be

due to the genetical characters exhibited by the genotype. These results are in contrast with Syamal and Mishra (1989).

FHIA-3 recorded the maximum number of hands (18.00) per bunch. Whereas, the minimum number of hands per bunch was (4.00) observed in the genotype Sakkarebale. This might be due to the genetic and inheritance characters of the genotype. Similar findings were obtained by Biswal *et al*. (2004) and Medhi (1994).

The highest number of fingers per bunch (276.33) was recorded in the genotype FHIA-3 . However, the lowest number of fingers per bunch (50.33) was recorded in genotype Karibale. This might be due to less number of fingers per hand and minimum number of hands in the bunch. Ara *et al*. (2011), Biswal *et al*. (2004*)*, Medhi (1994) and Syamal and Mishra (1989). Similarly, this study was supported by Oliveira *et al*. (2003).

Table 4, shows that the maximum bunch weight per plant (38.77 kg) was recorded in the genotype Hanuman and the minimum was recorded in Mitli (3.46 kg). The increase in bunch weight could be the result of an increase in bunch size. bigger finger size can be a major factor contributing to the bunch weight. The bunch weight was significantly contributed by palnt girth, number of leaves per plant, finger length, number of fingers per hand, number of hands per bunch and number of fingers per bunch as accordance with Deshmukh *et al*. (2004) recorded the maximum bunch weight in Acuminate group. Similar findings were obtained by Njuguna *et al*. (2008) and Devi *et al*. (2011).

The highest estimated yield per hectare was (43.07 tha^{-1}) recorded in the genotype Hanuman. Whereas, the lowest estimated yield per hectare was (3.84 tha^{-1}) recorded in genotype the Mitli. Number of fingers per bunch, finger weight, compactness of bunch leads to increasing the yield, and also improvement in yield was due to its genetical characters in general Hanuman belongs to the *acuminata* (AAA) group. Similar findings were obtained by Deshmukh *et al*. (2004), Medhi (1994) and Gaidashova *et al*. (2008).

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