Madras Agric. J. 88(7-9): 414-417 July-September 2001
https://doi.org/10.29321/MAJ.10.A00357

Determination of picking force of some major varieties of cotton

K. RANGASAMY, C. DIVAKER DURAIRAJ AND M. MUTHAMIL SELVAN
Dept. of Farm Machinery, College of Agrl. Engg., Tamil Nadu Agrl. University, Coimbatore-641 003.

Abstract : A test rig was developed to assess the magnitude of air flow rate required to effect pneumatic picking of cotton. The picking force was determined for the bolls of ten varieties. The regression analysis was carried out to establish the relationship between volume of boll and picking force. The linear, polynomial, logarithmic, power function and exponential relations were attempted. The corresponding R-squared values were also determined to see the goodness of fit. In 70E variety the highest average picking force of 307.4 g was recorded whereas in 'Savitha' variety it was lowest (251.9 g). The picking force increased in direct proportion with volume of boll. The regression analysis revealed that the volume of boll has good linear relationship with picking force. *(Key words : Cotton, Picking force, Boll volume).*

In India cotton is an important commercial crop and sustains the country's textile industry which is perhaps the largest segment of organized industry in the country. India ranks third in cotton production with 16.87 million bales from an area of 9.25 million hectares during 1988-99. In India cotton is hand picked by human labour which is laborious and tedious work. Hand picking is ten times costlier than irrigation and about twice the weeding operation. One grown-up person can pick only 20-70 kg of cotton per day (Prasad and Majumdar, 1999). Goyal *et al.* (1979) reported that 1965 man-h/ha is required in cotton picking by conventional practice of hand picking in India. The average labour requirement in manual picking is 0.9 man- h/kg (Garg, 1999). In recent years labour shortage appears during peak periods of cotton harvesting. The use of mechanical picking machine will be useful in minimizing the drudgery involved in hand picking as well as enhancing production of clear grade of seed cotton. The mechanical cotton picking system will also be helpful in achieving timeliness of operation for the next crop. The picking force is the base for the design of any harvesters for cotton. Hence a test rig was developed to assess the magnitude of air flow rate required to effect pneumatic picking of cotton.

Materials and Methods

A test rig has been developed to measure the force required for picking cotton from the bolls. The test rig consists of frame, motor (2 hp), blower, acrylic pipe with strain gauge system, strain indicator, and 'U' tube manometer. The frame is made of 'L' angle of size 37x37x6 mm. The overall dimensions are 1m x 0.3m x 0.5m. The test rig assembly consists of 150mm diameter acrylic pipe suitably fixed on the frame. It acts as a flow flume for avoiding turbulence during tests. At the longitudinal centre of the pipe, the boll stem is held by means of a suitable holding device. The holding device in turn is fixed to a cantilever beam of strain gauge tansducer. The transducer was designed to measure a maximum force of one kg. The output terminals of the strain gauge bridge are connected to a digital strain indicator.

The air flow effecting a suction and thereby the pneumatic picking is applied into the acrylic flume from the blower through a suitable flexible hose. The entire assembly is shown in Fig 1. The strain indicator was pre-calibrated for known mechanical forces and a calibration chart was prepared to relate the strain readings and the applied force. The force required to pick the cotton can be obtained from the chart from the observed reading from the strain indicator for the particular boll fixed in the test rig.

The bolls of ten varieties of cotton were collected. The major diameter, minor diameter and height of the bolls were measured accurately. Then they are fixed in the test rig and the strain was observed from the strain gauge indicator from which the picking force can be determined. For each variety, ten samples of various dimensions were taken for this study.

Regression analysis was carried out to establish the relationship between volume of boll (independent variable) and the picking force (dependent variable). The linear, polynomial, logrithmic, power function and exponential relations were attempted.

Table 1. Volume of boll and picking force (P.F.) for various varieties of cotton

Sample No.	M-12 Volume (mm^3)	M-12 P.F. (g)	ADT-1 Volume (mm^3)	ADT-1 P.F. (g)	Savitha Volume (mm^3)	Savitha P.F. (g)	NH 545 Volume (mm^3)	NH 545 P.F. (g)	Vikram Volume (mm^3)	Vikram P.F. (g)	T7 Volume (mm^3)	T7 P.F. (g)	LRA 5166 Volume (mm^3)	LRA 5166 P.F. (g)	70E Volume (mm^3)	70E P.F. (g)	AC738 Volume (mm^3)	AC738 P.F. (g)	Suman Volume (mm^3)	Suman P.F. (g)
1	50223	273	94167	365	33087	245	43133	273	30265	247	56778	290	48070	286	70769	370	30119	260	24389	220
2	101606	376	48462	270	20398	239	48898	282	101142	361	25608	240	32149	271	95181	382	33618	290	30984	235
3	21063	236	27111	235	34158	248	26421	245	72465	340	96428	371	75053	340	28047	276	77807	310	48535	290
4	35669	252	23479	230	28168	241	20952	240	40159	270	79478	334	26759	261	30810	272	30984	280	34927	240
5	29693	245	24389	235	90044	370	25820	242	30967	241	25802	247	103869	380	28989	256	18139	230	18964	220
6	45009	269	43973	268	20273	221	82316	360	24223	238	35424	269	72122	365	51396	285	36618	285	38547	270
7	24412	238	43223	263	51025	271	21340	240	83636	354	29004	252	31429	270	77136	375	39676	290	79683	320
8	28685	241	53697	175	29322	232	32925	271	35946	246	66639	320	76935	290	28260	254	104105	380	34247	290
9	40227	270	25498	241	20190	219	109131	369	27742	241	96925	369	23426	245	19206	236	76774	350	24223	240
10	17072	239	145826	390	30385	227	48070	281	68124	306	63633	318	25608	270	75914	368	68328	345	93957	360
Average		263.9		277.2		251.3		280.3		260.3		301.9		297.8		307.4		300.0		268.5

i) Linear, $y = bx + c$
ii) Polynomial order 2, $y = ax^2 + bx + c$
iii) Logrithmic, $y = b \, Ln \, (x) + c$
iv) Power, $y = b \, x^c$
v) Exponential, $y = b \, e^{cx}$

The corresponding r-squared values were also determined to see the goodness of fit. The fittness with R-squared values for selected varieties are listed.

Results and Discussion

The picking force varied considerably among the bolls of each variety. In variety '70E', the maximum average picking force (307.4 g)was recorded followed by 'T7' (301.9 g) among the varieties tested. The minimum average picking force was observed in 'Savitha' (251.3 g) followed by 'Vikram' (260.3 g) among the varieties taken for this study (Table 1).

The picking force increased with the volume of boll in direct proportion. In 'Savitha' variety the lowest picking force (219.9 g) was recorded for the lowest volume of boll (20190 mm^3). In 70E variety, the highest picking force was observed for the highest volume of boll (95181 mm^3).

The regression analysis revealed that volume of boll (independent variable) has linear relationship with the picking force (dependent variable) with a R-squared value of more than 0.95 in six varieties and more than 0.80 in the remaining four varieties studied. Although a small improvement in R-squared value was observed with polynomial relation of order two, the simple linear relationship can be taken with minimum error for simplicity. The other relations like logrithmic, power and exponential functions cannot be discarded since they also yielded better R-squared values.

Conclusions

- A test rig was developed to assess the magnitude of air flow rate required to effect pneumatic picking of cotton. The picking force was determined for the bolls of ten varieties.

- In variety '70E', the maximum average picking force (307.4 g)was recorded followed by 'T7' (301.9 g). The minimum average picking force was observed in 'Savitha' (251.3 g) followed by 'Vikram' (260.3 g)

Table 2. Statistical model of various cotton varieties

Sl.No.	Variety	Model	R^2 value
1.	M12	$Y = 0.0017\ x + 196.81$	0.97
		$Y = 74.943\ Ln\ (x) - 519.4$	0.82
		$Y = 8\ X\ 10^{-9}\ x^2 + 0.0007\ x + 218.48$	0.99
		$Y = 18.194\ x^{0.255}$	O.86
		$Y = 208.9\ e^{6E-6x}$	0.98
2.	ADT 1	$Y = 0.0014\ x + 203.22$	0.95
		$Y = 88.601\ Ln\ (x) - 670.02$	0.94
		$Y = -6\ X\ 10^{-9}\ x^2 + 0.0024\ x + 174.83$	0.98
		$Y = 11.602\ x^{0.2953}$	0.96
		$Y = 214.08\ e^{6E-6x}$	0.94
3.	Savitha	$Y = 0.002\ x + 178.22$	0.95
		$Y = 87.527\ Ln\ (x) - 656.36$	0.84
		$Y = 1\ X10^{-8}\ x^2 + 0.0004\ x + 211.35$	0.97
		$Y = 10.348\ x^{0.3065}$	0.86
		$Y = 193.01\ e^{7E-6x}$	0.95
4.	NH 545	$Y = 0.0016\ x + 206.4$	0.96
		$Y = 81.921 Ln\ (x) -586.66$	0.93
		$Y = -6X10^{-9}\ x^2 + 0.0023x + 189.61$	0.97
		$Y = 14.885\ x^{0.2763}$	0.95
		$Y = 216.63\ e^{5E-6x}$	0.95
5.	Vikram	$Y = 0.0018\ x + 190.77$	0.96
		$Y = 95.898\ Ln\ (x) -744.13$	0.95
		$Y = -8\ X10^{-9}\ x^2 + 0.0028\ x + 167.62$	0.97
		$Y = 8.3165\ x^{0.328}$	0.96
		$Y = 203.99\ e^{6E-6x}$	0.96
6	T7	$Y = 0.0018\ x + 200.07$	0.99
		$Y = 91.706\ Ln\ (x) -692.33$	0.96
		$Y = -8\ X\ 10^{-10}\ x^2 + 0.0019\ x + 197.62$	0.99
		$Y = 107.5\ x^{0.3069}$	0.98
		$Y = 212.82\ e^{6E-6x}$	0.98
7	LRA 5166	$Y = 0.0015\ x + 221.4$	0.81
		$Y = 75.164 Ln\ (x) - 507.00$	0.79
		$Y = 9\ X\ 10^{-9}\ x^2 + 0.0014\ x + 233.76$	0.81
		$Y = 21.399\ x^{0.2468}$	0.81
		$Y = 230.24\ e^{5E-6x}$	0.82
8	70E	$Y = 0.0021\ x + 201.13$	0.94
		$Y = 100.48\ Ln\ (x)-767.04$	0.92
		$Y = -9\ X10^{-9}\ x^2 + 0.0031\ x + 179.71$	0.94
		$Y = 9.3141\ x^{0.3255}$	0.93
		$Y = 214.88\ e^{7E-6x}$	0.93
9	AC 738	$Y = 0.0015\ x + 224.35$	0.87
		$Y = 77.737 Ln\ (x) - 531.15$	0.90
		$Y = -9\ X\ 10^{-9}\ x^2 + 0.0026\ x + 199.63$	0.87
		$Y = 18.721\ x^{0.2585}$	0.91
		$Y = 232\ e^{5E-6x}$	0.85
10	Suman	$Y = 0.0017\ x + 193.60$	0.88
		$Y = 84.961\ Ln\ (x) - 626.79$	0.88
		$Y = -1\ X\ 10^{-8}\ x^2 + 0.0029\ x + 168.14$	0.89
		$Y = 10.813\ x^{0.3036}$	0.88
		$Y = 203.63\ e^{6E-6X}$	0.84

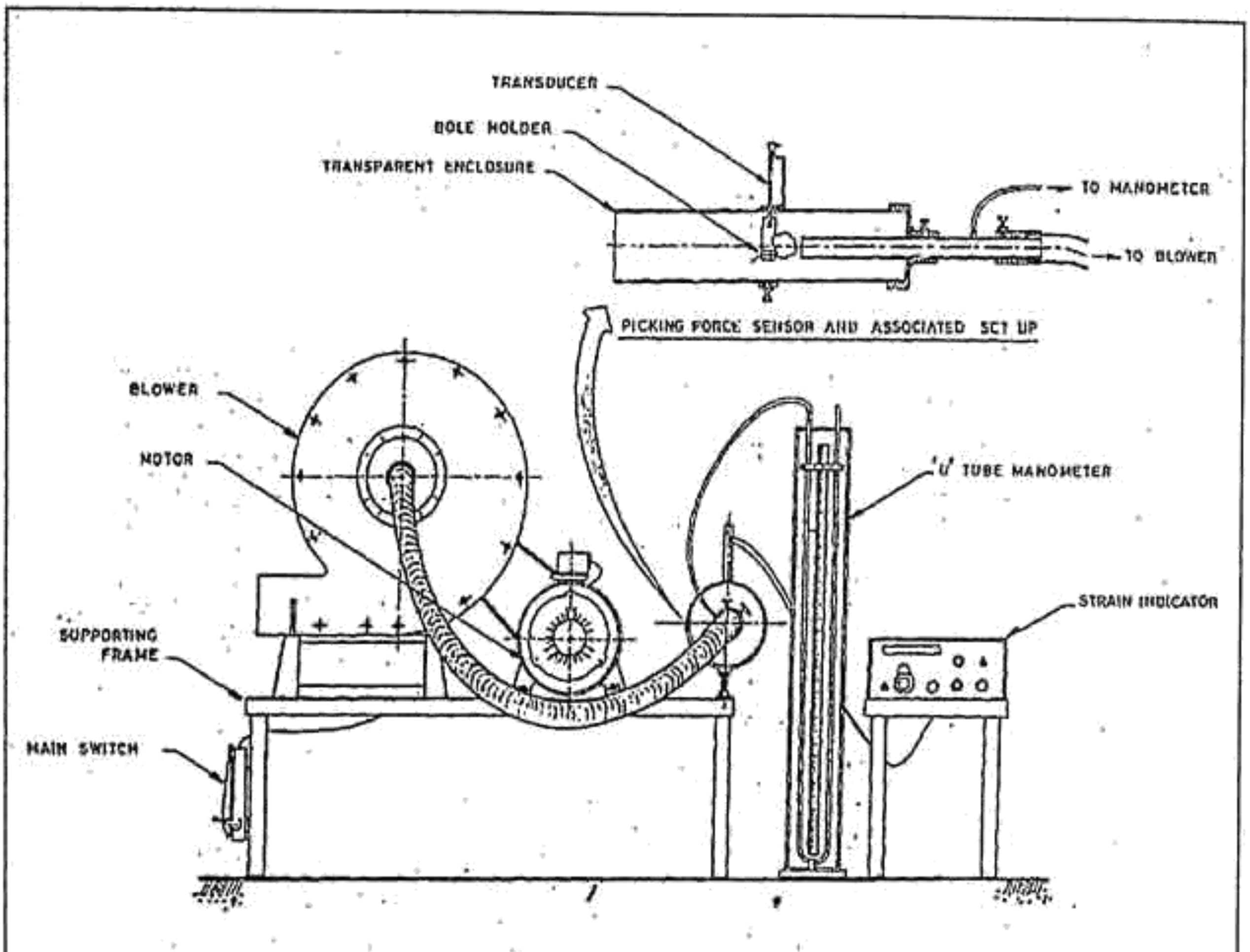

Fig.1 Setup for assessment of Cotton picking force

- The regression analysis shows that the volume of boll has linear relationship with picking force.
- The linear, polynomial, logrithmic, power function and exponential relations were attempted. The corresponding R-squared values were also determined to see the goodness of fit.

References

Garg, I.K. (1999). Design and development of power operated (knapsack type) cotton Quarterly report, PAU Ludhiana Centre for AICRP on Farm Implements and Machinery.

Goyal, M.R., Byg D.M. and Singh, K. (1979). Appropriate technology for cotton production in India. In : Agricultural Mechanization in Asia, Africa and Latin America. pp : 73-78.

Prasad, J. and Majumdar, G. (1999). Present practices and future needs for mechanization of cotton picking in *India. Agric. Engg.* Today, 23: 1-20.

(Received : July 2001; Revised: September 2001)