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Correlation and Path Coefficient Analysis in Indian Oil Palm genotypes

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Oil palm *Elaeis guineensis* Jacq is the highest oil-yielding perennial plant. In this paper, Genotypic and phenotypic correlation coefficients and path analysis study was discussed conducted on 58 Indian Oil palm genotypes for twenty four characters. Fresh fruit bunch yield (FFBY) was found to be significantly and positively correlated with bunch dry weight, bunch index, average bunch weight, number of bunches, total dry matter, number of leaflets and oil to bunch ratio. Path coefficient analysis also showed that bunch dry weight, bunch index, average bunch weight, number of bunches and total dry matter had maximum positive effect on FFBY. Hence these are the most potent characters influencing FFBY per palm in the selection programme.

Keywords: Oil palm, Fresh fruit bunch yield, path analysis, correlation.

The Oil palm *Elaeis guineensis* (Jacq) is a native of Guinea Bissau of West Africa and belongs to the family Arecaceae and order Arecales. In India, Oil palm has been introduced as an irrigated crop. Use of palm oil is known for the last 500 years in India. Oil palm cultivation has now been extended to about 50,000 hectares in almost eleven states. Oil palm is the highest vegetable oil yielding crop which is the second most important vegetable oil crop next to soya. It is grown on a commercial scale throughout Malaysia, Indonesia and southern parts of India. The mesocarp is the source of palm oil and the seed yields palm kernel oil (Wood *et al.,* 1984; Donough and Law, 1988; Chan *et al.,* 1989).

It produces 4-6 tonnes of crude palm oil/ha. As India is one of the highest consumers of palm oil, the yield did not meet the consumption, so India is still importing palm oil from other countries. An effective breeding programme for high yielding varieties can be developed by genetic variation in available resources, analysis of character association with FFBY and path analysis. As yield is complex, it is associated with number of component characters. These characters were interrelated. These interrelated characters may affect the yield which make correlation coefficient ineffective (Chitra *et al*., 2005). The path coefficient analysis provides direct and indirect causes of association of yield and their component characters. This will be helpful for

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developing the varieties or hybrids with high yielding and other improved characters (Krualee *et al*., 2013; Tanya *et al*., 2013; Sumalini and Manjulatha, 2012; Pulli Bai *et al*., 2005; Anuradha *et al*., 2005; Vinothini *et al*., 2005; Karunakar Raju *et al*., 2005 and Chitra *et al*., 2005).

In the present study, different characters of oil palm genotypes associated with Fresh fruit bunch yield (FFBY) was correlated with bunch dry weight, bunch index, average bunch weight, number of bunches, total dry matter, number of leaflets and oil to bunch ratio. Path coefficient analysis was carried out analyzing bunch dry weight, bunch index, average bunch weight, number of bunches and total dry matter.

MATERIALS AND METHODS

Sample collection and parameters analyzed

In the present study fifty eight oil palm genotypes from different Indian villages of Andhra Pradesh and Telangana states were selected (Table.1). At every location the experiment was laid out in randomized block design (RBD) with 3 replications i.e., 3 palms (from each genotype). 24 morphological traits were recorded in 3 replications in all the genotypes. Morphological biometric observations like 1.height (HT), 2.girth at base (GT), 3.height increment (HT incre), 4.sex ratio (SR), 5.number of leaves (NL), 6.petiole width (PW), 7.petiole depth (PD), 8.number of leaflets (NLL), 9.rachis length (RL), 10.leaflet length (LLL), 11.leaflet width (LLW), 12.leaf area (LA), 13.leaf dry weight (LDW), 14.total leaf dry weight (TLDW), 15.specific leaf weight (SLW), 16.trunk dry matter (TrDM), 17.vegetative dry matter (VDM), 18.total dry matter (TDM) and yield parameters like 19.bunch number (BN), 20.fresh fruit bunch yield (FFBY), 21.average bunch weight (ABW), 22.bunch dry weight (BDW), 23.bunch index (BI) and 24.oil/bunch ratio were recorded during year 2011-2016 as per Corley *et al*. (1971) and Kushairi *et al*. (1999). With the measuring tape height-HT of the palm was measured from the ground above 50 cm to 17th leaf base and girth-GT at base was measured at that 50 cm level from ground. Height increment was measured by comparing height for 5 years Total number of leaves-NL and number of spindles-NS produced per year was counted thrice per year by marking 17th leaf and 1st leaf with paint. Sex ratio-SR was obtained from the below formulae. Inflorescences in the leaf base was counted thrice in a year by marking 17th leaf and 1st leaf with paint. Number of leaflets-NLL, Rachis length-RL, Petiole width-PW, Petiole depth-PD, Leaflet length-LLL and Leaflet width-LLW were measured on 17th leaf. Bunch number-BN, fresh fruit bunch yield-FFBY and average bunch weight-ABW was recorded while harvesting the bunches. Leaf area-LA, Leaf dry weight-LDW, Specific leaf weight-SLW, Total leaf dry weight-TLDW, Trunk dry matter-TrDM, Vegetative dry matter-VDM, Bunch dry matter-BDM, Total dry matter-TDM and Bunch index-BI was measured using the indirect non destructive method and they are measured by below formulas (Corley *et al*., 1971 and Kushairi *et al*., 1999).

Sex ratio-SR = number of female inflorescence/ number of male+female+hermophrodite inflorescences.

Leaf area-LA = 0.455(NLL x LLL x LLW)-0.245

Leaf dry weight-LDW = 0.058(PW x PD)+0.00541 x RL-0.902

Total leaf dry weight-TLDW = LDW(NL + NS-1)

SLW = LDW/LA

Trunk dry matter-TDM = Diameter x volume x density of palm

Vegetative dry matter-VDM = TLDW + TrDM

Bunch dry weight-BDW = 0.53 x fresh fruit bunch weight-FFB

Total dry matter-TDM = VDM + BDW

Bunch index-BI = BDW/TDM

Oil to bunch ratio was obtained using bunch analysis (Soxhlet method). Three bunches from each genotype was collected. Weights of bunch, fruits, spikelets and stalk was recorded. Fresh weight and dry weight of mesocarp, kernel, nuts was recorded for obtaining moisture percentage and the dry samples of mesocarp were kept in soxhlet apparatus where the petroleum ether was evaporated on heating and after cooling it was converted into vapours where it will flush the oil from the dry mesocarp samples and the weights of samples was recorded before and after the extraction in soxhlet. The oil to bunch ratio was calculated by oil/fresh mesocarp to mesocarp/fruit to fruit/bunch.

Data Analysis

The Morphological data from 3 replications of 58 genotypes was recorded on 24 characters was submitted to statistical package WINDOSTAT 9.2 (INDOSTAT services Ltd. Hyderabad, India) to carry out the Genotypic and Phenotypic correlation coefficients and path analysis. Genotypic and Phenotypic correlation was carried out by using the formulae suggested by Falconer (1964) and path analysis as described by Dewey and Lu (1959) was carried out to calculate direct and indirect contribution of various traits to fresh fruit bunch yield-FFBY.

RESULTS AND DISCUSSION

The analyzed data showed positive genotypic correlation with reference to the number of leaflets-NLL (0.1278), petiole width-PW (0.1091), petiole depth-PD (0.0867), rachis length-RL (0.2012), leaflet length-LLL (0.0253), leaflet width-LLW (0.0596), leaf area-LA (0.0845), leaf dry weight-LDW (0.1467), total leaf dry weight-TLDW (0.2766), specific leaf weight-SLW (0.0548) and vegetative dry matter-VDM (0.1107) (Table.2; Fig.1). Number of leaves-NL had significant and positive correlation with bunch number-BN (Oboh and Fakorede, 1990). Number of leaves-NL was negatively associated in the present study with height-HT and average bunch weight-ABW but there was a positive association in the previous study (Rafii *et al*., 2013). It was also reported that rachis length-RL was negatively correlated with number of leaves-NL and has no correlation with FFBY and oil to bunch ratio (Rafii *et al*., 2013), but in the present study rachis length-RL was positively correlated with number of leaves-NL and negatively correlation with FFBY and oil to bunch ratio.

Similarly, positive phenotypic correlation (Table. 3; Fig. 2) was noticed for number of leaves-NL with number of leaflets-NLL (0.0031), rachis length-RL (0.1037), leaflet width-LLW (0.0143), total leaf dry weight-TLDW (0.1143) and vegetative dry matter-VDM (0.0297). Due to masking effect of environment on the genetic association with characters, mostly the genotypic correlation coefficients are higher than phenotypic correlations (Johnson *et al*., 1955; Chitra *et al*., 2005).

Number of leaflets-NLL showed positive correlation with girth (G=0.0564; P=0.0627), sex ratio-SR (G=0.3258; P=0.0903), number of leaves-NL (G=0.1278; P=0.0031), petiole width-PW (G=0.1195; P=0.1770) petiole depth-PD (G=0.0755; P=0.1494), rachis length-RL (G=0.5757; P=0.4434), leaflet width-LLW (G=0.0492; P=-0.0233), leaf area-LA (G=0.4748; P=0.4672), leaf dry weight-LDW (G=0.2926; P=0.2892), total leaf dry weight-TLDW (G=0.3129; P=0.3010), vegetative dry matter-VDM (G=0.1337; P=0.1868), bunch number-BN (G=0.2230; P=0.1694), average bunch weight-ABW (G=0.1137; P=0.0758), bunch dry weight-BDW (G=0.1899; P=0.1436), total dry matter-TDM (G=0.2980; P=0.2928), bunch index-BI (G=0.0716; P=-0.0012) and oil to bunch ratio (G=0.1627; P=0.0726). Number of leaflets-NLL showed different correlation for leaflet width-LLW and bunch index-BI which is positive for genotypic and negative for phenotypic correlation.

Height of the palm-HT exhibits positive correlation with girth-GT (G=0.1101; P=0.0837), height increment-HT incre (G=0.9835; P=0.9748), petiole width-PW (G=0.3528; P=0.2912), petiole depth-PD (G=0.4275; P=0.3025), leaflet length-LLL (G=0.2677; P=0.2242), leaf dry weight-LDW (G=0.2308; P=0.1876), total leaf dry weight-TLDW (G=0.2015; P=0.1671), specific leaf weight-SLW (G=0.4621; P=0.3846), trunk dry matter-TrDM (G=0.6697; P=0.5975), vegetative dry matter-VDM (G=0.5506; P=0.4804), total dry matter-TDM (G=0.3619; P=0.3192) and oil to bunch ratio (G=0.0431; P=0.0406). These results were in coordination with the previous work where height-HT was positively and significantly correlated to yield component like oil to bunch ratio (Rafii *et al*., 2013).

Leaf area-LA was maximum and significantly correlated with leaflet width-LLW (G=0.7755; P=0.7271), rachis length-RL (G=0.4885; P=0.4176) and number of leaflets-NLL (G=0.4748; P=0.4672). Leaf area-LA was positively correlated with total dry matter-TDM and it was also significantly correlated with FFBY and bunch number-BN (Tan and Hardon, 1976). Greater correlation for Leaf area-LA with height-HT was observed (Hardon *et al*., 1969).

Vegetative dry matter-VDM was significantly associated with height-HT (G=0.5506;

P=0.4804), height increment-HT incre (G=0.5553; P=0.4792), girth at base-GT (G=0.3356; P=0.2998), petiole width-PW (G=0.8193; P=0.7919), petiole depth-PD (G=0.7895; P=0.7512), rachis length-RL (G=0.3349; P=0.3269), leaflet length-LLL (G=0.3979; P=0.3017), leaf dry weight-LDW (G=0.8327; P=0.8325), total leaf dry weight-TLDW (G=0.8214; P=0.8315), specific leaf weight-SLW (G=0.6717; P=0.6516), total dry matter-TDM (G=0.5593; P=0.6515) and trunk dry matter-TrDM (G=0.5508; P=0.4804). Total dry matter-TDM was significantly correlated with vegetative dry matter-VDM (G=0.5593; P=0.6515), bunch dry weight-BDW (G=0.5244; P=0.4749), average bunch weight-ABW (G=0.5200; P=0.4653), leaf dry weight-LDW (G=0.4616; P=0.5573), total leaf dry weight-TLDW (G=0.4337; P=0.5370), petiole depth-PD (G=0.4092; P=0.5018), petiole width-PW (G=0.3984; P=0.4833), height increment-HT incre (G=0.3918; P=0.3415) and height of the palm-HT (G=0.3619; P=0.3192). Number of leaves-NL, height-HT and girth-GT had positively correlation with total dry matter-TDM (Lucas, 1980).

Bunch number-BN was positively associated with girth-GT (G=0.0363; P=0.0354), sex ratio-SR (G=0.1407; P=0.1055), number of leaflets-NLL (G=0.2230; P=0.1694), rachis length-RL (G=0.0974; P=0.0795), leaflet width-LLW (G=0.1434; P=0989), leaf area-LA (G=0.1299; P=0.0837), average bunch weight-ABW (G=0.3221; P=0.2277), bunch dry weight-BDW (G=0.7254; P=0.6857), total dry matter-TDM (G=0.3124; P=0.2591), bunch index-BI (G=0.6712; P=0.6153) and oil to bunch ratio (G=0.1425; P=0.1003). Similarly, positive correlation was

Table 1. List of genotypes and their sources

S.No	Village	Genotype	S.No	Village	Genotype
1	A Polavaram	APV	30	Ankannagudem	ANG
2	Annadevarapeta	ADP	31	Bandivarigudem	BVG
3	Bayyannagudem	BNG	32	Busarajupalli	BRP
4	Bhimolu	BMU	33	Chityala	CHT
5	Gavaravaram	GVM	34	Doramamidi	DRM
6	Jelugumilli	JLG	35	Eduvadalla Palu	EVP
7	Komatikunta	KMK	36	Guravaigudem	GVG
8	Kommugudem	KMG	37	Jaggavaram	JGV
9	Kuntala Gudem	KTG	38	Kanakadripuram	KKP
10	Lakkavaram	LKV	39	Kollivarigudem	KVG
11	Lingaraopalem	LGP	40	Krishnapuram	KSP
12	Mulagalampalli	MLG	41	P Rajavaram	PRM
13	P Narayanapuram	PNP	42	Rachanna gudem	RNG
14	R Ganapavaram	RGP	43	Rudrarajukotagudem	RRK
15	Rajavaram	RJV	44	Bandamcharla	BMC
16	Gudlapalli	GDP	45	Borrampalem	BMP
17	Kethavaram	KTV	46	Cherukumili	CRK
18	Laxmanagudem	LXG	47	Darbhagudem	DRB
19	Mysannna Gudem	MNG	48	Devulapalli	DVP
20	Peddipalli	PDP	49	Gangolu	GNG
21	Pullepudi	PLP	50	Gopalapuram	GPP
22	Rajupothepalli	RPP	51	Vegavaram	VGV
23	Ramacherllagudem	RCG	52	Kamayya Palem	KMP
24	Taduvai	TDV	53	Makkinavarigudem	MKV
25	Teklavarigudem	TVG	54	P Ankampalem	PAP
26	Aswaraopeta	ARP	55	Pangidigudem	PGG
27	Janagareddygudem	JRG	56	Parimpudi	PRP
28	Pedavegi	PED	57	Ponguturu	PGT
29	Akkampeta	AKP	58	Pragadapalli	PGD

observed for sex ratio-SR with bunch number-BN (Mason and Lewin, 1925). Bunch index-BI was positively and significantly correlated with bunch number-BN (G=0.6712; P=0.6153), average bunch weight-ABW (G=0.7801; P=0.7334) and bunch dry weight-BDW (G=0.9010; P=0.8695). Similar results had evinced that bunch index-BI is highly correlated with fresh fruit bunch yield (FFBY)

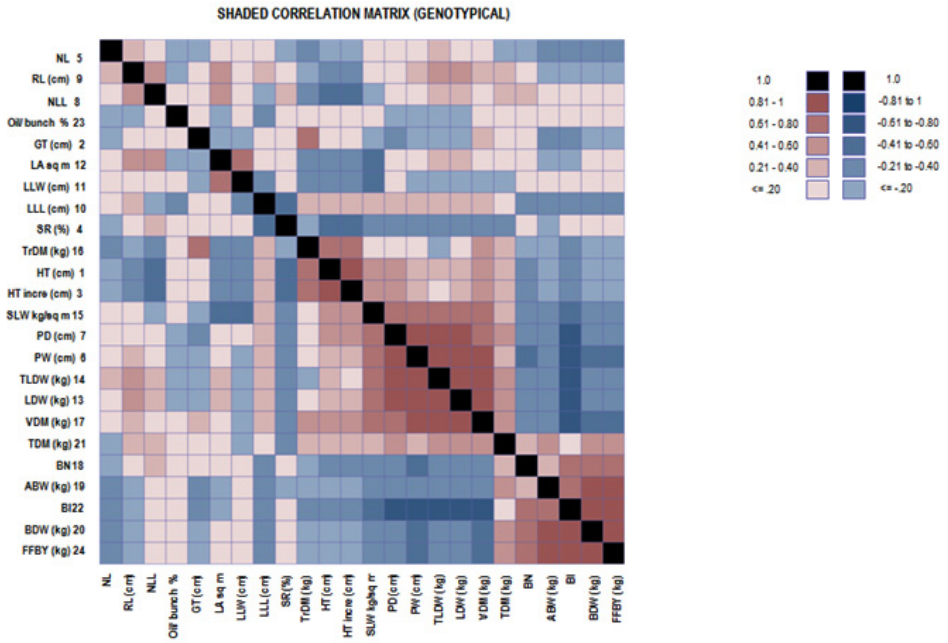

Fig.1. Genotypical Shaded Correlation Matrix

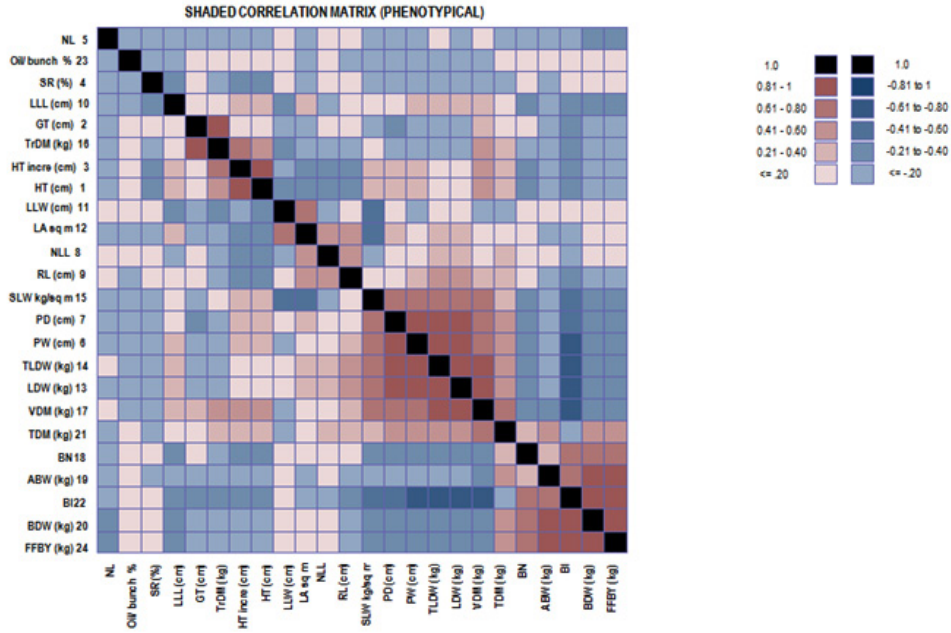

Fig. 2. Phenotypical Shaded Correlation Matrix

Table. 2. Genotypical Correlation Matrix for 24 characters

Character	HT (cm)	GT (cm)	HT incre (cm)	SR (%)	NL	PW (cm)	PD (cm)	NLL	RL) (cm	LLL (cm)	LLW (cm)	LA sq m	LDW (kg)	TLDW (kg)	SLW kg/sq m	TrDM (kg)	VDM (kg)	BN	ABW (kg)	BDW (kg)	TDM (kg)	BI	Oil/ bunch %
HT (cm)	1.0000	0.1101	0.9835	-0.4191	-0.1815	0.3528	0.4275	-0.4314	-0.3446	0.2677	-0.2563	-0.3026	0.2308	0.2015	0.4621	0.6697	0.5506	-0.3169	-0.0034	-0.1675	0.3619	-0.3672	0.0431
GT (cm)	0.1101	1.0000	0.1573	0.1525	-0.1114	-0.1643	-0.2098	0.0564	0.0830	0.1088	-0.1992	-0.0861	-0.1268	-0.1439	-0.0256	0.7991	0.3356	0.0363	-0.2268	-0.1529	0.1746	-0.2854	0.1207
HT incre (cm)	0.9835	0.1573	1.0000	-0.4169	-0.1995	0.3206	0.4065	-0.4141	-0.3284	0.2590	-0.2010	-0.2474	0.2128	0.1800	0.4078	0.7094	0.5553	-0.2624	-0.0034	-0.1396	0.3918	-0.3527	0.0403
SR (%)	-0.4191	0.1525	-0.4169	1.0000	-0.1033	-0.3269	-0.2953	0.3258	0.0177	-0.4666	0.1127	0.0184	-0.2738	-0.2719	-0.2947	-0.1310	-0.3021	0.1407	-0.0459	0.0545	-0.2329	0.1546	0.0180
NL	-0.1815	-0.1114	-0.1995	-0.1033	1.0000	0.1091	0.0867	0.1278	0.2012	0.0253	0.0596	0.0845	0.1467	0.2766	0.0548	-0.2105	0.1107	-0.1822	-0.2325	-0.2919	-0.1620	-0.2501	-0.0876
PW (cm)	0.3528	-0.1643	0.3206	-0.3269	0.1091	1.0000	0.9663	0.1195	0.2472	0.3104	-0.1285	0.0723	0.9590	0.9418	0.7958	0.0576	0.8193	-0.4427	-0.2546	-0.4037	0.3984	-0.6616	-0.0145
PD (cm)	0.4275	-0.2098	0.4065	-0.2953	0.0867	0.9663	1.0000	0.0755	0.1176	0.2505	0.0200	0.1805	0.9100	0.8963	0.6693	0.0721	0.7895	-0.3861	-0.2316	-0.3612	0.4092	-0.6144	-0.0645
NLL	-0.4314	0.0564	-0.4141	0.3258	0.1278	0.1195	0.0755	1.0000	0.5757	-0.0379	0.0492	0.4748	0.2926	0.3129	-0.1159	-0.2229	0.1337	0.2230	0.1137	0.1899	0.2980	0.0716	0.1627
RL (cm)	-0.3446	0.0830	-0.3284	0.0177	0.2012	0.2472	0.1176	0.5757	1.0000	0.2300	0.1286	0.4885	0.4995	0.5160	0.0997	-0.1679	0.3349	0.0974	-0.1016	-0.0247	0.2907	-0.1943	-0.0088
LLL (cm)	0.2677	0.1088	0.2590	-0.4666	0.0253	0.3104	0.2505	-0.0379	0.2300	1.0000	-0.3632	0.1260	0.3393	0.3219	0.2241	0.2260	0.3979	-0.2500	-0.2234	-0.2735	0.1231	-0.3870	-0.2597
LLW (cm)	-0.2563	-0.1992	-0.2010	0.1127	0.0596	-0.1285	0.0200	0.0492	0.1286	-0.3632	1.0000	0.7755	-0.0046	-0.0035	-0.5974	-0.2504	-0.1457	0.1434	0.0098	0.0654	-0.0766	0.1198	0.0047
LA sq m	-0.3026	-0.0861	-0.2474	0.0184	0.0845	0.0723	0.1805	0.4748	0.4885	0.1260	0.7755	1.0000	0.2884	0.2855	-0.5062	-0.2106	0.1182	0.1299	-0.0380	0.0306	0.1386	-0.0345	-0.0505
LDW (kg)	0.2308	-0.1268	0.2128	-0.2738	0.1467	0.9590	0.9100	0.2926	0.4995	0.3393	-0.0046	0.2884	1.0000	0.9912	0.6763	0.0090	0.8327	-0.3394	-0.2483	-0.3481	0.4616	-0.6350	-0.0348
TLDW (kg)	0.2015	-0.1439	0.1800	-0.2719	0.2766	0.9418	0.8963	0.3129	0.5160	0.3219	-0.0035	0.2855	0.9912	1.0000	0.6684	-0.0237	0.8214	-0.3460	-0.2631	-0.3672	0.4337	-0.6420	-0.0350
SLW kg/sq m	0.4621	-0.0256	0.4078	-0.2947	0.0548	0.7958	0.6693	-0.1159	0.0997	0.2241	-0.5974	-0.5062	0.6763	0.6684	1.0000	0.1991	0.6717	-0.3846	-0.2057	-0.3353	0.3226	-0.5524	0.0034
TrDM (kg)	0.6697	0.7991	0.7094	-0.1310	-0.2105	0.0576	0.0721	-0.2229	-0.1679	0.2260	-0.2504	-0.2106	0.0090	-0.0237	0.1991	1.0000	0.5508	-0.1455	-0.1454	-0.1855	0.3459	-0.3974	0.1342
VDM (kg)	0.5506	0.3356	0.5553	-0.3021	0.1107	0.8193	0.7895	0.1337	0.3349	0.3979	-0.1457	0.1182	0.8327	0.8214	0.6717	0.5508	1.0000	-0.3722	-0.3026	-0.4125	0.5593	-0.7628	0.0474
BN	-0.3169	0.0363	-0.2624	0.1407	-0.1822	-0.4427	-0.3861	0.2230	0.0974	-0.2500	0.1434	0.1299	-0.3394	-0.3460	-0.3846	-0.1455	-0.3722	1.0000	0.3221	0.7254	0.3124	0.6712	0.1425
ABW (kg)	-0.0034	-0.2268	-0.0034	-0.0459	-0.2325	-0.2546	-0.2316	0.1137	-0.1016	-0.2234	0.0098	-0.0380	-0.2483	-0.2631	-0.2057	-0.1454	-0.3026	0.3221	1.0000	0.8825	0.5200	0.7801	0.0403
BDW (kg)	-0.1675	-0.1529	-0.1396	0.0545	-0.2919	-0.4037	-0.3612	0.1899	-0.0247	-0.2735	0.0654	0.0306	-0.3481	-0.3672	-0.3353	-0.1855	-0.4125	0.7254	0.8825	1.0000	0.5244	0.9010	0.1017
TDM (kg)	0.3619	0.1746	0.3918	-0.2329	-0.1620	0.3984	0.4092	0.2980	0.2907	0.1231	-0.0766	0.1386	0.4616	0.4337	0.3226	0.3459	0.5593	0.3124	0.5200	0.5244	1.0000	0.1069	0.1368
BI	-0.3672	-0.2854	-0.3527	0.1546	-0.2501	-0.6616	-0.6144	0.0716	-0.1943	-0.3870	0.1198	-0.0345	-0.6350	-0.6420	-0.5524	-0.3974	-0.7628	0.6712	0.7801	0.9010	0.1069	1.0000	0.0517
Oil/ bunch %	0.0431	0.1207	0.0403	0.0180	-0.0876	-0.0145	-0.0645	0.1627	-0.0088	-0.2597	0.0047	-0.0505	-0.0348	-0.0350	0.0034	0.1342	0.0474	0.1425	0.0403	0.1017	0.1368	0.0517	1.0000
FFBY (kg)	-0.1676	-0.1528	-0.1396	0.0544	-0.2920	-0.4035	-0.3611	0.1900	-0.0246	-0.2735	0.0654	0.0308	-0.3479	-0.3670	-0.3352	-0.1854	-0.4123	0.7254	0.8824	1.0000	0.5246	0.9009	0.1017

Table 3. Phenotypical Correlation Matrix for 24 characters

Character	HT (cm)	GT (cm)	HT incre (cm)	SR (%)	NL	PW (cm)	PD (cm)	NLL	RL) (cm	LLL (cm)	LLW (cm)	LA sq m	LDW (kg)	TLDW (kg)	SLW kg/sq m	TrDM (kg)	VDM (kg)	BN	ABW (kg)	BDW (kg)	TDM (kg)	BI	Oil/ bunch %
HT (cm)	1.0000	0.0837	0.9748	-0.2405	-0.1402	0.2912	0.3025	-0.3251	-0.3218	0.2242	-0.2342	-0.2628	0.1876	0.1671	0.3846	0.5975	0.4804	-0.2921	-0.0056	-0.1642	0.3192	-0.3505	0.0406
GT (cm)	0.0837	1.0000	0.1153	0.0430	-0.0331	-0.1905	-0.2446	0.0627	0.0634	0.0801	-0.1826	-0.0733	-0.1770	-0.1863	-0.1060	0.8319	0.2998	0.0354	-0.1869	-0.1254	0.1807	-0.2553	0.0196
HT incre (cm)	0.9748	0.1153	1.0000	-0.2405	-0.1673	0.2584	0.2834	-0.3168	-0.3060	0.2126	-0.1716	-0.2082	0.1686	0.1428	0.3287	0.6336	0.4792	-0.2336	-0.0092	-0.1354	0.3415	-0.3329	0.0489
SR (%)	-0.2405	0.0430	-0.2405	1.0000	-0.0073	-0.1565	-0.1159	0.0903	0.0109	-0.2795	0.0549	-0.0511	-0.1265	-0.1273	-0.0809	-0.0900	-0.1623	0.1055	-0.0659	0.0129	-0.1424	0.0748	-0.0314
NL	-0.1402	-0.0331	-0.1673	-0.0073	1.0000	-0.0317	-0.0849	0.0031	0.1037	-0.0145	0.0143	-0.0124	-0.0332	0.1143	-0.0254	-0.1269	0.0297	-0.1305	-0.1852	-0.2316	-0.1600	-0.1728	-0.0687
PW (cm)	0.2912	-0.1905	0.2584	-0.1565	-0.0317	1.0000	0.8367	0.1770	0.2173	0.2159	-0.0634	0.1349	0.9236	0.9123	0.7546	-0.0200	0.7919	-0.3603	-0.1836	-0.3238	0.4833	-0.6272	-0.0109
PD (cm)	0.3025	-0.2446	0.2834	-0.1159	-0.0849	0.8367	1.0000	0.1494	0.1014	0.1611	0.0807	0.2237	0.9058	0.8836	0.6729	-0.0477	0.7512	-0.2709	-0.1484	-0.2539	0.5018	-0.5600	-0.0543
NLL	-0.3251	0.0627	-0.3168	0.0903	0.0031	0.1770	0.1494	1.0000	0.4434	-0.0599	-0.0233	0.4672	0.2892	0.3010	-0.0794	-0.1397	0.1868	0.1694	0.0758	0.1436	0.2928	-0.0012	0.0726
RL (cm)	-0.3218	0.0634	-0.3060	0.0109	0.1037	0.2173	0.1014	0.4434	1.0000	0.1960	0.1104	0.4176	0.4437	0.4616	0.1157	-0.1424	0.3269	0.0795	-0.0908	-0.0266	0.2867	-0.2022	-0.0198
LLL (cm)	0.2242	0.0801	0.2126	-0.2795	-0.0145	0.2159	0.1611	-0.0599	0.1960	1.0000	-0.2844	0.2135	0.2445	0.2347	0.0731	0.1706	0.3017	-0.2132	-0.1575	-0.2187	0.1068	-0.3129	-0.1961
LLW (cm)	-0.2342	-0.1826	-0.1716	0.0549	0.0143	-0.0634	0.0807	-0.0233	0.1104	-0.2844	1.0000	0.7271	0.0480	0.0453	-0.4925	-0.2221	-0.0840	0.0989	0.0207	0.0532	-0.0359	0.0888	0.0133
LA sq m	-0.2628	-0.0733	-0.2082	-0.0511	-0.0124	0.1349	0.2237	0.4672	0.4176	0.2135	0.7271	1.0000	0.3053	0.3015	-0.4498	-0.1725	0.1690	0.0837	-0.0099	0.0291	0.1832	-0.0661	-0.0554
LDW (kg)	0.1876	-0.1770	0.1686	-0.1265	-0.0332	0.9236	0.9058	0.2892	0.4437	0.2445	0.0480	0.3053	1.0000	0.9870	0.6999	-0.0650	0.8325	-0.2782	-0.1803	-0.2800	0.5573	-0.6225	-0.0361
TLDW (kg)	0.1671	-0.1863	0.1428	-0.1273	0.1143	0.9123	0.8836	0.3010	0.4616	0.2347	0.0453	0.3015	0.9870	1.0000	0.6905	-0.0873	0.8315	-0.2893	-0.1989	-0.3039	0.5370	-0.6376	-0.0407
SLW kg/sq m	0.3846	-0.1060	0.3287	-0.0809	-0.0254	0.7546	0.6729	-0.0794	0.1157	0.0731	-0.4925	-0.4498	0.6999	0.6905	1.0000	0.0783	0.6516	-0.2991	-0.1626	-0.2721	0.3931	-0.5282	-0.0066
TrDM (kg)	0.5975	0.8319	0.6336	-0.0900	-0.1269	-0.0200	-0.0477	-0.1397	-0.1424	0.1706	-0.2221	-0.1725	-0.0650	-0.0873	0.0783	1.0000	0.4808	-0.1103	-0.1327	-0.1626	0.3209	-0.3645	0.0616
VDM (kg)	0.4804	0.2998	0.4792	-0.1623	0.0297	0.7919	0.7512	0.1868	0.3269	0.3017	-0.0840	0.1690	0.8325	0.8315	0.6516	0.4808	1.0000	-0.3163	-0.2491	-0.3582	0.6515	-0.7645	-0.0014
BN	-0.2921	0.0354	-0.2336	0.1055	-0.1305	-0.3603	-0.2709	0.1694	0.0795	-0.2132	0.0989	0.0837	-0.2782	-0.2893	-0.2991	-0.1103	-0.3163	1.0000	0.2277	0.6857	0.2591	0.6153	0.1003
ABW (kg)	-0.0056	-0.1869	-0.0092	-0.0659	-0.1852	-0.1836	-0.1484	0.0758	-0.0908	-0.1575	0.0207	-0.0099	-0.1803	-0.1989	-0.1626	-0.1327	-0.2491	0.2277	1.0000	0.8617	0.4653	0.7334	0.0343
BDW (kg)	-0.1642	-0.1254	-0.1354	0.0129	-0.2316	-0.3238	-0.2539	0.1436	-0.0266	-0.2187	0.0532	0.0291	-0.2800	-0.3039	-0.2721	-0.1626	-0.3582	0.6857	0.8617	1.0000	0.4749	0.8695	0.0813
TDM (kg)	0.3192	0.1807	0.3415	-0.1424	-0.1600	0.4833	0.5018	0.2928	0.2867	0.1068	-0.0359	0.1832	0.5573	0.5370	0.3931	0.3209	0.6515	0.2591	0.4653	0.4749	1.0000	-0.0141	0.0645
BI	-0.3505	-0.2553	-0.3329	0.0748	-0.1728	-0.6272	-0.5600	-0.0012	-0.2022	-0.3129	0.0888	-0.0661	-0.6225	-0.6376	-0.5282	-0.3645	-0.7645	0.6153	0.7334	0.8695	-0.0141	1.0000	0.0567
Oil/ bunch %	0.0406	0.0196	0.0489	-0.0314	-0.0687	-0.0109	-0.0543	0.0726	-0.0198	-0.1961	0.0133	-0.0554	-0.0361	-0.0407	-0.0066	0.0616	-0.0014	0.1003	0.0343	0.0813	0.0645	0.0567	1.0000
FFBY (kg)	-0.1642	-0.1254	-0.1354	0.0130	-0.2317	-0.3237	-0.2539	0.1436	-0.0265	-0.2186	0.0532	0.0292	-0.2799	-0.3038	-0.2721	-0.1626	-0.3582	0.6856	0.8618	1.0000	0.4749	0.8695	0.0813

Table 4. Genotypical Path Matrix of FFBY

Character	HT (cm)	GT (cm)	HT incre (cm)	SR (%)	NL	PW (cm)	PD (cm)	NLL	RL) (cm	LLL (cm)	LLW (cm)	LA sq m	LDW (kg)	TLDW (kg)	SLW kg/sq m	TrDM (kg)	VDM (kg)	BN	ABW (kg)	BDW (kg)	TDM (kg)	BI	Oil/ bunch %
HT (cm)	0.0023	0.0003	0.0023	-0.0010	-0.0004	0.0008	0.0010	-0.0010	-0.0008	0.0006	-0.0006	-0.0007	0.0005	0.0005	0.0011	0.0016	0.0013	-0.0007	0.0000	-0.0004	0.0008	-0.0009	0.0001
GT (cm)	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000	-0.0001	0.0000	0.0001	-0.0001	0.0000
HT incre (cm)	-0.0007	-0.0001	-0.0007	0.0003	0.0001	-0.0002	-0.0003	0.0003	0.0002	-0.0002	0.0001	0.0002	-0.0001	-0.0001	-0.0003	-0.0005	-0.0004	0.0002	0.0000	0.0001	-0.0003	0.0002	0.0000
SR (%)	0.0001	0.0000	0.0001	-0.0002	0.0000	0.0001	0.0001	-0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NL	-0.0006	-0.0004	-0.0007	-0.0003	0.0033	0.0004	0.0003	0.0004	0.0007	0.0001	0.0002	0.0003	0.0005	0.0009	0.0002	-0.0007	0.0004	-0.0006	-0.0008	-0.0010	-0.0005	-0.0008	-0.0003
PW (cm)	0.0027	-0.0013	0.0025	-0.0025	0.0008	0.0078	0.0075	0.0009	0.0019	0.0024	-0.0010	0.0006	0.0075	0.0073	0.0062	0.0004	0.0064	-0.0034	-0.0020	-0.0031	0.0031	-0.0052	-0.0001
PD (cm)	0.0006	-0.0003	0.0005	-0.0004	0.0001	0.0013	0.0013	0.0001	0.0002	0.0003	0.0000	0.0002	0.0012	0.0012	0.0009	0.0001	0.0010	-0.0005	-0.0003	-0.0005	0.0005	-0.0008	-0.0001
NLL	0.0002	0.0000	0.0002	-0.0001	-0.0001	-0.0001	0.0000	-0.0004	-0.0002	0.0000	0.0000	-0.0002	-0.0001	-0.0001	0.0000	0.0001	-0.0001	-0.0001	0.0000	-0.0001	-0.0001	0.0000	-0.0001
RL (cm)	-0.0011	0.0003	-0.0011	0.0001	0.0007	0.0008	0.0004	0.0019	0.0033	0.0008	0.0004	0.0016	0.0016	0.0017	0.0003	-0.0006	0.0011	0.0003	-0.0003	-0.0001	0.0010	-0.0006	0.0000
LLL (cm)	-0.0005	-0.0002	-0.0005	0.0009	0.0000	-0.0006	-0.0005	0.0001	-0.0004	-0.0019	0.0007	-0.0002	-0.0006	-0.0006	-0.0004	-0.0004	-0.0008	0.0005	0.0004	0.0005	-0.0002	0.0007	0.0005
LLW (cm)	0.0007	0.0005	0.0005	-0.0003	-0.0002	0.0003	-0.0001	-0.0001	-0.0003	0.0010	-0.0026	-0.0020	0.0000	0.0000	0.0016	0.0007	0.0004	-0.0004	0.0000	-0.0002	0.0002	-0.0003	0.0000
LA sq m	0.0014	0.0004	0.0012	-0.0001	-0.0004	-0.0003	-0.0009	-0.0023	-0.0023	-0.0006	-0.0037	-0.0048	-0.0014	-0.0014	0.0024	0.0010	-0.0006	-0.0006	0.0002	-0.0001	-0.0007	0.0002	0.0002
LDW (kg)	0.0059	-0.0033	0.0055	-0.0070	0.0038	0.0246	0.0233	0.0075	0.0128	0.0087	-0.0001	0.0074	0.0256	0.0254	0.0173	0.0002	0.0213	-0.0087	-0.0064	-0.0089	0.0118	-0.0163	-0.0009
TLDW (kg)	-0.1053	0.0752	-0.0940	0.1420	-0.1445	-0.4920	-0.4682	-0.1634	-0.2695	-0.1682	0.0018	-0.1491	-0.5177	-0.5224	-0.3491	0.0124	-0.4290	0.1808	0.1374	0.1918	-0.2265	0.3353	0.0183
SLW kg/sq m	-0.0048	0.0003	-0.0043	0.0031	-0.0006	-0.0083	-0.0070	0.0012	-0.0010	-0.0023	0.0063	0.0053	-0.0071	-0.0070	-0.0105	-0.0021	-0.0070	0.0040	0.0022	0.0035	-0.0034	0.0058	0.0000
TrDM (kg)	-0.2269	-0.2707	-0.2404	0.0444	0.0713	-0.0195	-0.0244	0.0755	0.0569	-0.0766	0.0848	0.0713	-0.0030	0.0080	-0.0675	-0.3388	-0.1866	0.0493	0.0493	0.0628	-0.1172	0.1346	-0.0455
VDM (kg)	-0.1472	-0.0897	-0.1484	0.0807	-0.0296	-0.2190	-0.2110	-0.0357	-0.0895	-0.1063	0.0390	-0.0316	-0.2225	-0.2195	-0.1795	-0.1472	-0.2672	0.0995	0.0809	0.1102	-0.1495	0.2039	-0.0127
BN	-0.0014	0.0002	-0.0012	0.0006	-0.0008	-0.0020	-0.0017	0.0010	0.0004	-0.0011	0.0006	0.0006	-0.0015	-0.0015	-0.0017	-0.0006	-0.0017	0.0045	0.0014	0.0032	0.0014	0.0030	0.0006
ABW (kg)	0.0000	-0.0013	0.0000	-0.0003	-0.0014	-0.0015	-0.0014	0.0007	-0.0006	-0.0013	0.0001	-0.0002	-0.0015	-0.0016	-0.0012	-0.0009	-0.0018	0.0019	0.0059	0.0052	0.0031	0.0046	0.0002
BDW (kg)	-0.0276	-0.0252	-0.0230	0.0090	-0.0481	-0.0666	-0.0596	0.0313	-0.0041	-0.0451	0.0108	0.0050	-0.0574	-0.0605	-0.0553	-0.0306	-0.0680	0.1196	0.1455	0.1649	0.0865	0.1486	0.0168
TDM (kg)	0.3313	0.1598	0.3586	-0.2132	-0.1483	0.3647	0.3746	0.2728	0.2661	0.1127	-0.0701	0.1269	0.4225	0.3970	0.2953	0.3166	0.5120	0.2860	0.4760	0.4801	0.9154	0.0978	0.1252
BI	0.0033	0.0025	0.0031	-0.0014	0.0022	0.0059	0.0055	-0.0006	0.0017	0.0034	-0.0011	0.0003	0.0056	0.0057	0.0049	0.0035	0.0068	-0.0060	-0.0069	-0.0080	-0.0009	-0.0089	-0.0005
Oil/ bunch %	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0002
FFBY (kg)	-0.1676	-0.1528	-0.1396	0.0544	-0.2920	-0.4035	-0.3611	0.1900	-0.0246	-0.2735	0.0654	0.0308	-0.3479	-0.3670	-0.3352	-0.1854	-0.4123	0.7254	0.8824	1.0000	0.5246	0.9009	0.1017
Partial R^2	-0.0004	0.0000	0.0001	0.0000	-0.0010	-0.0031	-0.0005	-0.0001	-0.0001	0.0005	-0.0002	-0.0001	-0.0089	0.1917	0.0035	0.0628	0.1102	0.0032	0.0052	0.1649	0.4802	-0.0080	0.0000

R SQUARE = 1.0000 RESIDUAL EFFECT = SQRT(1- 1.0000)

Table 5. Phenotypical Path Matrix of FFBY

Character	HT (cm)	GT (cm)	HT incre (cm)	SR (%)	NL	PW (cm)	PD (cm)	NLL	RL) (cm	LLL (cm)	LLW (cm)	LA sq m	LDW (kg)	TLDW (kg)	SLW kg/sq m	TrDM (kg)	VDM (kg)	BN	ABW (kg)	BDW (kg)	TDM (kg)	BI	Oil/ bunch %
HT (cm)	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
GT (cm)	0.0001	0.0007	0.0001	0.0000	0.0000	-0.0001	-0.0002	0.0000	0.0000	0.0001	-0.0001	0.0000	-0.0001	-0.0001	-0.0001	0.0006	0.0002	0.0000	-0.0001	-0.0001	0.0001	-0.0002	0.0000
HT incre (cm)	0.0003	0.0000	0.0003	-0.0001	0.0000	0.0001	0.0001	-0.0001	-0.0001	0.0001	0.0000	-0.0001	0.0000	0.0000	0.0001	0.0002	0.0001	-0.0001	0.0000	0.0000	0.0001	-0.0001	0.0000
SR (%)	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NL	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PW (cm)	0.0002	-0.0001	0.0002	-0.0001	0.0000	0.0007	0.0006	0.0001	0.0002	0.0002	0.0000	0.0001	0.0007	0.0007	0.0006	0.0000	0.0006	-0.0003	-0.0001	-0.0002	0.0004	-0.0005	0.0000
PD (cm)	0.0001	-0.0001	0.0001	0.0000	0.0000	0.0004	0.0004	0.0001	0.0000	0.0001	0.0000	0.0001	0.0004	0.0004	0.0003	0.0000	0.0003	-0.0001	-0.0001	-0.0001	0.0002	-0.0002	0.0000
NLL	-0.0001	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
RL (cm)	-0.0001	0.0000	-0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0003	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	-0.0001	0.0000
LLL (cm)	0.0001	0.0000	0.0001	-0.0001	0.0000	0.0001	0.0001	0.0000	0.0001	0.0004	-0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	-0.0001	-0.0001	-0.0001	0.0000	-0.0001	-0.0001
LLW (cm)	-0.0001	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0001	0.0005	0.0004	0.0000	0.0000	-0.0003	-0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
LA sq m	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0002	-0.0002	-0.0001	-0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LDW (kg)	0.0002	-0.0002	0.0002	-0.0001	0.0000	0.0009	0.0009	0.0003	0.0004	0.0002	0.0000	0.0003	0.0009	0.0009	0.0007	-0.0001	0.0008	-0.0003	-0.0002	-0.0003	0.0005	-0.0006	0.0000
TLDW (kg)	-0.0133	0.0149	-0.0114	0.0102	-0.0091	-0.0728	-0.0705	-0.0240	-0.0368	-0.0187	-0.0036	-0.0241	-0.0788	-0.0798	-0.0551	0.0070	-0.0664	0.0231	0.0159	0.0243	-0.0429	0.0509	0.0033
SLW kg/sq m	0.0001	0.0000	0.0001	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0.0000	-0.0002	-0.0001	0.0002	0.0002	0.0003	0.0000	0.0002	-0.0001	-0.0001	-0.0001	0.0001	-0.0002	0.0000
TrDM (kg)	-0.0297	-0.0414	-0.0315	0.0045	0.0063	0.0010	0.0024	0.0070	0.0071	-0.0085	0.0111	0.0086	0.0032	0.0043	-0.0039	-0.0498	-0.0239	0.0055	0.0066	0.0081	-0.0160	0.0181	-0.0031
VDM (kg)	-0.1418	-0.0885	-0.1415	0.0479	-0.0088	-0.2338	-0.2217	-0.0551	-0.0965	-0.0891	0.0248	-0.0499	-0.2457	-0.2454	-0.1923	-0.1419	-0.2952	0.0934	0.0735	0.1057	-0.1923	0.2257	0.0004
BN	-0.0001	0.0000	-0.0001	0.0000	0.0000	-0.0001	-0.0001	0.0000	0.0000	-0.0001	0.0000	0.0000	-0.0001	-0.0001	-0.0001	0.0000	-0.0001	0.0003	0.0001	0.0002	0.0001	0.0002	0.0000
ABW (kg)	0.0000	-0.0001	0.0000	0.0000	-0.0001	-0.0001	-0.0001	0.0001	-0.0001	-0.0001	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0002	0.0002	0.0007	0.0006	0.0003	0.0005	0.0000
BDW (kg)	-0.1097	-0.0838	-0.0905	0.0086	-0.1548	-0.2164	-0.1697	0.0959	-0.0178	-0.1461	0.0355	0.0194	-0.1871	-0.2031	-0.1818	-0.1087	-0.2394	0.4582	0.5759	0.6683	0.3173	0.5811	0.0543
TDM (kg)	0.1298	0.0735	0.1389	-0.0579	-0.0651	0.1966	0.2041	0.1191	0.1166	0.0435	-0.0146	0.0745	0.2267	0.2184	0.1599	0.1305	0.2650	0.1054	0.1893	0.1932	0.4068	-0.0058	0.0263
BI	-0.0002	-0.0002	-0.0002	0.0000	-0.0001	-0.0004	-0.0004	0.0000	-0.0001	-0.0002	0.0001	0.0000	-0.0004	-0.0004	-0.0003	-0.0002	-0.0005	0.0004	0.0005	0.0005	0.0000	0.0006	0.0000
Oil/ bunch %	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
FFBY (kg)	-0.1642	-0.1254	-0.1354	0.0130	-0.2317	-0.3237	-0.2539	0.1436	-0.0265	-0.2186	0.0532	0.0292	-0.2799	-0.3038	-0.2721	-0.1626	-0.3582	0.6856	0.8618	1.0000	0.4749	0.8695	0.0813
Partial R^2	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0002	-0.0001	0.0000	0.0000	-0.0001	0.0000	0.0000	-0.0003	0.0242	-0.0001	0.0081	0.1057	0.0002	0.0006	0.6683	0.1932	0.0005	0.0000

R SQUARE = 1.0000 RESIDUAL EFFECT = 0.0009

and bunch number (BN) (Junaidah *et al*., 2004; Kushairi *et al*., 1999).

Sex ratio-SR (G=0.0544; P=0.0130), number of leaflets-NLL (G=0.1900; P=0.1436), total dry matter-TDM (G=0.5246; P=0.4749), leaflet width-LLW (G=0.0654; P=0.0532), bunch number-BN (G=0.7254; P=0.6856), bunch index-BI (G=0.9009; P=0.8695), average bunch weight-ABW (G=0.8824; P=0.8618) and oil to bunch ratio (G=0.1017; P=0.0813) had strong positive association with fresh fruit bunch yield-FFBY per palm and hence maximum emphasis should given for these characters to increase the fresh fruit bunch yield-FFBY per palm. Similar results were noticed where positive correlation was observed for fresh fruit bunch yield-FFBY with oil to bunch ratio (Krualee *et al*., 2013). Positive and significant correlation for fresh fruit bunch yield-FFBY with height-HT, number of leaflets-NLL, leaflet length-LLL, leaflet width-LLW, rachis length, petiole width-PW, petiole depth-PD, leaf area-LA and average bunch weight-ABW, but negatively associated with oil to bunch ratio (Marhalil *et al*., 2013). Highest correlation was obtained for fresh fruit bunch-FFB with number of leaves-NL (Oboh and Fakorede, 1990). Girth-GT and leaf area-LA were positively and significantly correlated with fresh fruit bunch yield-FFBY (Subronto *et al*., 1989; Agyei-Dwarko *et al*., 2012). Petiole width-PW, petiole depth-PD, rachis length-RL, leaflet length-LLL, leaflet width-LLW, leaf area-LA, leaf dry weight-LDW, total leaf dry weight-TLDW, specific leaf weight-SLW and vegetative dry matter-VDM were interrelated among themselves and would bring in simultaneous improvement in addition to FFBY.

The path analysis indicated (Table.4 & 5) that bunch number-BN, average bunch weight-ABW, bunch dry weight-BDW, total dry matter-TDM and bunch index-BI exerted direct positive effect on fresh fruit bunch yield-FFBY and for these traits direct selection can be made to improve the yield. Selecting FFBY alone could not get the superior hybrids, which can be improved by selecting high bunch index-BI and other vegetative character traits in breeding may get good superior high yielding and uniform palms (Corley *et al*., 1971). Average bunch weight-ABW had positive and indirect effect on yield via number of leaflets-NLL, leaflet width-LLW, bunch number-BN, bunch dry weight-BDW, total dry matter-TDM, bunch index-BI and oil to bunch ratio. For average bunch weight-ABW maximum indirect effect on yield was obtained through bunch index-BI, bunch dry weight-BDW, total dry matter-TDM and bunch number-BN. Hence selection through these characters may bring about improvement in fresh fruit bunch yield-FFBY.

Bunch number-BN exhibited positive indirect effect on yield through girth-GT, sex ratio-SR, number of leaflets-NLL, rachis length-RL, leaflet width-LLW, leaf area-LA, average bunch weight-ABW, bunch dry weight-BDW, total dry matter-TDM, bunch index-BI and oil to bunch ratio. Bunch dry weight-BDW had positive indirect effect on yield via, sex ratio-SR, number of leaflets-NLL, leaflet width-LLW, leaf area-LA, average bunch weight-ABW, bunch number-BN, total dry matter-TDM, bunch index-BI and oil to bunch ratio. Number of leaves-NL, sex-ratio-SR and other bunch characters, would be effective as indirect selection criteria for bunch number-BN and fresh fruit bunch yield-FFBY (Oboh and Fakorede, 1990). Total dry matter-TDM had indirect effect on yield via height-HT, girth-GT, height increment-HT incre, petiole width-PW, petiole depth-PD, number of leaflets-NLL, rachis length-RL, leaflet length-LLL, leaf area-LA, leaf dry weight-LDW, total leaf dry weight-TLDW, specific leaf weight-SLW, trunk dry matter-TrDM, vegetative dry matter-VDM, bunch number-BN, average bunch weight-ABW, bunch dry weight-BDW, bunch index-BI and oil to bunch ratio. Selection of high total dry matter-TDM character may increase the yields of the hybrids which had indirect effect on bunch number-BN (Rees, 1963). Total dry matter-TDM production is going to bunch number-BN in fraction or more. Path coefficient analysis results show that fresh fruit bunch yield-FFBY was directly influenced by average bunch weight-ABW and bunch number (Tanya *et al*., 2013). The characters fresh fruit bunch yield-FFBY and bunch number-BN shows highly positive correlation with large direct and indirect positive effects on oil yield and percent oil/bunch (Eksomtramage *et al*., 2001).

CONCLUSION

The trait fresh fruit bunch yield-FFBY can be improved through bunch number-BN,

average bunch weight-ABW, bunch dry weight-BDW, total dry matter-TDM and bunch index-BI and these characters showed positive association with quality parameter like oil to bunch ratio and the major emphasis should be laid on selection process with high number of bunch number-BN, average bunch weight-ABW, bunch dry weight-BDW, total dry matter-TDM and bunch index-BI for better genotypes with superior oil quality and for realizing higher fresh fruit bunch yield-FFBY.

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