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The Effect of Harvesting Time and Variety on Fiber andCottonStalkYield Potential and its Companent for Use in the Pulp andPaperIndustry

ZeinolabedinAkhlaghi Amiri[1i,] Mohammad Reza Dehghani Firouzabadi[2]

[1],M.Sc. graduated in Pulp and Paper technology, Gorgan University of Agricultural Sciences and Natural Resources, Iran

Akhlaghi3@gmail.com

[2], Prof. Dept. of Pulp and Paper Technology, Gorgan University of Agricultural Sciences and Natural Resources, Iran

m_r_dehghani@mail.ru

ABSTRACT

Survey of cotton fiber yield, in addition to the identification of its best variety can cause cotton residual enhancement. The remainder of cotton stalk in farms is an illness-causing agent and leads to yield reduction in the next cultivation stage, an event which requires burial. So the usage of cotton stalk in the pulp and paper industry,which faces a shortage of raw material, results in a reduction intillage costs, thus, fiber and stalk yield potential gain importance. In this study, we investigated the effect of variety and harvesting time on cotton yield and its components, which was obtained from experiments of the plot of the 2009 cultivation year. An amount of dry material of each part of the components was also obtained. Experiments on factors containedfive varieties: Sepid, Sahel, Armaghan, Golestan and number200. The harvesting times were also three, namely: 145, 175 and 205 days after cultivation replicated in 4 blocks. Results of the variance analysis showed that the effects of variety and harvesting time on total dry material yields, leaf, stalk, bast and the core, cotton yield, empty and closed boll, stalk height and diameter were significated. The Armaghan variety in the second harvesting time had the highest cotton yield(2413.95$\frac{kg}{ha}$) ,whilethe Sepid variety had the most cotton stalk yield in the third harvesting time(3716.76$\frac{kg}{ha}$). Except for boll, cotton and total dry material yield, in the other evaluated characteristics, the third harvesting time had the best yield, and the most total dry material yield was related to the second harvesting time.

Keywords

cotton stalk- yield- harvesting time- variaty

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INTRODUCTION

Cotton is one of the most popular fiberous plants, and alsoa natural fiber production resourceof the world [17]. It is fromthe Gossypium Genus and Malvaceae family,and the majority of its variaties in Iran are from the *hirsutum*type [32]. The cotton plant's fibers and its different components' yields are ofthe most important conditions in cotton planting that are calculated in hectar units. For this reason,tendency to use more yield variatieshas recently risen.Comparison among diverse varieties has shown significant differences in fiber yield [5] , [12]. Ramazani-Moghadam et.al (2007) investigated the genetic diversity in Diploid cottons through applying morphological features. Yield epithet average comparison results showed that the Sorkhesemnan and Aria variaties have more yields, with 1617 and 1539/7 $\frac{kg}{h}$, respectively. In addition,difference among yield times in different varietie salso affected fiber yields. So that difference in the yield time among different varieties have effected on their yield. Thus, early yields among different varieties werequite different [8]. Harvesting time depends on variety type, and earliness affects the yield as well [3]. Copur et al, 2010 investigaed the effect of different harvesting times on seed-set efficiency in cotton (*Gossypiumhirsutum*L.) varieties. Results showed that effects of harvesting time and variety on the cotton yield were significant in the level of 1%. Dehghani Firouzabadi in 2008, investigated the effects of harvesting times on fiber morphological properties and kenaf yield. Four harvesting time (85, 105, 135 and 155 days after plantation) results showed that kenaf fiber yield increases by harvesting time addition, and that from the1st to 4th stages, 6056, 9981, 12512 & 12482 kg/h of dry materials were obtained, respectively. Harvesting time effect on cultivated plants' yield depends on plant type, and each plant has its own specific reaction. The results of analyzing theeffects of planting date and source - sink limitation on grain yield and yield components in three rapeseed (*Brassica napus*L.) cultivars showed that planting time and variety effects on hight of herb and yield were significant, and the best results were for the first planting date [20]. Also, cotton yield is effected by soil quality, planting type, irrigation variety and cotton culture location.Donyavian et al in 2007 investigated the effects of density on yield, yield components and fiber quality of Sahel cotton. The factors were: number of plants in a hill (1,3,5,7), and spacing between hills (20,40,60 cm). Results from combined analysis indicated that 3 pl/hill or 11.4 pl/m2/ had the highest fiber yield in comparison with other treatments, but increasing of the spacing between hills and interaction between treatments didn't have any significant effect on the fiber yield. Moshtagh Ali et al in 2010 investigated effects of variety and planting way on cottonseed yield reaction. Results showed that 59260 plant aggregation with 2474 kg in hectar unit, had the most cottonseed yield. Javadi et al in 2004 investigated effects of distance between the first and second irrigation on yield and yield components of cottonvarieties. Treatments included the Birjand cotton race and the varamin variety with 5 distances between the first and second irrigations (weeks 1,2,3,4 and5).The results show that seed index, lint index, boll number per m^2, seed number per m^2, boll size and the fruiting coefficient were high in the Varamin variety.Varieties were not significantly different in traits as fiber yield , lint percentage, seed numbers of boll, lint yield, seed yield. Ghaderifar et al in 2010 indicated that cotton seed yield depends on irrigation and is different in hectar from 1600 to 3700 kg. Savari et al in 2008 evaluated Glycine Betaine effects on some agronomic traits of cotton (*Gossypiumhirsutum*L.) cultivars under water-drought stress. Results showed that plant height in the Varamin variety (86.5 to 92.5 cm) was singnificantly less than in the Sahel variety (90.25 to 104.75 cm) both of which weremore than the two other varieties.Moreover, fiber yield is also affected by variety and Glycine usage amount.The fiber yield in Varamin and Sahel varieties with 2014 and 2044 kg/h Glycine usage respectively, showed improvement. Iqbal et al in 2011 investigated fiber's yield and quality improvement in different cotton genotypes by sooner harvesting with virus attackes. Result showed thet as a result of sooner harvesting, cotton yield will improve. Rashidi and gholami investigated the response of yield components of cotton to different rates of nitrogen fertilizers. 200 kg nitrogen usage caused fiber yield improvement from 3642 kg to 4363 kg in hectare. Ghorbani and Gharanjiki in 2008 researched about the effect of two irrigation methods in different growth stages on cotton and its components yield of two variaties in Gorgan. Results showed that there was significant difference between Sahel and Sepid varieties concerning yield and yield components. Accordingly, in the Sepid variety with 3265 kg/h, cotton yield quantity was 8.3 percent more than in the Sahel variety. Furthermore, the Sepid variety precocity with 81.5 % , was more than that of the Sahel variety with 77.2 %. In addition to these factors, removing residuals of prior cultivations could be effective in cotton yield enhancement and prevent illnesses. Hoshiarfard and Gharanjiki in 2009 investigated the effect of tillage and residue management on damping-off and verticillium wilt diseases, yield and yield components of cotton (*Gossypiumhirsutum*L.). Results showed that choosing a suitable way for the burial of cotton stalk and planting bed preparation could reduce too much cotton damping off and the verticillium wiltsillness and enhance cotton yield from 1237 to 2339 kg/h. Tillage is a part of the cultivation process that is done for soil preparation, and it requires 60 percent of the mechanical energy used in agriculture. In addition, through using cotton stalk in the paper making industry, which always has problems producing raw material, tillage expenditures may be lowered. Furthermore,using non-wood materials as raw material in the paper making industry has a great deal of importance.At the moment, non-wood fibers are 9 percent of the fibers used in the pulp and paper industry [33]. SarwarJahan et al in 2000 worked on substituting wood with non-wood fibers in papermaking as a solution for the raw material problems in Bangladesh.Results showed that cotton stalk's anatomical, chemichal and morphological features are comparable to those of broadleafs, and its soda anthraquinone pulp yield is 40 to 45 % which could be used when mixed with other species. Cotton stalk is among those non-wood plants upon which much research has been conducted, specifically research concerning its morphological features and its usage in the pulp and paper industry [10].The results of the research show that both cotton stalk bast and core are suitable for paper making, however,the core's paper making features are better than those of the bast [28]. But unfortunately,a 97% reduction of cotton cultivation since 35 years ago in Golestan province,which was one of the main cotton poles and largest manufacturer in Iran, has caused worry over its supply cultivation owners.Golestan is now only the third producer of cotton stalk after the two provinces of Khorasan Razavi and Fars.Thus, advantages of cotton stalk using in thepulp and paper industries could be quite effective in motivating cultivation. In order to harvest cotton stalk economically,and using it in the pulp and paper industries, paying more attention to cotton stalk yield sounds to be necessary,and more stalk yield in

hectare unit could attract the paper industry owners. Zohurul Islam et al in 2003 specified that cotton stalk yield, like its fibers, depends on the chemichals applied for removing bacteria, and it varies from 1782 to 2219 kg in each hectare unit. Ullah Khan et al in 2007 studied growth and yield with improved commercial cotton cultivars. Results showed that cotton stalk yield was 3.81 to 8.41 tons in hectare, under the influence of cotton stalk variety. Thus, cotton stalk yield enhancement, while considering the Superior variety, and also finding the place the remnants of this plant could be used, could be useful for supplying raw materials for the paper-making process. Moreover,recognizing different varieties, the superior varietyof cotton in terms of yield amount in addition to the total dry material yield in Gorgan province which has a suitable potential for cotton production, could be effective in cotton yield enhancement in similar cultivations areas. It's note worthy to mention that [19] found that suitable variety selection is one of the most important factors in returning money after investment.

Materials and methods

The present study, which has been done to investigate fiber and stalk yield potentials for some cotton stalk in Iran, was implemented in 2009 at Hashem Abad cotton research center of Gorgan in a completely randomized block design with 4 repetitions. Treatments included cotton variations of Sepid, Sahel, Armaghan, Golestan and Number200. Each plot, with 8 lines of 8 meter length, and with the distance of plants in each line and between lines being 20 and 80 centimeter respectively, contained a total number of 62500 plants per hectare. The plants have been harvested in three different periods (145, 175 and 205 days) after cultivation. After being gathered, the stalks with similar conditions were packed in each harvesting period. Then, they were sent to the lab for being divided and for the yield component to be measured. Overall, for each variety in each harvesting time, 30 to 40 plants were selected for yield and yield components potential measurement. For avoiding margin effects, no samples from verge rows and those one meter far from each row were picked. So only samples from the 2nd and the 3rd rows with one meter distance from two sides of the block raw borders were picked. With respect to different features of cotton stalk bast and core [28], debasting was done on the stalks before cotton stalk yield potential measurement. The measurement was done on stalk bast and core substances separately. Generally, in cotton yield and its components evaluation, the share of each cotton plant component was identified Separately in a way that plants were divided to stalks and branches (consisting of bast and core), leaves, closed bolls, cotton (fibers and seeds) and empty opened bolls (in this study, stalk and branch are considered as stalk). After separating the leaves, stalks length was obtained through measuring from soil surface to the end of the stalks, the diameter of which was measured in several points. Then stalks were completely debasted and cottons were dissevered from bolls. Samples were air dried due to their high primary moisture and each of their components was oven dried at 103 centigrade heat. Oven drying time for bast, cores and bolls was 24 hours and varied between 8 to 14 hours for leaves and fibers. To make sure that samples are dried in zero percent moisture range, they were weighed every 2 hours. Finally, the weight of completely oven-dried samples was obtained by digital balance with 0.01 gram accuracy and different components were compared to each other. Each evaluated quality yield was calculated in hectare unit. Considering the results obtained, stalk bast percent and its amount with respect to the total plant weight were obtained. For statistical analysis of different varieties in different harvesting periods, univariate analysis had been done in a completely Randomized block design by SAS software, and for means comparison, LSD test was used. For yield separation in each variety for each harvesting time, one way anova analysis with SPSS software was used.

Results

Leaves yield: The analysis of variance results showed that the variety and harvesting time effects on leaves yield with 1% probability level and variety∗harvesting time interaction in 5% probability level were significant (table 1) which confirms the effects of harvesting time and variety on cotton yield, similar to kenaf yield [27]. through leaves yield means comparison among different varieties, it was found that Armaghan variety with 3152.2 kg/hectare in average, has the most leave yield, but it doesn't have any significant statistical difference with Sahel and Golestan variety but has significant difference with Sepid and number-200 variety. Least leaves yield means in three harvesting periods with 2058/7 kg/hectare is related to number-200 variety (table 2). Also harvesting time effects on leaves yield was significant with 1% probability level (table 1). With different harvesting time means comparison, it can be seen that the most leave yield with 3313.8 kg/ hectare was related to the third harvesting period and statistically, leave yield in the 2nd and 3rd harvesting time fell in the first group. So the 1st harvesting time with a statistically significant difference (5% probability level compared to the other harvesting periods, has the least leave yield (table 3). Based on the results obtained by comparing the effects mean on harvesting time,v, the most leaves yield in 2nd harvesting time was related to Armaghan variety with 4443/3 kg/hectare. Also the most leaves yield for Sahel variety was related to the 2nd harvesting time, but in Sepid, Golestan and Number-200 varieties, the most leaves yield was observed in the 3rd harvesting time.

Stalk yield: stalk yield based on the results of variance analysis (table 1), the harvesting time, and variety effects in 1% confidence level were significant, but harvesting time∗ variety interaction on the cotton stalk yield doesn't show any significant difference. Cotton stalks yield means for 5 investigated varieties were placed in 4 groups and the results from the 1st and 2nd harvesting stages are consistent with that of [36], and were lower compared to the extracted results from [31]. In a way that Sahel variety with 3037 kg/ hectare yield in average has the most yield significance in 95% confidence level compared to Sepid, Golestan and Number-200 varieties but this variety's Excellence compared to Armaghan variety wasn't significant. After them, there were Sepid and Golestan varieties and Number-200 variety with 2175.9 kilogram dry stalk in hectare which had the least yield (table 2). Stalk yield means comparison in three different harvesting times (table 3) shows significant yield increase parallel to the increase in harvesting time. And with means separated in three groups, the most cotton stalk yield with statistical difference of 5% level, belonged to the 3rd harvesting time. variety∗ harvesting

time interaction means comparison results (table4) showed that the most stalk yield belonged to Sepid variety in the third harvesting time with 3716.8 kg/ hectare mean. In the first harvesting time, the most cotton stalk yield belonged to Sahel and Armaghan varieties and in the second time, Sahel variety was recognized as the best variety. In the final harvesting time, Sepid, Sahel, Armaghan and Golestan varieties had 3716.8, 3636.1, 3501.4 and 3072.5 kg/ hectare cotton stalk yield respectively and the least stalk yield was for Number-200 variety with 2991.8 kg in hectare unit. The difference in the results from cotton stalk yield with other researcher's results could be attributed to each variety different reaction and their cultivation geography [19].

Cotton stalk core yield: The analysis of variance results demonstrated that the variety and the harvesting time effects on cotton stalk core yield in 99% confidence level and their interaction effect in 95% confidence level were significant (table1). Cotton stalk core yield means comparison among different varieties showed that Sahel, Armaghan, Sepid and Golestan varieties had the most Cotton stalk core yield with 1840, 1752.8, 1594 and 1471 kg/hectare respectively and Number-200 variety with 1343.7 kilogram has the least stalk core yield in each hectare. Armaghan variety stalk core yield didn't have any difference statistically to Sahel and Sepid variety. So these three varieties had more yield than Golestan and Number-200 (table 2). Cotton stalk core yield means comparison in three harvesting stages showed that cotton stalk core yield in the 1st, 2nd and third harvesting periods, with 914.7, 1815.2 and 2072 kg/ hectare respectively, had a significant difference in 5% level. Based on the results of variety∗ harvesting time interaction effect means comparison on core yield components, it can be seen that Sepid variety in the 3rd harvesting stage with 2253.5 kg in hectare oven dry material, had the most cotton stalk core yield (table 4).

Cotton stalk bast yield: As for the results of cotton stalk bast yield analysis variance (table 1), the variety and harvesting time effects in 1% level were significant, but harvesting time∗ variety interaction effect wasn't significant. Means comparison showed that the most cotton stalk bast yield (similar to that of their core) was related to Sahel variety with 1196.3 kg/ hectare as Armaghan, Sepid, Golestan and Number-200 varieties respectively with 1094.6, 1047.2, 947.05 and 832.1 kg/ hectare standing after Sahel variety and means with significant 5% difference were separated in 4 different groups (table 2). Harvesting time effect on cotton stalk bast yield (table 3) showed that the 1st, 2nd and 3rd harvesting time with 1311.8, 1173.7 and 584.9 kg/ hectare means had the most stalk yield respectively and means fall in 3 different groups. variety∗ harvesting time interaction effect means comparison results (table 4) showed that the most stalk bast yield was for Sepid variety in the 3rd harvesting time with 1463.3 kg/ hectare and we can consider the second harvesting time of its bast yield acceptable.

Boll yield: the cotton's empty boll which remains after cotton harvesting from the plant, considering its fiber usage possibility in industries such as pulp and paper and suitable production volume in hectare, could be suitable along with some benefits such as the number of bolls in each plant, each boll weight, biological yield and harvesting indexes effects on fiber yield [34]. the results of variances analysis (table 1) showed that the effects of harvesting time and variety at 1% level and the effect of harvesting time∗ variety interaction at 5% level on cotton empty boll yield were significant. Means comparison showed that Golestan variety with 867.2 kg in hectare, has by far the most cotton empty boll yield in comparison to other varieties at 5% level and the least boll yield belonged to Sahel variety with 311.7 kg in hectare (table2). Means comparison in different harvesting time (table 3) showed that the 2nd harvesting time with 701.9 kg in hectare, has the most boll yield while there isn't any significant difference between the 1st and the 2nd harvesting time .variety∗ harvesting time interaction means comparison (table 4) showed that in all varieties except Number-200, which has the most boll yield in the 3rd harvesting time, the most cotton boll yield occured in the 2nd harvesting time and Golestan variety boll yield ,1045.6 kg/ hectare, was more than the other varieties.'

Cotton yield: Based on the results of cotton yield analysis of variance (table 1), variety and harvesting time effect in a 1% level and harvesting time∗ variety mutual effect in a 5% level on cotton yield were significant. Fibers yield mean comparisons demonstrated that among different varieties (table 2),Golestan variety, with 2092.3 kg per hectare mean, had significantely the most cotton yield in comparison with other varieties in a 5% level while Armaghan and Golestan varieties, with 1571.6 and 1435 kg/ per hectare respectively, were in the second group. In addition, cotton yield mean comparisons in different harvesting times,introduced the second harvesting time, with 1823.7 kg/ per hectare mean, as the best time,significantely in a 5% level, and there weren't any significant differences found between the first and the third harvesting times (table 3). That is, considering some varieties' prematurity, variety∗ harvesting time mutual effect mean comparisons on cotton yield (table 4) showed that Golestan and Armaghan varieties in the second harvesting time, with 2530.1 and 2414 kg/ per hectare, had the most cotton yield, respectively. Considering, the sum total of three harvesting times, Golestan variety, with more than 6 tons per hectare (lint and seed yield), and, following that, Armaghan variety, with approximately 4700 kg per hectare, were the best varieties while Sahel variety, with 1734 kg per hectare, had the least cotton yield in comparison with other varieties. Considering the fact that lint percentage is normally about 40%, obtained results from researched varieties is comparable to [11], [29] and [2] results.

Closed boll yield: Closed or unopened boll could be considered as an index of each delayed maturity; by evaluating this index, the total ovem dry materials can be calculated and a distinction between precocious and delayed mature varieties can be made as well. Closed boll yield analysis of variance results (table 1) showed that variety, harvesting time and variety∗ harvesting time mutual effects were significant in a 1% level, statistically. Mean comparisons showed that Sahel variety, with 847 kg, and Golestan variety, with 737.2 kg per hectare, had the most closed boll yield and by taking into account the proportion of opened boll to closed boll, it has been proved that Sahel variety was more delayed mature than other varieties and Sepid variety, with the least closed boll yield mean, could be well placed in precocious varieties (table 2), which meets [8] and [13] results. Closed boll yield mean comparisons in three different

harvesting times (table 3) showed that the first harvesting time, with 969.6 kg per hectare, had the most significant yield in comparison with other varieties in a 99% confident level. The results of variety* harvesting time mutual effect mean comparisons (table 4) demonstrated that Armaghan, Golestan and Number-200 varieties, which had an intensive reduction in closed boll yield, are precocious and high yield, and Sepid variety, with suitable precocious, had afew closed bolls in all harvesting times.

Total oven dry material yield: The total cotton plant dry material was obtained from whole stalks, bolls, cotton, empty bolls and leaves yield, which expresses cotton plant totally oven dry weight per hectare unit. Total raw material analysis of variance results (table 1) showed that harvesting time and variety effects in a 1% level and harvesting time* variety mutual effect in a 5% level on the total dry material yield were statistically significant. Total dry material yield mean comparisons for five investigated varieties (table 2) showed that Golestan and Armaghan varieties, with 9033.1 and 8792 kg per hectare respectively, had the most yield which was 5% more then other varietiesin a significante level. Following them, Sahel and Sepid varieties, with 7735.3 and 6870.5 kg per hectare means respectively, had more yield and the least total oven dry material yield anented to Number-200 variety, with 6122.7 kg per hectare. Harvesting time effect on total dry material (table 3) showed that the most yield, 9178.3 kg per hectare, belonged to the second harvesting time, but there was not any diffrences seen between the second and the third harvesting times statistically. The comparison of harvesting time variety* mutual effect means (table 4) underlined that Armaghan variety in the second harvesting time, with 11539.8 kg per hectare, has the most yield; following that, Golestan showed superior variety in the second and and the third harvesting times, with a yield near to 10 tons per hectar.

Stalk bast percentage: Stalk yield baste weigth percentage with respect to total stalk and also variety and harvesting time effect on this feature are the most important measured factors in stalk yield measuring section due to the fact that cotton stalk bast amount, because of its more chemical usage, could affect pulping quality. Results indicate that cotton stalks' bast percentages were around 38 to 41 % in all cases, and there weren't any significant differences among varieties and harvesting times in bast percentage (table 1); by increasing the harvesting time, yield growth rate for both bast and core inceased identically. Furthermore, the results showed that the most bast percentage, with 39.91 % mean, was related to Sepid variety and the least bast were dedicated to Armaghan (38.43) and Number-200 (38.48 %), but there were not any significant differences among them (table 2). Harvesting time increase caused insignificante cotton stalk bast percent decrease (table 3). Variety* harvesting time mutual effect mean comparisons (table 4) indicate that Sepid variety in the first harvesting time, with 40.97 %, had the most and Number-200 variety in the thirs harvesting time, with 37.34%, had the least bast fiber percent in which there was the only significant statistical difference in a 5% level. Therefore, in relation to bast usage limitation aspects, there were not any differences among varieties, and all varieties in each harvesting time had the similar reaction.

Cotton stalk yield percentage to total dry material: The analysis of variances showed that harvesting time, variety and their mutual effects on the percentage of cotton stalk yield to total dry material ratio in a 1% level were stasistically significant (table 1). The percentage of stalk yield to total dry material ratio means (table 2) showed that Sahel variety, with 39.2 % stalk, has significantly more ratio than other varietiesin a 5% level, and the least stalk to total dry material was that of Golestan variety, with 26.3 % average. By increasing the harvesting time, stalk yield in plant enhanced significantly, and in the third harvesting time, with 39.8 %, the most stalk percentage was observed, and the least stalk percentage in a 5% level, with 28.6 %, belonged to the first harvesting time (table 3). Variety mutual effects in harvesting time on cotton plant stalk percentage (table 4) showed that Sepid and Sahel varieties, with 46% and 44% in the third harvesting time respectively, had the most stalk percentages. The most important factor in investigating cotton yield and its components is the stalk weight effect per hectare and its yield investigation separately. Therefore, Sahel and Sepid varieties can be used better for pulp and paper industry and also postponing the harvesting time to the third stage, could be effective to achieve this goal.

Stalk height: The results of the analysis of cotton stalk height variance (table 1) showed significant harvesting time and variety in a 1% level and also their mutual effect in a 5% level thatis sonsistent with [19] and [18] results. Cotton stalk height means (table 2) in Sahel, Sepid and Number-200 varieties respectively with 109.95, 108.7 and 105.08 cm, put them in the firs group, and with a significante difference in a 5% level, were taller than thanArmaghan and Golestan which was due to their too many small branches.

By increasing the harvesting time, the stalk height increased significantly. The results of harvesting time effect mean comparisons on cotton stalk height (table 3) showed that the highest stalk with 111.06 cm belonged to the third harvesting time. According to variety mutual effect mean comparisons in harvesting time, Number-200 and Sahel varieties in the third harvesting stage, with 126.1, 122.62 and 122.56 cm respectively, had the highest stalk (table 4).

Stalk diameter: Stalk diameter was affected by variety and harvesting stage in a significant 1% level (table 1) and cotton stalk diameter mean comparisons for different varieties (table 2) showed that Sahel variety, with the average of 11.85 mm, had the most thick-set stalk in comparison with other varieties with a significant difference in a 5% level, and no significante difference among other varieties has been observed. By increasing the harvesting time, this factor also increased. According to stalk diameter mean comparisons in different harvesting times (table 3), the most diameter was observed in the third time, with 12.61 mm, that had significant differences in comparison with the third and the second time. In addition, variety* harvesting time mutual effect mean comparisons (table 4) demonstrated that Golestan variety, with 11.98 mm, was assigned the most cotton stalk diameter in comparison with other conditions.

Correlation coefficients results among related characteristics to cotton varieties components yield: Correlation coefficients results among different investigated factors (table 5) indicated that total dry material yield, with 0.929, had the most correlation with leaves yield. It showed a significant correlation with stalk, its bast and core, empty boll and cotton yields and stalk diameter in a 1% level,but stalk height didn't have any correlation with total dry material yield. Stalk yield had strong correlation with its height and diameter (especially for stalk diameter). By enhancing the diameter,

its yield also increased significantly in a 1% level while this factor didn't have any significant differences between core and bast, and by enhancingthe stalk height and diameter, bast, core and atalk total amount yields enhanced significantly in a 1% level.Furthermore, by enhancing the stalk height and diameter respectively, leaves yield enhanced significantely in 5% and 1% levels. Cotton yield along with empty bolls yield enhanced significantely in a 1% level, but by increasing the number of closed bolls, it decresed significantly in a 5% level. Also cotton stalk length and diameter correlation results showed that by enhancing each of these factores, the second factors increased significantly in a 1% level, and both of them caused a significant increment of total dry material yield in a 1% level.

discution

Generally speaking, the new Golestan and Armaghan varieties in spite of lower height, had the 1st and 2nd rank respectively for the most cotton yield, empty bolls yield and total yield and the best stalk, core and its bast yields were related to Sahel and Armaghan varieties. Also, the most leaves' yield was related to Arnaghan, Sahel and Golestan varieties where overall, theArmaghan variety was known to be the best variety due to its cotton yield, stalk yield and other related component features. In different harvesting times, the 3rd harvesting time was the best time in terms of stalk and its component yield, stalk bast percentage, stalk yield to total dry materials yield and cotton stalk diameter and height, but in terms of total dry material yield, for empty bolls yield and cotton yield which are the most important goal in cotton cultivation, the 2nd harvesting time was better other harvesting times. Totally, the best cotton yield was for Armaghan and Golestan varieties in the 2nd harvesting time, and the most cotton stalk yield was related to Sepid, Sahel and Armaghan varieties, respectively. Differences in cotton and its components' yields among different investigated varieties and different harvesting times, and considering the investigation results concerning this tendency, shows that the differences could be related to anatomical and location properties and their different cultivation conditions, and it is clear that variety is the most important effective factor [19]. For this reason, it is recommended to delay cotton harvesting to the 2nd and 3rd stages and develop Armaghan and Golestan new varieties cultivation, and also to investigate their quality features. Finally it's better to investigate new varieties and genotypes quality and quantity properties of raunchy varieties (with low yield) elimination, and to achieve fibers and stalk manufacturing amount enhancement with appropriate features.

Table1- Combined analysis of variance of 5 cotton variaties' yield and it's related characteristics in different harvesting times in Gorgan climate conditions

S.O.V	d.f	Leaf yield (MS)	Stalk yield (MS)	Core yield (MS)	Bast yield (MS)	Empty boll yield (MS)	Cotton yield (MS)	Closed boll yield (MS)	Total oven dry material yield (MS)	Stalk bast percent (MS)	Stalk yield % to Total oven dry material (MS)	Stalk height (MS)	Stalk diameter (MS)
Block	3	816578.03*	614827.78**	267615.48**	73827.157*	29115.581 ns	150986.01 ns	395904.076*	6180471**	4.682926 ns	3.574348 ns	20.89515 ns	1.568833*
Harvesting time	2	18589281.9**	19745512.6**	7386265.12**	2980470.69**	542106.632**	400117676.39**	3043913.514**	8652751.6**	1.760865 ns	631.711802**	5658.49654**	46.53282**
Block* Harvesti time	6	90557.92 ns	93258.67 ns	32578.79 ns	21310.292 ns	48463.496*	218542.6 ns	184763.504 ns	741801.1 ns	4.0812615 ns	5.712455 ns	28.75199 ns	0.861073 ns
variaty	4	2993650.02**	1391847.6**	490701.61**	233860.341**	500328.107**	3837852.43**	1099761.061**	843921 6.1**	4.8533315 ns	292.468727**	2803.41521**	1.6261041**
Harvesting time*variaty	8	4900008.61*	2640866.75 ns	1110254*	34608.397 ns	55242.714*	405018.56*	697414.831**	2772342.1*	2.7344345 ns	29.163057**	115.9754*	0.81974485ns
Eror	36	210557.64	125989.36	49303.51	22030.493	20211.603	174166.57	116084.25	1137897	3.1184551 ns	8.6503	46.057	0.388889
CV %		17.3	13.53	13.87	14.502	25.341	30.91	65.156	13.834	4.52	8.705	7.007561	5.531104

*and** respectively shows Significantly at 5% and 1% probability levels and ns shows Non significant.

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Table2- comparison of fiber characteristics' average in 5 different cotton variety

variaty	Leaf yield (kg/hr)	Stalk yield (kg/hr)	Core yield (kg/hr)	Bast yield (kg/hr)	Empty boll yield (kg/hr)	Cotton yield (kg/hr)	Closed boll yield (kg/hr)	Total oven dry material yield (kg/hr)	Stalk bast percent (kg/hr)	Stalk yield % to Total oven dry material (kg/hr)	Stalk height (cm)	Stalk diameter(mm)
Sepid	2172.9^{B}	2641.3^{BC}	1594.07^{BC}	1047.19^{BC}	509.13^{BC}	1435^{B}	112.2^{C}	6870.5^{BC}	39.915^{A}	36.728^{B}	108.7^{A}	10.938^{B}
Sahel	2961.1^{A}	3037.2^{A}	1840.89^{A}	1196.32^{A}	311.7^{D}	578.3^{D}	847^{A}	7735.3^{B}	39.472^{AB}	39.207^{A}	109.95^{A}	11.858^{A}
Armaghan	3152.2^{A}	2847.4^{AB}	1752.82^{AB}	1094.62^{AB}	622.27^{B}	1571.6^{B}	598.5^{AB}	8792^{A}	38.437^{B}	32.052^{C}	81.592^{B}	11.2575^{B}
Golestan	2917.7^{A}	2418.6^{CD}	1471.6^{C}	947.05^{CD}	867.25^{A}	2092.3^{A}	737.2^{A}	9033.1^{A}	39.038^{AB}	26.032^{D}	78.908^{B}	11.334^{B}
Ir-200	2058.7^{B}	2175.9^{D}	1343.75^{D}	832.14^{D}	494.76^{C}	1073.5^{C}	319.8^{BC}	6122.7^{C}	38.486^{AB}	34.623^{B}	105.079^{A}	10.9843^{B}
LSD(0.05)	379.93	293.89	183.85	122.89	117.71	345.54	282.1	883.21	1.4621	2.4352	5.619	0.5163

Means in each column by similar letters are not significantly different in statistical at 5% probability level (LSD test p‹0.05)

Table3- means comparison of cotton fiber yield related characteristics in three harvest times

variaty	Leaf yield (kg/hr)	Stalk yield (kg/hr)	Core yield (kg/hr)	Bast yield (kg/hr)	Empty boll yield (kg/hr)	Cotton yield (kg/hr)	Closed boll yield (kg/hr)	Total oven dry material yield (kg/hr)	Stalk bast percent (kg/hr)	Stalk yield% to Total oven dry material (kg/hr)	Stalk height (cm)	Stalk diameter (mm)
1st harvest time	1546.33^{B}	1499.63^{C}	914.74^{C}	584.89^{C}	380.02^{B}	934.9^{B}	969.6^{A}	5330.5^{B}	39.1534^{A}	28.6456^{C}	78.275^{C}	9.6135^{C}
2nd harvest time	3097.38^{A}	2988.92^{B}	1815.18^{B}	1173.75^{B}	701.86^{A}	1823.7^{A}	349.9^{B}	9178.3^{A}	39.3159^{A}	32.9259^{B}	101.205^{B}	11.598^{B}
3rd harvest time	3313.86^{A}	3383.72^{A}	2071.96^{A}	1311.76^{A}	601.19^{A}	1291.8^{B}	249.2^{B}	8623.3^{A}	38.7403^{A}	39.7866^{A}	111.058^{A}	12.6123^{A}
LSD (0.05)	232.85	236.3	139.66	112.96	170.34	361.73	332.6	666.44	1.5632	1.8494	4.1491	0.718

Means in each column by similar letters are not significantly different in statistical at 5% probability level (LSD test p‹0.05)

Table4- cotton stalk yield in different variaties and harvesting times

variaty	Harvesting time (day)	Leaf yield **	Stalk yield **	Core yield **	Bast yield **	Empty boll yield **	Cotton yield **	Closed boll yield **	Total oven dry Material yield **	Stalk Bast percent (ns)	Stalk yield to Total oven dry material **	Stalk height **	Stalk diameter **
Sepid	145	1136.92^{G}	1156.23^{H}	683.348^{F}	472.88^{G}	487.41^{CD}	1390.78^{B}	58.48^{E}	4229.82^{E}	40.968^{A}	27.31^{F}	82^{EF}	9.14^{E}

	175	2680.22 CD	3050.8 BCD	1845.357 AB	1205.446 ABC	577.344 CD	1879.82 A B	96.92 E	8285.11 BC	39.506 AB	36.87 CD	118.01 AB	10.95 C
	205	2701.63 CD	3716.76 A	2253.504 A	1463.26 A	462.63 CD	1034.26 CDE	181.138 E	8096.43 BC	39.27 AB	46.01 A	126.09 A	12.72 A
Sahel	145	1968.06 DEF	1979.33 FG	1193.82 DE	785.51 EF	83.44 E	164.49 F	1165.91 B	5361.23 DE	39.65 AB	37.17 CD	95.65 C	10.38 CD
	175	3638.93 B	3496.2 ABC	2109.665 A	1386.54 A	519.442 CD	1080.58 CDE	858.772 B CD	9593.93 B	39.85 AB	36.41 CD	111.64 B	12.38 AB
	205	3276.41 BC	3636.116 AB	2219.196 A	1416.92 A	332.21 D	489.89 EF	516.183 C DE	8250.8 BC	38.917 AB	44.04 AB	122.56 A	12.81 A
Armaghan	145	1571.38 FG	1604.87 GH	983.817 EF	621.05 FG	340.29 D	793.06 DEF	1082.031 BC	5391.63 DE	38.58 AB	29.1 F	66.19 G	8.82 DE
	175	4443.48 A	3436.07 ABC	2120.58 A	1315.49 A BC	857.21 AB	2413.951 A	389.06 DE	11539.8 A	38.11 AB	29.76 F	85.12 D EF	12.25 AB
	205	3441.72 BC	3501.38 ABC	2154.06 A	1347.321 AB	669.31 BC	1507.92 B C	324.263 D E	9444.6 B	38.62 AB	37.29 CD	93.46 C D	12.19 AB
Golestan	145	1792.23 EFG	1489.71 GH	931.272 EF	558.437 F G	574.33 CD	1457.77 B CD	1952.656 A	7266.7 C	38.05 AB	20.73 G	66.01 G	9.54 DE
	175	3388.84 BC	2693.75 DE	1628.705 BC	1065.045 CD	1045.65 A	2530.313 A	229.02 E	9887.57 AB	39.52 AB	27.3 F	80.16 F	11.48 BC
	205	3571.99 B	3072.48 BCD	1854.82 AB	1217.656 ABC	981.786 A	2288.84 A	29.89 E	9944.98 AB	39.55 AB	30.93 EF	90.55 C DE	12.98 A
IR-200	145	1263.06 FG	1268.03 H	781.451 F	486.562 G	414.62 CD	868.35 CDE	589 BCDE	4403.04 E	38.52 AB	28.92 F	81.52 E F	9.68 DE
	175	2417.83 DE	2267.79 EF	1371.58 CD	896.205 D E	509.64 CD	1213.97 B CD	175.89 E	6585.13 CD	39.59 AB	34.37 DE	111.09 B	10.92 C
	205	2495.16 DE	2991.85 CD	1878.214 AB	1113.638 BCD	560.02 CD	1138.3 CDE	194.46 E	7379.8 C	37.34 B	40.66 BC	122.62 A	12.36 AB

ns and ** respectedly show non Significant and Significant at 1% probability level. also Means in each column by similar letters are not significantly different in statistical at 5% probability level (LSD test p‹0.05)

table5- pearson Correlation coefficients among related characteristics to cotton fibers yield

	Leaf yield	Stalk yield	Core yield	Bast yield	Empty boll yield	Cotton yield	Closed boll yield	Total oven dry material yield	Stalk bast %	Stalk yield% to Total oven dry material	Stalk height	Stalk diameter
Leaf yield	1											
Stalk yield	0.837**	1										
Core yield	0.838**	0.966**	1									
Bast yield	0.822**	0.991**	**0.975	1								
Empty boll yield	0.492**	0.291	*0.305	*0.263	1							
Cotton yield	0.495**	0.226 ns	0.228 ns	0.219 ns	**0.917	1						
Closed boll	-0.197 ns	-0.242 ns	-0.234 ns	-0.251 ns	*-0.324	*-0.329	1					

yield											
Total oven dry material yield	0.929**	0.813**	**0.817	**0.795	**0.662	**0.637	ns -0.068	1			
Stalk bast%	-0.146 ns	0.103 ns	-0.185ns	0.027ns	ns -0.237	ns -0.096	ns -0.161	ns -0.206	1		
Stalk yield% to Total oven dry material	0.239 ns	0.635**	**0.643	**0.658	**-0.339	**-0.413	*-0.321	0.111ns	ns 0.064	1	
Stalk height	0.287*	0.615**	**0.609	**0.615	ns -0.184	ns -0.221	**-0.348	ns 0.19	ns 0.024	**0.824	1
Stalk diameter	0.759**	0.887**	**0.883	**0.880	**0.355	ns -0.232	ns -0.247	**0.742	ns -0.105	**0.564	**0.564

*and** respectively shows Significantly at 5% and 1% probability levels and ns shows Non significant.

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Author' biography with Photo

Zeinolabedin Akhlaghi Amiri

Date and place of birth: 6th july 1985, Babol, Islamic Republic of Iran

nationality: Iranian

Status: M.Sc. graduated in Pulp and Paper technology from Gorgan University of Agricultural Sciences and Natural Resources- Iran