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Research Article

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Correlation and Path Analysis for Neps in Cotton (*Gossypium hirsutum* L.)

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Abstract Ginned lint mostly includes seed coat nep and nep and, their existence causes problems in the cotton final product. This study was conducted to determine the relationships between nep and other agronomic and quality characters using correlation and path analysis. The data was obtained from the F_1 population (24 reciprocal) and their parents (4 lines and 3 testers) via line x tester mating design. Seed coat nep count was significantly negative correlated with boll number (r= -0.55*), first boll opening days (r= -0.51*), number of sympodial branch/plant (r= -0.56*) and maturity (r= -0.62). Seed coat nep size exhibited a significant and negative correlation with the number of sympodial branch/plant (r= -0.54*), whereas the correlation coefficients of seed coat nep size with maturity and elongation were significant and positive. Nep count significantly negative correlated with fiber strength (r= -0.56*) and uniformity (r= -0.55*) but positively correlated with elongation (r=0.57*) while nep size showed negative significant correlation with agronomic traits such as seed cotton yield/plant, boll weight, 100 seed weight, plant height and first boll opening days. The direct effect of elongation and indirect effects through elongation were found to be high for all four characters examined in terms of nep.

Keywords Correlation, elongation, nep, path analysis, seed coat nep

1. Introduction

The cotton fiber is utilized to turn into yarn which is additionally utilized for making socks, draperies, and towels, and so on. Its fiber additionally devoured in the material industry for fabric making [7]. Cotton, a cash crop, has very important for breeders to improve the target characteristics of genetic architecture due to economic importance in growing areas [5]. The morphological, anatomical, physiological, agronomic and quality characteristics are complex trait are affected by genetics and environmental conditions [8]. The relationships among characters affected yield and economic quality traits and estimate of correlations were found to be important to select of genotype with high yield and favorable fiber performance in designing and evaluating cotton breeding programs [5, 6].

There are complains of cotton fabrics about the high micronaire, short fiber and high neps in many cotton producer countries. Due to little or no secondary wall thickening, significant amounts of immature fiber caused the neps formation, provokes irregularities in yarn; leads to non-uniform dyeing of fabrics; and decreases processing efficiencies [4]. The manipulation of the fibers during processing sourced mechanical neps with entangled fiber clusters [1, 2], whereas the parts of a seed coat that have been broken from the surface of either mature or immature seeds during mechanical processing have been defined as seed coat fragments [3].

Although many studies have examined the correlation coefficients between yield and quality characteristics in cotton, the relationships between nep and seed coat nep (SCN) and yield components and fiber properties have been evaluated in very few studies. The correlation coefficients between lint yield and nep and SCN count were found to be significant and negative (favorable), unfavorable correlations were identified for nep count vs. fineness and SCN count vs. fiber bundle strength (r= 0.60) [9]. The significant and negative correlation between nep count and micronaire is supported by other researchers [10]. Similarly, nep count was unfavorably correlated to 2.5% span length [9]. The same researchers emphasized that a significant positive correlation between nep count and immature fiber content indicate the effect of maturity on nep content in ginned fibers. In addition, nep formation can be influenced by maturity and fineness [1], it was revealed that micronaire was more strongly related than maturity ratio [4].

The characteristics of nep and seed coat nep are correlated naturally yield, yield components and fiber quality, determination of relationship among traits will help breeders designating characters that may be simultaneously improved for target characters such as nep and seed coat nep. This study was aimed to determine the correlation among neps and other characters and to define the direct effects on neps through path analysis.

2. Materials and Methods

The data used for correlation and path analysis were obtained from the population mated as a result of line x tester crosses. The line varieties vz. Gloria, Claudia, Carmen and Julia with superior color grade and tester varieties vz. ST-468, Carisma and Flash with low SCN count and size and adaptation capacity were reciprocally crossed to derive 24 F_1 populations. The SCN count for lines were higher (11.25 - 16.70 number g^{-1}) than that of testers (25.80 - 34.75 number g^{-1}) in our preliminary study. The experiment was performed at Nazilli Cotton Research Institute (latitude 31°25′N, longitude 73°09′E, and latitude 184.4 m from sea level) Aydın, Turkey. The parents and F_1, totally 31 genotypes, were planted in RCBD with 3 replicates in May 2014. Each plot consisted of a single row of 12 m in length (row spaces= 0.7 m, plant to plant= 0.2 m). The 20 randomized plants from all parcels were sampled and, samples were ginned on roller gins (laboratory type) with no lint cleaning.

The measured agronomical characters were boll number $plant^{-1}$, boll weight (g), plant height (cm), first flowering days, first boll opening days, seed cotton yield $plant^{-1}$, 100 seed weight, number of monopodial branch $plant^{-1}$, number of sympodial branch $plant^{-1}$. The fiber fineness (mic.), fiber length (cm), fiber strength (g tex^{-1}), fiber moisture, fiber maturity, uniformity, short fiber content (%) and elongation were tested in high volume instruments (HVI). Fiber properties of nep size (µm), nep count (number g^{-1}), seed coat nep size (SCN; µm), seed coat nep count (SCN; number g^{-1}), totally nep count (number g^{-1}), and totally nep size (µm) were detected using USTER AFIS.

The estimates of phenotypic correlation were worked out by using the formula [11]. Correlation coefficients were partitioned into path coefficients to determine direct and indirect effects [12]. The correlation and path analysis was carried out using TARPOPGEN statistical program [16]. Nep size, nep count, seed coat nep size and seed coat nep count were separately considered as dependent variables and, other characters were considered as independent variables.

3. Results and Discussions

Seed coat nep count was significantly negative correlated with boll number (r= -0.55*), first boll opening days (r= -0.51*), number of sympodial branch/plant (r= -0.56*), maturity (r= -0.62), whereas the correlation coefficient between seed coat nep count and elongation was significant and positive (r= 0.59**). Seed coat nep size exhibited a significant and negative correlation with the number of sympodial branch/plant (r= -0.54*). It was found that the correlation coefficients of seed coat nep size with maturity and elongation were significant and positive (Table 1). Similarly, a study evaluated correlations with seed coat neps, SCN count significant and negative correlated with lint yield, but the correlations between SCN count and fiber strength, SCN count and fiber length were significant and positive [9]. It can be said that the increase in lint yield by simultaneous selection can reduce SCN count in cotton breeding. In another study, fiber strength, reflectance and upper quartile length were significant and negative correlated with SCN count whereas the correlation coefficient

between SCN count and fineness was significant and positive [13]. On the contrary, it was reported that SCF count did not change significantly with fiber fineness [10].

Table 1: Correlation coefficients among studied characters

Chr.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	0,65**	0,57*	-0,09	0,50*	-0,04	0,13	0,06	0,32	0,49*	0,08	0,07	0,28	-0,22	-0,25	0,18	-0,54*	-0,63**	0,34	0,09	0,08	-0,38	-0,30
2	**1,00**	0,28	0,06	0,16	-0,13	0,32	0,15	0,51*	0,57*	0,05	0,42	-0,01	-0,55*	0,00	-0,09	-0,21	-0,58**	-0,07	0,36	0,33	-0,36	-0,26
3		**1,00**	-0,27	0,63**	-0,06	-0,26	-0,08	0,11	0,60**	0,56*	0,30	0,50*	-0,17	0,22	0,12	-0,58*	-0,22	0,33	0,25	0,20	-0,28	-0,58**
4			**1,00**	-0,71**	0,11	0,17	-0,18	0,02	-0,29*	-0,12	0,09	-0,28*	-0,28	0,16	-0,01	0,06	0,14	-0,30*	0,23	0,38	-0,21	0,05
5				**1,00**	0,17	-0,33	0,10	-0,08	0,52*	0,25	0,00	0,51*	0,03	-0,07	0,15	-0,51*	-0,30	0,52*	0,02	-0,29	-0,08	-0,27
6					**1,00**	-0,14	0,08	-0,49*	-0,26	0,03	-0,38	0,07	0,17	0,10	0,10	-0,49*	0,17	0,46*	0,01	0,00	-0,42	0,14
7						**1,00**	0,17	0,32	-0,11	-0,31	0,15	-0,14	0,24	-0,08	-0,19	0,18	-0,28	-0,23	-0,24	0,23	-0,20	0,21
8							**1,00**	0,19	-0,17	-0,13	-0,15	0,15	-0,51*	0,17	-0,18	-0,54*	0,00	-0,13	0,14	0,27	-0,16	-0,26
9								**1,00**	0,29	-0,09	0,60**	-0,17	-0,56*	-0,54*	-0,24	-0,05	-0,24	-0,48*	0,08	0,35	-0,21	0,01
10									**1,00**	0,31	0,49*	0,30	-0,07	0,00	-0,15	-0,15	-0,20	0,11	0,28	-0,04	0,02	-0,38
11										**1,00**	0,04	0,52*	0,03	0,20	-0,13	-0,05	-0,08	0,30	0,11	0,40	-0,40	-0,33
12											**1,00**	-0,15	-0,29	-0,05	-0,18	-0,04	0,06	-0,45	0,29	0,17	0,09	-0,11
13												**1,00**	-0,16	0,26	-0,56*	0,06	0,12	0,47*	0,19	0,31	-0,41	-0,56*
14													**1,00**	-0,12	0,24	0,17	-0,06	0,36	-0,62**	-0,41	0,21	0,59**
15														**1,00**	-0,10	-0,02	0,22	0,06	0,53*	0,33	-0,06	0,51*
16															**1,00**	-0,15	-0,36	0,28	-0,27	-0,55*	0,24	0,57*
17																**1,00**	-0,01	-0,19	-0,33	-0,13	0,30	0,34
18																	**1,00**	-0,10	0,17	0,05	0,18	-0,05
19																		**1,00**	0,05	-0,04	-0,35	-0,02
20																			**1,00**	0,53*	-0,26	-0,70**
21																				**1,00**	-0,76**	-0,42
22																					**1,00**	0,21

1: Yield; 2: Boll number; 3: Boll weight; 4: Ginning out-turn; 5: Seed index; 6: Plant height; 7:First flowering days; 8: First boll open days; 9: Sympodial branch; 10: Monopodial branch; 11: Fiber lenght; 12: Fiber fineness; 13: Fiber strenght; 14: Seed coat nep count; 15: Seed coat nep size; 16: Nep count; 17: Nep size; 18:SCI; 19: Moisture; 20: Maturity; 21: Uniformite; 22: Short fiber; 23: Elongation

Table 2: The percentage of direct and indirect effects of independent variables on seed coat nep count

Chr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**2,7**	1,9	-5,3	1,6	-14,4	-1,4	-0,2	0,1	6,4	-6,1	0,2	1,2	3,1	5,9	6,5	-0,1	-0,3	-7,0	11,4
2	2,1	**3,6**	-3,1	-1,4	-5,7	-5,6	-0,5	0,4	12,5	-8,7	0,1	8,8	-0,1	6,7	-1,5	-0,9	-1,5	-8,2	12,3
3	1,3	0,7	**-7,9**	4,4	-15,7	-1,9	0,3	-0,1	1,7	-6,4	1,0	4,4	4,7	1,8	5,5	-0,5	-0,6	-4,4	19,0
4	-0,3	0,2	3,2	**-23,9**	26,3	5,0	-0,3	-0,5	0,4	4,7	-0,3	2,0	-4,0	-1,7	-7,3	-0,6	-1,7	-5,1	-2,3
5	1,2	0,4	-5,3	12,1	**-26,7**	5,5	0,4	0,2	-1,5	-5,9	0,5	0,1	5,1	2,5	9,1	-0,1	1,0	-1,4	9,5
6	-0,1	-0,4	0,6	-2,1	-4,9	**35,4**	0,2	0,2	-9,6	3,2	0,1	-6,4	0,7	-1,6	8,6	-0,1	0,0	-7,7	-5,4
7	0,5	1,4	3,5	-4,7	14,1	-7,2	**-1,8**	0,5	9,2	2,0	-0,9	3,9	-2,3	3,8	-6,3	0,7	-1,2	-5,4	-12,0
8	0,3	0,8	1,2	5,7	-4,9	4,8	-0,4	**3,6**	6,4	3,6	-0,4	-4,3	2,9	0,1	-4,1	-0,5	-1,6	-5,1	16,6
9	0,9	1,5	-1,0	-0,3	2,4	-17,1	-0,4	0,4	**19,5**	-3,6	-0,2	1,1	-1,9	2,2	-9,1	-0,2	-1,2	-3,7	-0,3
10	1,3	1,7	-5,6	5,5	-15,1	-9,1	0,1	-0,4	5,8	**-12,4**	0,6	8,3	3,3	1,9	2,2	-0,6	0,1	0,4	14,5
11	0,3	0,2	-7,2	3,0	-10,1	1,4	0,5	-0,4	-2,6	-5,3	**2,7**	1,0	8,0	1,0	7,9	-0,3	-1,9	-10,3	17,3
12	0,2	1,5	-3,4	-2,1	-0,1	-16,3	-0,2	-0,4	14,5	-7,4	0,1	**20,9**	-2,0	-0,7	-10,5	-0,7	-0,7	2,0	5,3
13	0,7	-0,1	-4,3	4,9	-13,8	2,2	0,2	0,3	-3,2	-3,4	1,0	-2,4	**10,3**	-1,0	8,3	-0,4	-1,0	-7,1	19,9
14	-2,5	-2,5	3,1	-4,0	12,9	9,1	0,5	-0,0	-7,1	3,8	-0,2	1,6	2,0	**-14,0**	-2,7	-0,5	-0,3	5,1	2,7
15	0,9	-0,2	-2,9	5,4	-14,4	15,4	0,3	-0,3	-9,1	-1,3	0,6	-7,4	4,9	0,9	**18,1**	-0,1	0,1	-6,2	0,8
16	0,3	1,2	-2,7	-4,9	-0,6	0,3	0,3	0,3	1,8	-4,0	0,3	5,8	2,4	-1,8	1,1	**-2,4**	-2,2	-5,5	30,6
17	0,2	1,1	-2,0	-7,9	9,5	-0,1	-0,3	0,6	7,7	0,5	0,9	3,2	3,8	-0,5	-0,8	-1,2	**-3,9**	-15,7	17,9
18	-1,1	-1,2	2,8	4,5	2,7	-16,5	0,3	-0,4	-4,5	-0,3	-0,9	1,7	-5,0	-1,9	-7,5	0,6	3,0	**20,5**	-8,9
19	-0,7	-0,7	4,8	-0,8	7,2	4,5	-0,2	-0,5	0,1	4,3	-0,6	-1,8	-5,6	0,4	-0,4	1,3	1,3	3,5	**-34,5**

1: Yield; 2: Boll number; 3: Boll weight; 4: Ginning out-turn; 5: Seed index; 6: Plant height; 7:First flowering days; 8: First boll open days; 9: Sympodial branch; 10: Monopodial branch; 11: Fiber lenght; 12: Fiber fineness; 13: Fiber strenght; 14:SCI; 15: Moisture; 16: Maturity; 17: Uniformite; 18: Short fiber; 19: Elongation

The highest negative (favorable) direct effect on SCN count was exerted by elongation (34.5%) followed by 100 seed weight (26.7%) and ginning out-turn (23.9), whereas plant height had the highest positive (unfavorable) direct effect (35.4%). The indirect effect of first flowering days through elongation was negative in direction (Table 2).

Maturity, fiber strength, boll weight, uniformity, fiber length, first flowering days, boll number and seed cotton yield/plant had positive indirect effects through elongation. When direct effects on SCN size were evaluated, high and negative (favorable) values were recorded in elongation (32.4%), ginning out-turn (23.4%) and boll weight (14.3%), respectively. The direct effects of plant height (27.1%), SCI (21.8%) and boll number (16.7%) were high and positive (unfavorable). Maturity, uniformity and fiber length through elongation; ginning out-turn through 100 seed weight exhibited positive indirect effects through elongation. Although elongation exhibited a positive relationship with SN count, the direct effect of elongation on SCN count was the highest and negative direct and indirect effects of fiber strength, boll weight, uniformity, fiber length, first flowering days, boll number and seed cotton yield/plant trough elongation were positive. This indicated that the correlation between elongation and SCN count explained the false relationship, and direct selection of elongation will be effective on SCN count but positive indirect effects through elongation should be considered. The selection of short plants with high elongation, ginning out-turn and 100 seed weight can be successful for breeding aimed at reducing SCN count.

Table 3: The percentage of direct and indirect effects of independent variables on seed coat nep size

Chr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**12,6**	9,8	-8,8	1,1	-4,3	-0,8	-0,3	0,3	-0,2	-5,0	0,2	0,6	-0,3	-9,7	-3,5	0,1	0,1	2,5	11,9
2	8,9	**16,7**	-4,6	-0,8	-1,5	-2,8	-0,8	0,7	-0,4	-6,4	0,1	4,1	0,0	-9,8	0,7	0,2	0,5	2,6	11,3
3	6,7	3,9	**-14,3**	3,1	-5,1	-1,1	0,6	-0,3	-0,1	-5,8	1,2	2,5	-0,5	-3,2	-3,2	0,1	0,2	1,7	21,4
4	-2,1	1,7	8,0	**-23,4**	11,7	4,2	-0,8	-1,5	-0,1	5,8	-0,5	1,6	0,6	4,3	5,9	0,2	0,9	2,6	-3,6
5	7,1	2,8	-11,1	10,0	**-10,0**	3,8	0,9	0,5	0,1	-6,1	0,7	0,0	-0,6	-5,2	-6,1	0,1	-0,4	0,6	12,4
6	-0,7	-2,7	1,3	-1,9	2,0	**27,1**	0,4	0,5	0,4	3,6	0,1	-4,7	-0,1	3,7	-6,4	0,1	0,0	3,7	-7,7
7	2,5	7,5	6,1	-3,2	4,3	-4,1	**-3,6**	1,2	-0,3	1,7	-1,1	2,1	0,2	-6,5	3,5	-0,2	0,4	1,9	-12,9
8	1,2	3,8	2,0	3,6	-1,4	2,6	-0,7	**7,2**	-0,2	2,9	-0,5	-2,2	-0,3	-0,0	2,1	0,1	0,5	1,7	16,7
9	5,5	10,5	-2,3	-0,3	1,0	-13,1	-1,0	1,1	**-0,9**	-4,1	-0,3	7,3	0,3	-5,0	6,7	0,1	0,6	1,8	-0,4
10	6,7	9,8	-10,2	4,0	-4,9	-5,5	0,3	-0,8	-0,2	**-11,3**	0,8	4,8	-0,4	-3,4	-1,3	0,2	-0,1	-0,1	16,6
11	1,8	1,4	-16,1	2,7	-4,0	1,0	1,4	-1,1	0,1	5,9	**4,4**	0,7	-1,0	-2,3	-5,8	0,1	0,9	4,9	24,2
12	1,2	9,3	-6,8	-1,7	-0,0	-10,9	-0,5	-1,0	-0,6	-7,3	0,1	**13,2**	0,2	1,4	6,8	0,2	0,3	-0,8	6,6
13	4,0	-0,1	-8,8	3,9	-5,0	1,5	0,4	0,8	0,1	-3,5	1,4	-1,5	**-1,2**	2,1	-5,4	0,1	0,4	3,0	25,2
14	-11,1	-12,4	4,8	-2,5	3,6	4,8	0,9	-0,0	0,2	2,9	-0,3	0,8	-0,2	**21,4**	1,4	0,1	0,1	-1,7	2,7
15	5,4	-1,2	-6,5	4,7	-5,7	11,3	0,7	-0,7	0,4	-1,5	0,9	-5,2	-0,6	-1,9	**-12,9**	0,0	-0,1	2,9	1,1
16	1,1	5,5	-3,9	-2,8	-0,1	0,1	0,6	0,6	-0,1	-2,9	0,3	2,6	-0,2	2,6	-0,5	**0,5**	0,7	1,7	27,5
17	1,2	6,1	-3,7	-5,7	3,1	-0,1	-0,7	1,4	-0,3	0,5	1,1	1,9	-0,4	0,9	0,4	0,3	**1,5**	6,0	20,3
18	-6,1	-7,0	5,4	3,4	0,9	-10,5	0,6	-0,9	0,2	-0,3	-1,2	1,0	0,6	3,6	4,6	-0,2	-1,2	**-8,2**	-10,6
19	-3,1	-3,2	7,3	-0,5	1,9	2,3	-0,4	-0,9	-0,0	3,2	-0,6	-0,8	0,5	-0,6	0,2	-0,3	-0,4	-1,1	**-32,4**

1: Yield; 2: Boll number; 3: Boll weight; 4: Ginning out-turn; 5: Seed index; 6: Plant height; 7:First flowering days; 8: First boll open days; 9: Sympodial branch; 10: Monopodial branch; 11: Fiber lenght; 12: Fiber fineness; 13: Fiber strenght; 14:SCI; 15: Moisture; 16: Maturity; 17: Uniformite; 18: Short fiber; 19: Elongation

When the correlations of nep size and count with other characters, nep size significantly negative correlated with fiber strength (r= -0.56*) and uniformity (r= -0.55*) but positively correlated with elongation (r=0.57*). Results revealed that nep count showed a negative significant correlation with agronomic traits such as seed cotton yield/plant, boll weight, 100 seed weight, plant height and first boll opening days (Table 1). It was found that nep counts were negatively associated with lint yield, whereas nep count negatively correlated with fiber fineness, fiber strength and 2.5% span length [9]. It was emphasized that a significantly positive correlation between nep count and immature fiber content indicate the effect of maturity on nep content in ginned fibers [9], nep formation can be influenced by maturity and fineness [1] and finally, fiber fineness was more strongly related than maturity ratio [4]. In addition, the nep content of the final product is due to low uniformity and high short fiber index [14].

Plant height (37.2%), fiber fineness (19.9%) and boll number (15.1) showed a high and negative (favorable) direct effect on nep count but elongation (39.1%), ginning out-turn (25.2%) and 100 seed weight (21.9) had high and positive (unfavorable) effects. Indirect effects of maturity (35.4%), fiber strength (28.5%), uniformity (24.7%), boll weight (23.0%) and first boll opening days (20.4%) through on elongation were high and negative in direction (Table 4). As for the nep size, the results of path analysis showed that the highest and negative direct effects were recorded in plant height (41.9%) and fiber fineness (18.1%). Direct effects of elongation (37.8%), ginning out-turn (26.2%) and 100 seed weight (18.6%) were high and positive (unfavorable). Besides the direct effects of elongation, indirect effects of moisture (33.9), fiber strength (28.3), fiber length (26.2%),

boll weight (25.6%), uniformity (23.9%) and first boll opening days (21.7%) were high and negative, respectively (Table 5). It was emphasized that fiber fineness and fiber length had the highest direct effects on nep count according to the results of path analysis and lower fiber fineness and longer fiber length caused an increase in nep count [15].

Table 4: The percentage of direct and indirect effects of independent variables on nep count

Chr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**-7,1**	-8,4	8,5	-1,5	10,8	1,3	0,2	-0,2	-4,4	7,2	-0,2	-1,0	-2,3	2,6	-1,6	0,1	0,1	3,1	-13,9
2	-5,4	**-15,1**	4,8	1,2	4,0	4,9	0,7	-0,5	-8,0	9,7	-0,2	-7,0	0,1	2,8	0,4	0,4	0,7	3,5	-14,2
3	-3,5	-3,0	**12,6**	-4,0	11,6	1,7	-0,4	0,2	-1,3	7,5	-1,3	-3,7	-3,5	0,8	-1,4	0,2	0,3	1,9	-23,0
4	0,9	-1,1	-5,9	**25,2**	22,3	5,3	0,5	0,7	0,3	6,3	0,5	1,9	3,4	0,9	2,1	0,3	1,0	2,6	3,3
5	-3,6	-2,1	9,7	-12,3	**21,9**	-5,6	-0,6	-0,3	1,1	7,6	-0,7	-0,1	-4,3	1,2	-2,5	0,1	-0,5	0,7	-12,8
6	0,3	1,9	-1,1	2,2	4,2	**-37,2**	-0,3	-0,3	7,4	-4,2	-0,1	6,1	-0,6	-0,8	-2,5	0,0	0,0	3,9	7,5
7	-1,5	-6,8	-6,3	4,8	-11,5	7,3	**2,9**	-0,8	-6,9	-2,5	1,4	-3,6	1,9	1,8	1,8	-0,4	0,7	2,6	16,1
8	-0,7	-3,4	-2,0	-5,3	3,7	-4,5	0,5	**-4,7**	-4,4	-4,2	0,6	3,6	-2,2	0,0	1,1	0,2	0,8	2,3	-20,4
9	-2,7	-7,7	1,9	0,4	-2,1	18,6	0,7	-0,6	**-15,5**	5,0	0,3	-10,0	1,7	1,1	2,7	0,1	0,7	2,0	0,4
10	-3,4	-7,2	8,8	-5,0	10,9	8,2	-0,2	0,5	-3,8	**14,3**	-0,8	-6,8	-2,4	0,8	-0,5	0,3	-0,1	-0,2	-17,3
11	-0,9	-1,0	12,9	-3,1	8,3	-1,4	-0,9	0,5	1,9	6,9	**-4,2**	-0,9	-6,7	0,5	-2,2	0,2	1,1	5,1	-23,5
12	-0,7	-7,6	6,2	2,2	0,1	17,1	0,4	0,6	-11,2	0,9	-0,2	**-19,9**	1,7	-0,4	3,0	0,4	0,4	-1,0	-7,3
13	-2,2	0,1	8,2	-5,3	12,0	-2,4	-0,3	-0,5	2,5	4,7	-1,5	2,3	**-9,1**	-0,5	-2,5	0,2	0,6	3,7	-28,5
14	7,6	12,7	-5,6	4,2	-10,8	-9,5	-0,8	0,0	5,4	-5,0	0,4	-1,5	-1,7	**-6,9**	0,8	0,3	0,1	-2,5	-3,8
15	-3,0	1,6	6,2	-6,5	14,0	-18,6	-0,5	0,4	8,1	2,1	-1,0	8,9	-4,8	0,5	**-6,0**	0,1	0,1	3,6	1,3
16	-0,7	-5,1	4,1	4,3	0,4	-0,3	-0,5	-0,4	-1,1	4,5	-0,3	-4,5	-1,7	-0,8	-0,3	**1,0**	1,0	2,3	-35,4
17	-0,7	-5,4	3,7	8,3	-8,0	0,1	0,5	-0,9	-5,9	-0,7	-1,3	-3,0	-3,2	-0,2	0,2	0,6	**2,2**	7,9	-24,7
18	3,5	6,1	-5,3	-4,8	-2,3	17,9	-0,5	0,6	3,6	0,4	1,4	-1,7	4,5	-1,0	2,2	-0,3	-1,8	**-10,7**	12,7
19	1,8	2,8	-7,2	0,7	-4,9	-3,9	0,3	0,6	-0,1	-4,7	0,7	1,4	3,9	0,2	0,1	-0,5	-0,6	-1,4	**39,1**

1: Yield; 2: Boll number; 3: Boll weight; 4: Ginning out-turn; 5: Seed index; 6: Plant height; 7:First flowering days; 8: First boll open days; 9: Sympodial branch; 10: Monopodial branch; 11: Fiber lenght; 12: Fiber fineness; 13: Fiber strenght; 14: Seed coat nep count; 15: Seed coat nep size; 16: Nep count; 17: Nep size; 18:SCI; 19: Moisture; 20: Maturity; 21: Uniformite; 22: Short fiber; 23: Elongation

Table 5: The percentage of direct and indirect effects of independent variables on nep size

Chr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**-11,1**	-10,1	9,0	-1,4	8,4	1,2	0,4	-0,3	-2,2	7,0	-0,2	-0,9	-0,7	6,8	0,7	0,0	0,0	0,4	-14,7
2	-8,0	**-17,5**	4,8	1,1	3,0	4,3	1,0	-0,8	-3,9	9,1	-0,1	-6,4	0,0	7,0	-0,2	0,2	0,1	0,4	-14,3
3	-5,7	-3,9	**14,0**	-4,1	9,6	1,7	-0,7	0,3	-0,7	7,7	-1,3	-3,7	-1,2	2,2	0,6	0,1	0,1	0,3	-25,6
4	1,5	-1,8	-6,8	**26,2**	-19,0	-5,3	0,8	1,4	-0,2	-6,7	0,5	-2,0	1,2	-2,5	-1,0	0,1	0,2	0,4	3,7
5	-6,0	-2,7	10,8	-12,8	**18,6**	-5,6	-1,0	-0,5	0,6	8,1	-0,7	-0,1	-1,4	3,5	1,2	0,0	-0,1	0,1	-14,7
6	0,6	2,8	-1,4	2,6	4,0	**-41,9**	-0,6	-0,6	4,7	-5,1	-0,1	7,2	-0,2	-2,6	1,3	0,0	0,0	0,6	9,8
7	-2,2	-7,8	-6,2	4,3	-8,5	6,3	**4,4**	-1,3	-3,3	-2,4	1,2	-3,2	0,6	4,6	-0,7	-0,1	0,1	0,3	16,2
8	-1,1	-4,1	-2,1	-5,1	2,9	-4,1	0,9	**-8,4**	-2,2	-4,2	0,6	3,4	-0,7	0,0	-0,5	0,1	0,1	0,3	-21,7
9	-4,0	-8,9	1,9	0,4	-1,6	16,2	1,0	-1,0	**-7,5**	4,7	0,3	-9,1	0,5	2,9	-1,1	0,0	0,1	0,2	0,4
10	-5,2	-8,6	9,2	-4,7	4,5	7,4	-0,3	0,8	-1,9	**13,9**	-0,8	-6,4	-0,7	2,1	0,2	0,1	-0,0	-0,0	-18,2
11	-1,4	-1,3	14,3	-3,2	6,8	-1,4	-1,4	1,0	1,0	7,1	**-4,1**	-0,9	-2,2	1,4	1,0	0,1	0,2	0,7	-26,2
12	-1,0	-8,8	6,3	2,0	0,1	15,0	0,6	1,0	-5,4	9,3	-0,1	**-18,1**	0,5	-0,9	-1,3	0,1	0,1	-0,1	-7,4

13	-3,2	0,1	8,1	-4,8	8,9	-2,1	-0,4	-0,8	1,2	4,4	-1,4	2,1	**-2,6**	-1,3	1,0	0,1	0,1	0,5	-28,3
14	9,0	11,8	-4,5	3,1	-6,5	-6,7	-1,0	0,0	2,1	-3,8	0,3	-1,1	-0,4	**-14,1**	-0,3	0,1	0,0	-0,3	-3,1
15	-4,9	1,3	6,9	-6,5	11,6	-17,8	-0,8	0,8	4,3	2,1	-1,0	8,1	-1,6	1,4	**2,7**	0,0	-0,0	0,5	-1,5
16	-1,0	-5,6	3,9	3,7	0,3	-0,2	-0,7	-0,7	-0,5	4,0	-0,3	-3,9	-0,5	-1,8	0,1	**0,4**	0,1	0,3	-33,9
17	-1,0	-6,0	3,6	7,2	-5,7	0,0	0,7	-1,5	-2,7	-0,6	-1,2	-2,6	-0,9	-0,6	-0,1	0,2	**0,3**	0,9	-23,9
18	6,1	8,2	-6,2	-5,1	-2,0	18,0	-0,8	1,1	2,0	0,4	1,5	-1,8	1,5	-2,9	-1,1	-0,1	-0,3	**-1,5**	14,9
19	2,5	3,1	-7,0	0,6	-3,5	-3,2	0,5	1,0	-0,1	-4,2	0,6	1,2	1,1	0,4	-0,1	-0,2	-0,1	-0,2	**37,8**

1: Yield; 2: Boll number; 3: Boll weight; 4: Ginning out-turn; 5: Seed index; 6: Plant height; 7:First flowering days; 8: First boll open days; 9: Sympodial branch; 10: Monopodial branch; 11: Fiber lenght; 12: Fiber fineness; 13: Fiber strenght; 14: Seed coat nep count; 15: Seed coat nep size; 16: Nep count; 17: Nep size; 18: SCI; 19: Moisture; 20: Maturity; 21: Uniformite; 22: Short fiber; 23: Elongation

4. Conclusions

The results of correlation and path analysis from this study indicated that elongation had highly associations with nep and seed coat nep. Selection to be made by considering elongation can be successful in reducing the count and size of nep in cotton breeding. Restrictions should be imposed to nullify the undesirable indirect effects of yield components and fiber quality characters.

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