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ACCEPTANCE SAMPLING PLAN FOR TRUNCATED LIFE TESTS BASED ON GOMPERTZ DISTRIBUTION USING MEAN

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ABSTRACT

The design of acceptance sampling plan is proposed for the truncated life tests assuming that the lifetime of a product follows Gompertz distribution using mean. The minimum sample sizes of the zero-one double sampling plan and special double sampling plan are determined to ensure that the mean life is longer than the given life at the specified consumer's confidence level. The operating characteristic values are analysed. The minimum mean ratios are obtained so as to meet the producer's risk at the specified consumer's confidence level. Numerical illustrations are provided to explain the use of constructed tables. Efficiency of the proposed plan is studied by comparing the single sampling plan.

KEYWORDS

Zero-one double sampling plan, special double sampling plan, Truncated life tests, Operating characteristic function, Average sample number, Consumer's risk, Producer's risk.

INTRODUCTION

Acceptance sampling is the methodology that deals with procedures by which decision to accept or reject the lot is made on the results of the inspection of samples. It is to be pointed out that the acceptance sampling plans are used to reduce the cost of inspection. If the quality characteristic is regarding the lifetime of the products, then the acceptance sampling plan is called a life test plan. Quality personnel would like to know whether the lifetime of the products reach the consumer's expectation.

Sampling plans based on truncated life tests have been developed and investigated by many authors. Single Sampling plans for truncated life tests using exponential distribution was first discussed by Epstein[2].The results were extended by Goode and Kao[3] for Weibull distribution, Gupta and Groll [4] for gamma distribution, Kantam and Rosaiah [5] for half log-logistic , Kantam etal [6] for log-logistic distribution, Balki and El Masri [1] for Birnbaum-saunders distribution. Tsai and Wu[8] developed sampling plans for generalized Rayleigh distribution.

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Gompertz distribution plays a vital role in describing the distribution of adult life spans by demographers and it has also many applications in biology, gerontology, marketing science and computer fields. Nature of Gompertz distribution are obtained by Pollard and Valkovics[9],Wu and Lee[10],Read[11] , Kunimura[12] and Saracoglu et al[13] investigated the statistical inference for reliability and stress strength for Gompertz distribution. Wenhao Gui and Shangli Zhang [15] developed only single acceptance sampling plan for Gompertz distribution using mean.

This initiates the researcher to pursue with the designing of life test plan using Gompertz distribution with zero-one double acceptance sampling plans and special double sampling plans .Minimum sample sizes for the specified consumer's confidence level with minimum average sample number, the operating characteristic values and the minimum mean ratios of the life time for the specified producer's risk with illustration of tables are given for zero-one double sampling and special double sampling plan . Atlast , the analysis of effectiveness is presented.

GOMPERTZ DISTRIBUTION

Assume that the lifetime of a product follows Gompertz distribution, whose probability density function and cumulative distribution function are given respectively as

$$f(t;\theta,\sigma)=\frac{\theta}{\sigma}e^{t/\sigma}\exp[-\theta(e^{t/\sigma}-1)],\ t>0,\theta>0,\sigma>0$$

$$and\ F(t;\theta,\sigma)=1-\exp[-\theta(e^{t/\sigma}-1)],\ t>0,\theta>0,\sigma>0 \quad (1)$$

where θ is the shape parameter, σ is the scale parameter.

For $0 < \theta < 1$,the distribution has mode at $-\sigma\ln\theta$, for $\theta \geq 1$,the distribution has mode at 0. The failure rate function of Gompertz distribution is given by $\theta e^{t/\sigma}/\sigma$.

The mean of the Gompertz distribution is $\mu = F(T) = e^{\theta}\Gamma(0,\theta)\sigma$

where $\Gamma(s,x)=\int_x^{\infty} t^{s-1}e^{-t}dt$ is known as the upper incomplete gamma function. For the fixed shape parameter θ mean is directly proportional to the scale parameter σ.

Assume that the life time of a product follows Gompertz distribution and the quality of a product may be represented by its mean lifetime ,μ. The submitted lot will be accepted if the data supports the following null-hypothesis H_0: $\mu \geq \mu_0$ against the alternative hypothesis, H_1:$\mu < \mu_0$.The significance level for the test is 1-P* , where P* is the consumer's confidence level. Design of the sampling plans for the truncated life test consists of determination of (i) Sample sizes (ii) the ratio of true mean life to the specified mean life μ/μ_0 .

DESIGN OF THE ZERO-ONE DOUBLE SAMPLING PLAN

The operating procedure of zero-one double sampling plan for the truncated life test consists is as follows:

Select a random sample of size n_1 from the submitted lot and put on test for preassigned experimental time t_0.If there is no failure within the experimental time, accept the lot. If there are 2 or more failures within the experimental time ,reject the lot.

If the number of failures in the experimental time t_0 is 1 then select a second random sample of size n_2 and if the number of failures in the second sample is 0, accept the lot otherwise reject the lot.

It is more convenient to make a termination time as a multiple of the specified mean life μ_0, by assigning $t_0 = a\mu_0$ for the specified multiplier **a**. For a given P*, the proposed zero-one double sampling plan may be characterized by the parameters (n_1, n_2, θ, a).

The probability of accepting a lot under binomial model for zero-one double sampling is obtained by $(1-p)^{n_1}\left[1+n_1 p(1-p)^{n_2-1}\right]$

where p =F (t_0; θ, σ) is the probability of a failure during the time t_0 is $1-\exp\left[-\theta(e^{t_0/\sigma}-1)\right]$

$= 1-\exp\left[-\theta(e^{ae^{\theta}\Gamma(0,\theta)/(\mu/\mu_0)}-1)\right]$

The minimum sample sizes ensuring $\mu \geq \mu_0$ at the consumer's confidence level P*may be found as the solution of the inequality

$$(1-p)^{n_1}\left[1+n_1 p(1-p)^{n_2-1}\right] \leq 1-P^* \qquad (2)$$

Equation (2) gives multiple solutions for the sample sizes n_1 and n_2 .In order to find the unique sample sizes the minimum ASN is incorporated along with specification (2).The determination of the minimum sample sizes for zero-one double sampling plan reduces to

Minimize $$ASN = n_1 + n_1 n_2 p(1-p)^{n_1-1}$$

subject to $$(1-p)^{n_1}\left[1+n_1 p(1-p)^{n_2-1}\right] \leq 1-P^* \qquad (3)$$

where n_1 and n_2 are integers with $n_2 \leq n_1$.

DESIGN OF THE SPECIAL DOUBLE SAMPLING PLAN

The operating procedure of special double sampling plan for the truncated life test has the following steps:

Step 1: Draw a sample of size n_1 from the lot and put on the test for pre-assigned experimental time t_0 and observe the number of defectives d_1. If $d_1 \geq 1$ reject the lot.

Step 2: If $d_1 = 0$, draw a second random sample of size n_2 and put them on the test for time t_0 and observe the number of defectives d_2.If $d_2 \leq 1$ accept the lot, Otherwise reject the lot.

In a special double sampling plan the decision of acceptance is made only after inspecting the second sample. This aspect differs from usual double sampling plan in which decision of acceptance can be made with either the inspection of first or second sample. It is more convenient to make a termination time in terms of acceptable mean of lifetime μ_0 .

The probability of accepting a lot under binomial model for special double acceptance sampling is obtained by $(1-p)^{n_1+n_2}\left(1+\frac{n_2 p}{1-p}\right)$

where p =F (t_0; θ, σ) is the probability of a failure during the time t_0 is $1-\exp\left[-\theta(e^{t_0/\sigma}-1)\right]$ $=1-\exp\left[-\theta(e^{ae^{\theta}\Gamma(0,\theta)/(\mu/\mu_0)}-1)\right]$

The minimum sample sizes ensuring $\mu \geq \mu_0$ at the consumer's confidence level P*may be found as the solution of the inequality

$$(1-p)^{n_1+n_2}\left(1+\frac{n_2 p}{1-p}\right)\leq 1-P^* \tag{4}$$

Equation (4) provides multiple solutions for sample sizes n_1 and n_2 satisfying the specified consumer's confidence level. In order to find the unique sample sizes the minimum ASN is incorporated along with the probability of the acceptance of the lot less than or equal to 1-P* and $n_2 \leq n_1$.The determination of the minimum sample sizes for special double sampling plan reduces to

Minimize $$ASN = n_1 + n_2(1-p)^{n_1}$$

subject to $$(1-p)^{n_1+n_2}\left(1+\frac{n_2 p}{1-p}\right)\leq 1-P^* \tag{5}$$

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where n_1 and n_2 are integers.

Tables 1 and 2 are constructed to present the minimum sample sizes for the first and second sample with specified P*(=0.75,0.90,0.95,0.99),**a**(=0.4,0.6,0.8,1.0,1.5,2.0,2.5,3.0) and shape parameter θ (=1,2,3,4) under Gompertz distribution for zero-one double sampling plan and special double sampling plan using equation (3) and (5) respectively.The choice of **a** is consistent with the corresponding tables of Tsai and Wu[8],Gupta and Groll[4],Kantam et al.[6] and Aslam et al. [14].

Numerical values of Table 1 and 2 reveal that

(i) increase in P* increases the sample sizes irrespective of **a**

(ii) increase in **a** decreases the sample sizes irrespective of P*

(iii) increase in θ decreases the sample sizes irrespective of P*

Figure 1and 2 plots the required minimum first sample size versus $a=t_0/\mu_0$ for some selected values of the shape parameter θ. This figure indicates that first sample size decreases for increase in **a** with nonconstant rate.

OPERATING CHARACTERISTIC VALUES

The operating characteristic function of the proposed lifetest acceptance sampling plan depict the performance of the sampling plan in discriminating the quality of the submitted product. Tables 3 and 4 gives the operating characteristic values for zero-one double sampling plan and special double sampling plan under Gompertz distribution respectively.

Numerical values of Tables 3 and 4 reveal that

(i) increase in P* decreases the OC value for fixed **a** and μ/μ_0

(ii) increase in **a** decreases the OC value for fixed P* and μ/μ_0

(iii) increase in μ/μ_0 increases the OC value for fixed **a** and P*

Figure 3 and 4 shows the trend of OC values according to the quality levels for various values of θ of the Gompertz distribution.

MINIMUM MEAN RATIO

The minimum mean ratio, μ/μ_0 to keep the producer's risk and consumer's confidence at the required level, may be obtained by solving $P_a \geq 1-\alpha$ using the sample sizes presented in Tables 1and 2 are presented in Tables 5 and 6.

Numerical value in Tables 5 and 6 indicate that

(i) increase in **θ** decreases the minimum mean ratios for fixed P* and **a**

(ii) increase in **a** increases the minimum mean ratios for fixed P* and **θ**

(iii) increase in P* decreases the minimum mean ratios for fixed **a** and **θ**

ILLUSTRATION OF TABLES FOR ZERO-ONE DOUBLE SAMPLING PLAN

Assume that the life time of sleeve bearings follow Gompertz distribution with θ=1.Suppose that the experimenter would like to know whether the mean life time of sleeve bearings is longer than or equal to 40 million revolution with a confidence of 95%.The experimenter wants to truncate the experiment at 24 million revolutions.This leads to the experiment termination ratio a=0.6.Then from Table 1 gives the minimum sample sizes for the assumed specifications are n_1=8 and n_2=5.The selected zero-one double sampling plan for life test of sleeve bearings is put into operations as follows:

Select randomly 8 units as first sample from the lot and put on test for 24 million revolutions. Based on first sample results accept the lot if no failures in the specified test and reject the lot if there are more than one failure. Otherwise take a second sample of 5 units randomly and put them on test for 24 million revolutions.If no failure occurs accept the lot or else reject the lot.

ILLUSTRATION OF TABLES FOR SPECIAL DOUBLE SAMPLING PLAN

Assume that the life time of a product follows Gompertz distribution with parameter θ. Suppose that the experiment wants to know whether the mean life time of the product is longer than or equal to 730 days at 95% confidence level. The experimenter wants to run the experiment only for 438 days by applying special double sampling plan. This makes the termination time a=0.6 and the sample sizes as n_1=5 and n_2=5 for θ=1.The selected plan is applied as follows:

Select a random sample of 5 units from the lot and put them on test for 438 days. Reject the lot if the number of defectives is greater than or equal to one. If the number of failures is zero then select a second random sample of 5 units and put them on test. If the number of failures is less than or equal to 1 accept the lot otherwise reject the lot.

COMPARITIVE STUDY WITH SINGLE SAMPLING

The ASN values of single sampling plan, zero-one double sampling plan and special double sampling plan using Gompertz distribution with shape parameter θ=1 at consumer's confidence level P*=0.75 are obtained as follows:

plan \ a		0.4	0.6	0.8	1.0	1.5	2.0	2.5	3.0
SSP	C=0	6	4	3	2	1	1	1	1
	C=1	11	7	5	4	3	2	2	2
DSP(0,1)		8.6	5.5	4.2	3.3	2.3	1.8	1.9	1.9
SDSP		5.5	3.5	2.5	2.1	1.2	1.1	1.0	1.0

ASN value of zero-one double sampling acceptance plan is higher than the single sampling plan with c=0 and lesser than the single sampling plan with c=1 when the lifetime of the product under consideration follows Gompertz distribution.ASN values of special double sampling plan, using mean provide minimum sample size when compared with the zero-one double sampling plan and single sampling plan.This explains that special double sampling plan is economical.

CONCLUSION

In this paper, a truncated life test acceptance sampling plan is developed when the lifetime of the product follows the Gompertz distribution. The table for the minimum sample sizes required to guarantee a certain mean lifetime of the test items is presented .The operating characteristic function values and the associated producer's risk are also discussed .The proposed plans may be used for life testing. The determination of optimal parameters by using two points on the operating characteristic curve approach is on progress.

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Table 1 Minimum sample sizes for zero-one double sampling plan under Gompertz distribution

θ	P*	a= t_0/μ_0							
		0.4	0.6	0.8	1	1.5	2	2.5	3
1	0.75	7,5	4,4	3,3	3,1	2,1	1,1	1,1	1,1
	0.9	10,7	6,6	5,3	4,2	2,2	2,1	1,1	1,1
	0.95	12,10	8,5	6,3	4,4	3,1	2,1	2,1	1,1
	0.99	18,12	11,9	8,5	6,4	4,2	3,1	2,1	2,1
2	0.75	6,5	4,3	3,2	3,1	2,1	1,1	1,1	1,1
	0.9	9,6	6,4	4,4	3,3	2,2	2,1	2,1	1,1
	0.95	11,7	7,5	5,4	4,3	3,1	2,1	2,1	1,1
	0.99	15,15	10,7	7,7	6,3	4,2	3,1	2,1	2,1
3	0.75	6,4	4,3	3,2	2,2	2,1	1,1	1,1	1,1
	0.9	8,7	5,5	4,3	3,3	2,2	2,1	2,1	1,1
	0.95	10,8	7,4	5,3	4,3	3,1	2,1	2,1	2,1
	0.99	15,8	10,5	7,5	6,3	4,2	3,1	2,2	2,1
4	0.75	5,5	4,2	3,2	2,2	2,1	1,1	1,1	1,1
	0.9	8,6	5,5	4,3	3,3	2,2	2,1	2,1	1,1
	0.95	10,6	6,6	5,3	4,3	3,1	2,1	2,1	2,1
	0.99	14,10	9,8	7,4	6,2	4,2	3,1	2,2	2,1

Table 2 Minimum sample sizes for special double sampling plan under Gompertz distribution

θ	P*	a							
		0.4	0.6	0.8	1	1.5	2	2.5	3
1	0.75	5,2	3,2	2,2	2,1	1,1	1,1	1,1	1,1
	0.9	7,6	5,3	3,3	3,1	2,1	2,1	1,1	1,1
	0.95	8,8	5,5	4,3	3,3	2,2	2,1	1,1	1,1
	0.99	12,11	8,7	6,4	4,4	3,2	2,2	2,1	1,1
2	0.75	4,3	3,1	2,2	2,1	1,1	1,1	1,1	1,1
	0.9	6,5	4,3	3,3	3,1	2,1	2,1	1,1	1,1
	0.95	7,7	5,4	4,3	3,2	2,2	2,1	2,1	1,1
	0.99	10,10	7,6	5,5	4,4	3,2	2,2	2,1	2,1
3	0.75	4,2	3,1	2,1	2,1	1,1	1,1	1,1	1,1
	0.9	6,4	4,3	3,2	3,1	2,1	2,1	1,1	1,1
	0.95	7,6	5,4	4,2	3,2	2,2	2,1	2,1	1,1
	0.99	10,9	7,5	5,4	4,3	3,1	2,2	2,1	2,1
4	0.75	4,2	3,1	2,1	2,1	1,1	1,1	1,1	1,1
	0.9	5,5	4,3	3,2	3,1	2,1	2,1	1,1	1,1
	0.95	7,5	5,3	4,2	3,2	2,2	2,1	2,1	1,1
	0.99	9,9	6,6	5,4	4,3	3,2	2,2	2,1	2,1

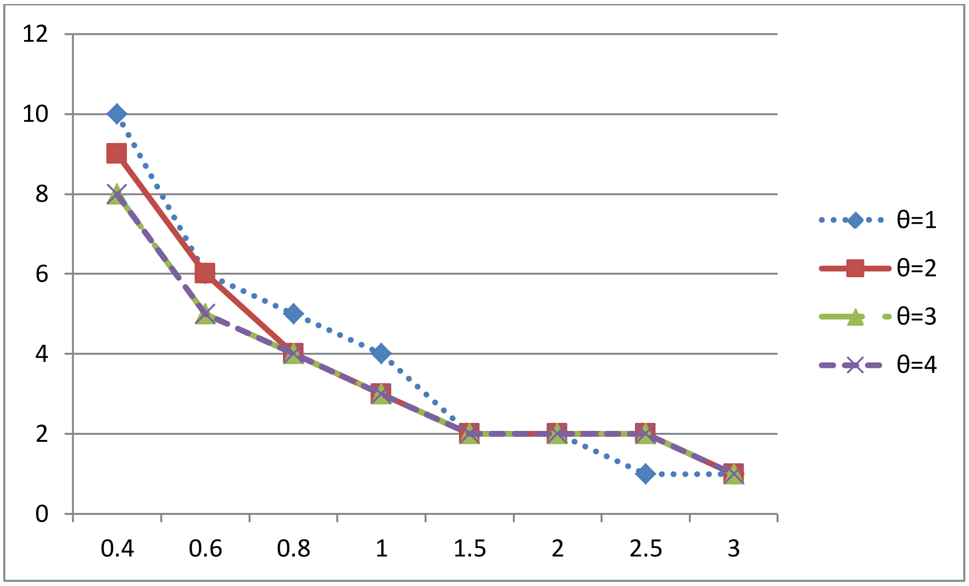

Fig 1 The first sample size Vs. experiment time for zero-one double sampling plan under Gompertz distributions when P*=0.90

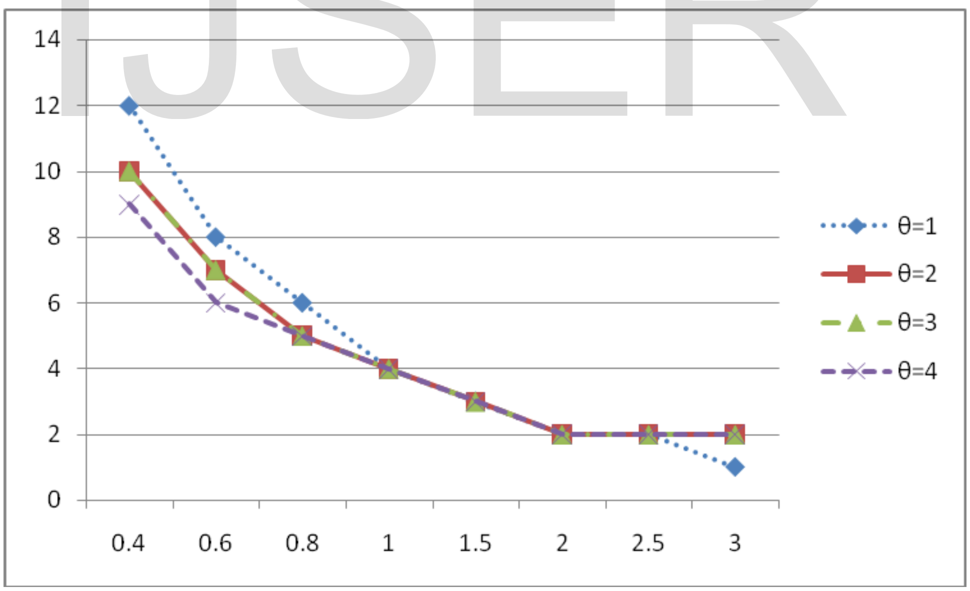

Fig.2 The first sample size Vs. experiment time for special double sampling plan under Gompertz distributions when P*=0.99

Table3 Operating Characteristic values for special double sampling plan under Gompertz distribution when θ =1

P*	t_0/μ_0	n_1	n_2	μ/μ_0				
				2	4	6	8	10
0.75	0.4	7	5	0.6187	0.8626	0.9309	0.9587	0.9725
	0.6	4	4	0.6373	0.8734	0.9371	0.9626	0.9753
	0.8	3	3	0.6299	0.8733	0.9377	0.9631	0.9757
	1	1	1	0.6632	0.8924	0.9485	0.9699	0.9803
	1.5	1	1	0.6027	0.8744	0.9404	0.9654	0.9775
	2	1	1	0.6891	0.9139	0.9610	0.9779	0.9858
	2.5	1	1	0.5517	0.8679	0.9396	0.9657	0.9779
	3	1	1	0.4155	0.8142	0.9139	0.9509	0.9683
0.9	0.4	10	7	0.4385	0.7639	0.8743	0.9225	0.9476
	0.6	6	6	0.4324	0.7619	0.8735	0.9222	0.9474
	0.8	5	3	0.4392	0.7759	0.8836	0.9293	0.9526
	1	4	2	0.4558	0.7916	0.8937	0.9361	0.9574
	1.5	2	2	0.4824	0.8148	0.9084	0.9458	0.9643
	2	2	1	0.4140	0.7922	0.8955	0.9404	0.9609
	2.5	1	1	0.5517	0.8679	0.9396	0.9657	0.9779
	3	1	1	0.4155	0.8142	0.9139	0.9509	0.9683
0.95	0.4	12	10	0.3185	0.6751	0.8182	0.8849	0.9209
	0.6	8	5	0.3442	0.7055	0.8397	0.9001	0.9320
	0.8	6	3	0.3628	0.7268	0.8544	0.9102	0.9394
	1	4	4	0.3523	0.7184	0.8493	0.9071	0.9371
	1.5	3	1	0.4222	0.7851	0.8924	0.9361	0.9576
	2	2	1	0.4141	0.7922	0.8985	0.9404	0.9609
	2.5	2	1	0.2554	0.6997	0.8485	0.9098	0.9404
	3	1	1	0.4155	0.8142	0.9139	0.9509	0.9683
0.99	0.4	18	12	0.1566	0.5114	0.7026	0.8031	0.8607
	0.6	11	9	0.1632	0.5233	0.7127	0.8109	0.8668
	0.8	8	5	0.1904	0.5711	0.7512	0.8397	0.8887
	1	6	4	0.2016	0.5908	0.7666	0.8512	0.8973
	1.5	4	2	0.2075	0.6203	0.7916	0.8701	0.9116
	2	3	1	0.2315	0.6632	0.8232	0.8924	0.9279
	2.5	2	1	0.2554	0.6997	0.8485	0.9098	0.9404
	3	2	1	0.1402	0.6027	0.7922	0.8744	0.9163

Table4 Operating Characteristic values for special double sampling plan under Gompertz distribution when θ =1

P*	t_0/μ_0	n_1	n_2	μ/μ_0				
				2	4	6	8	10
0.75	0.4	5	2	0.7815	0.8858	0.9227	0.9416	0.9531
	0.6	3	2	0.7964	0.8953	0.9296	0.9471	0.9575
	0.8	2	2	0.8111	0.9048	0.9365	0.9523	0.9619
	1	2	1	0.7762	0.8844	0.9221	0.9413	0.9529
	1.5	1	1	0.8221	0.9107	0.9404	0.9553	0.9642
	2	1	1	0.7638	0.8810	0.9206	0.9404	0.9523
	2.5	1	1	0.7065	0.8515	0.9008	0.9526	0.9404
	3	1	1	0.6504	0.8221	0.8810	0.9107	0.9285
0.9	0.4	7	6	0.6891	0.8378	0.8906	0.9175	0.9338
	0.6	5	3	0.6800	0.8304	0.8848	0.9128	0.9299
	0.8	3	3	0.7217	0.8579	0.9049	0.9286	0.9428
	1	3	1	0.6838	0.8316	0.8854	0.9132	0.9301
	1.5	2	1	0.6758	0.8293	0.8844	0.9126	0.9297
	2	2	1	0.5835	0.7762	0.8475	0.8844	0.9069
	2.5	1	1	0.7065	0.8515	0.9008	0.9255	0.9404
	3	1	1	0.6504	0.8221	0.8810	0.9107	0.9285
0.95	0.4	8	8	0.6409	0.8124	0.8738	0.9050	0.9239
	0.6	5	5	0.6596	0.8236	0.8815	0.9109	0.9286
	0.8	4	3	0.6529	0.8170	0.8761	0.9064	0.9248
	1	3	3	0.6571	0.8231	0.8814	0.9108	0.9285
	1.5	2	2	0.6544	0.8227	0.8812	0.9108	0.9285
	2	2	1	0.5835	0.7762	0.8475	0.8844	0.9069
	2.5	1	1	0.7065	0.8515	0.9008	0.9255	0.9404
	3	1	1	0.6504	0.8221	0.8810	0.9107	0.9285
0.99	0.4	12	11	0.5041	0.7282	0.8146	0.8596	0.8871
	0.6	8	7	0.5058	0.7294	0.8153	0.8601	0.8874
	0.8	6	4	0.5222	0.7363	0.8189	0.8623	0.8889
	1	4	4	0.5591	0.7667	0.8426	0.8814	0.9049
	1.5	3	2	0.5380	0.7492	0.8287	0.8700	0.8953
	2	2	2	0.5509	0.7652	0.8421	0.8812	0.9048
	2.5	2	1	0.4992	0.7250	0.8114	0.8566	0.8844
	3	1	1	0.6504	0.8221	0.8810	0.9107	0.9285

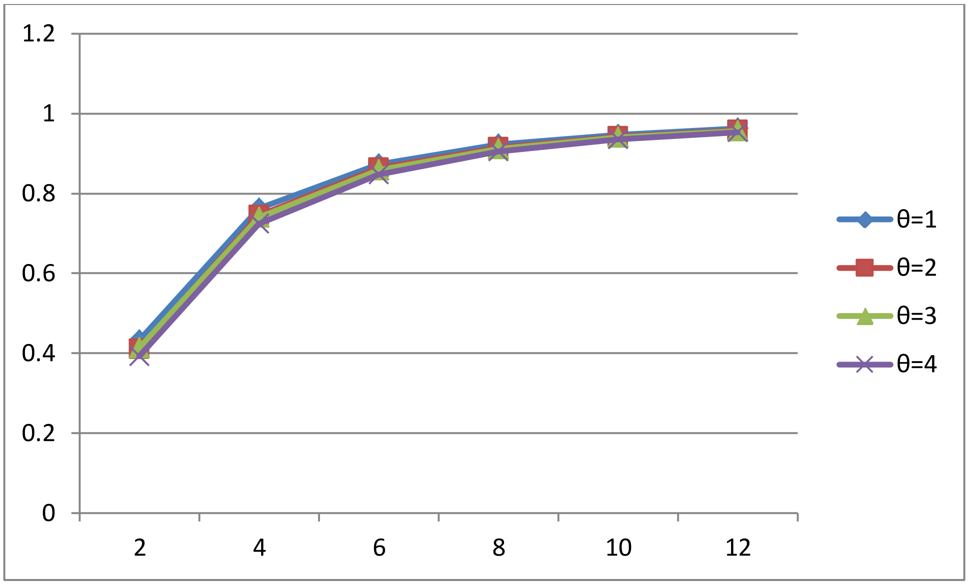

Fig 3 OC curves of zero-one double sampling plan under Gompertz distribution with P*=0.90 and a = 0.6

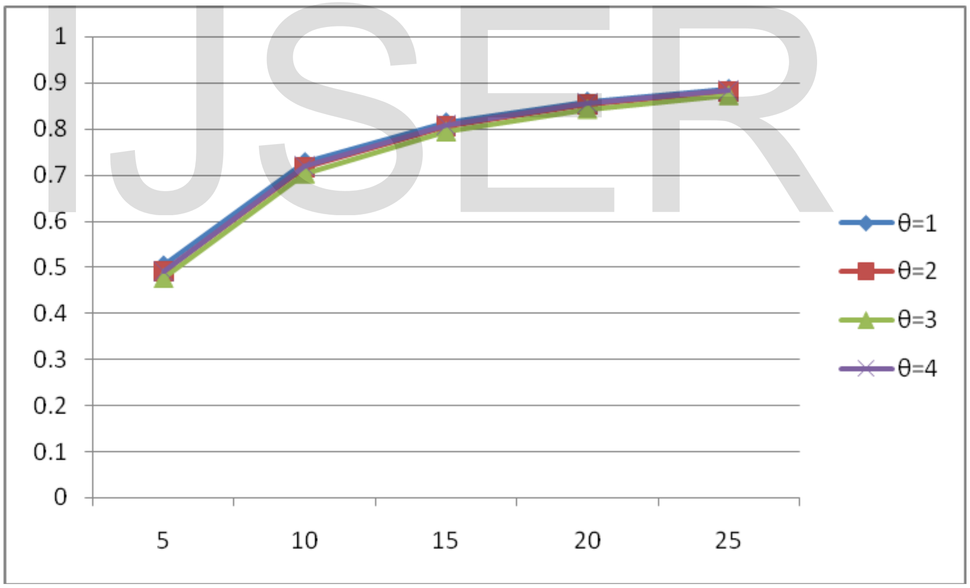

Fig 4 OC curves of special double sampling plan under Gompertz distribution with P*=0.99 and $t_0/\mu_0 = 0.6$

Table 5 Minimum mean ratios of zero-one double sampling plan under Gompertz distribution

θ	P*	a = t_0/μ_0							
		0.4	0.6	0.8	1	1.5	2	2.5	3
1	0.75	0.0542	0.0832	0.1197	0.1552	0.2517	0.3999	0.5072	0.6099
	0.90	0.0469	0.0769	0.1097	0.1452	0.2497	0.3399	0.4972	0.5899
	0.95	0.0449	0.0739	0.1047	0.1392	0.2307	0.3449	0.4262	0.5899
	0.99	0.0419	0.0689	0.0987	0.1292	0.2167	0.3139	0.4262	0.5179
2	0.75	0.0512	0.0832	0.1187	0.1502	0.2417	0.3679	0.4572	0.5399
	0.90	0.0484	0.0779	0.1097	0.1452	0.2377	0.3209	0.3972	0.5499
	0.95	0.0469	0.0749	0.1067	0.1392	0.2217	0.3209	0.4032	0.5389
	0.99	0.0439	0.0719	0.0997	0.1292	0.2087	0.3009	0.4042	0.4779
3	0.75	0.0482	0.0762	0.1067	0.1412	0.2127	0.3179	0.3972	0.4779
	0.90	0.0459	0.0732	0.1017	0.1312	0.2127	0.2879	0.3572	0.4779
	0.95	0.0443	0.0699	0.0977	0.1272	0.1999	0.2839	0.3562	0.4289
	0.99	0.0420	0.0699	0.0939	0.1192	0.1907	0.2709	0.3482	0.4279
4	0.75	0.0442	0.0690	0.0957	0.1252	0.1917	0.2779	0.3472	0.4109
	0.90	0.0442	0.0659	0.0917	0.1182	0.1877	0.2539	0.3172	0.4109
	0.95	0.0412	0.0649	0.0897	0.1152	0.1807	0.2539	0.3172	0.3789
	0.99	0.0392	0.0619	0.0857	0.1102	0.1737	0.2429	0.3152	0.3789

Table 6 Minimum mean ratios of special double sampling plan under Gompertz distribution

θ	P*	t_0/μ_0							
		0.4	0.6	0.8	1	1.5	2	2.5	3
1	0.75	0.0432	0.0692	0.0997	0.1292	0.2267	0.2909	0.3692	0.4399
	0.90	0.0399	0.0639	0.0947	0.1192	0.1917	0.2519	0.3672	0.4499
	0.95	0.0388	0.0629	0.0897	0.1182	0.1907	0.2549	0.3662	0.4499
	0.99	0.0368	0.0589	0.0837	0.1102	0.1787	0.2499	0.3162	0.4469
2	0.75	0.0452	0.0712	0.0999	0.1292	0.2207	0.2909	0.3682	0.4399
	0.90	0.0442	0.0689	0.0949	0.1202	0.1907	0.2509	0.3682	0.4399
	0.95	0.0412	0.0659	0.0919	0.1202	0.1907	0.2509	0.3202	0.4399
	0.99	0.0392	0.0629	0.0879	0.1142	0.1807	0.2509	0.3202	0.3799
3	0.75	0.0432	0.0672	0.0939	0.1192	0.1997	0.2609	0.3182	0.3899
	0.90	0.0402	0.0632	0.0889	0.1122	0.1767	0.2349	0.3292	0.3899
	0.95	0.0392	0.0622	0.0860	0.1122	0.1767	0.2349	0.2952	0.3939
	0.99	0.0379	0.0602	0.0837	0.1072	0.1677	0.2349	0.2952	0.3539
4	0.75	0.0392	0.0612	0.0859	0.1082	0.1787	0.2389	0.2982	0.3499
	0.90	0.0382	0.0592	0.0819	0.1022	0.1617	0.2169	0.2982	0.3499
	0.95	0.0372	0.0582	0.0789	0.1022	0.1617	0.2169	0.2682	0.3499
	0.99	0.0362	0.0562	0.0769	0.0989	0.1517	0.2169	0.2682	0.3199