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THE RELATIONSHIP BETWEEN GINNING PROCESSES AND NEP FORMATION IN COTTON FIBER AND YARN

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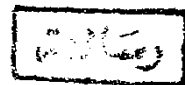
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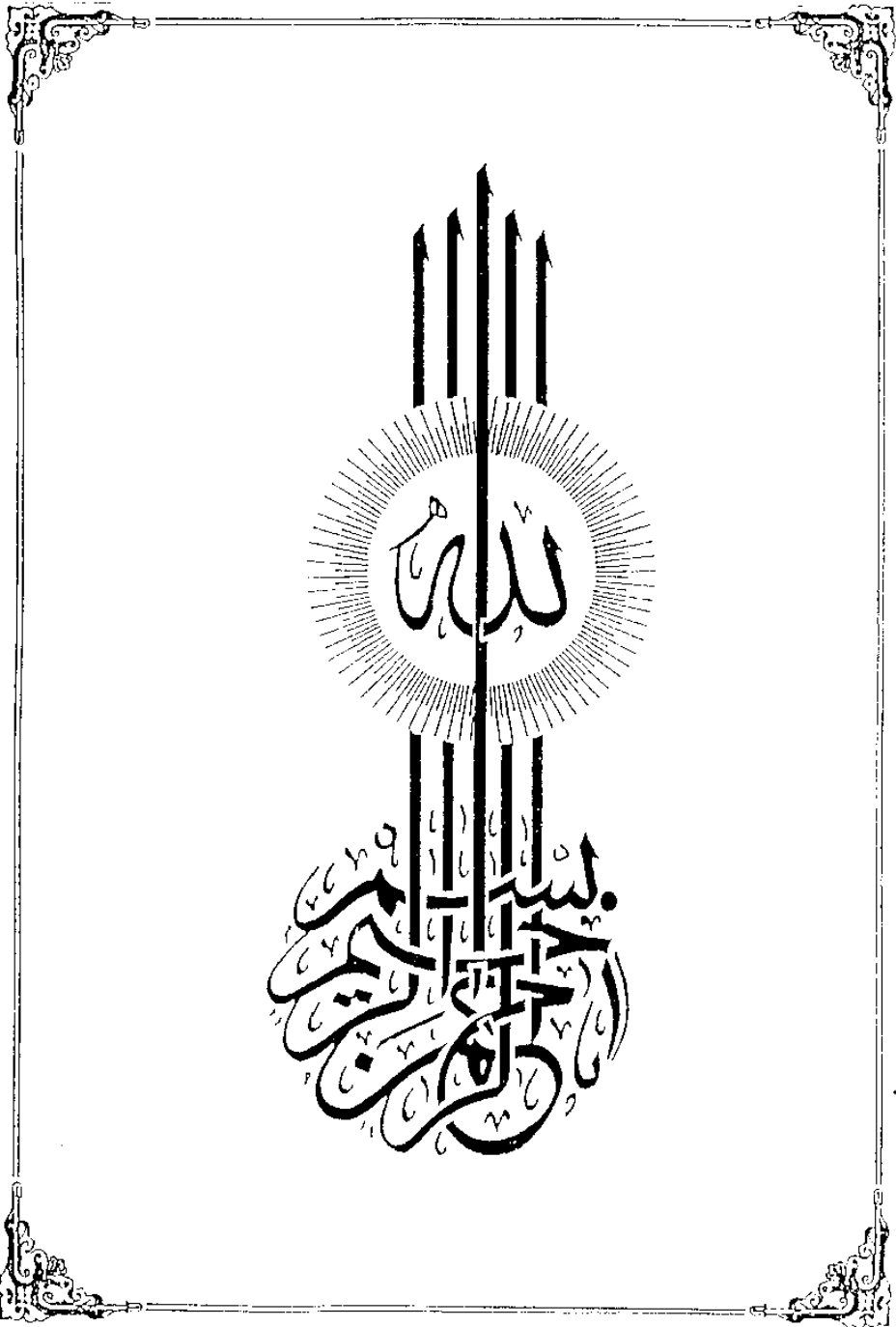
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INTRODUCTION

Ever since man has produced , harvested , and ginned cotton for the use of their fibers , equipment used in the cotton industry has been developed and improved many times over .

Undoubtedly , the first method of ginning cotton (separation of lint from their seeds) was by hand--a tedious task that produced less than 1 kg of fiber per worker per day. A while later, the Churka method of ginning, a true roller gin which was used for centuries in India , employed a pair of small counterrotating wood or steel rollers to pinch and pull fibers from the seeds (Bennett, 1959) .

In 1794, Eli Whitney's invention of the spike-tooth cotton gin was one of the most dramatic developments in the history of the cotton industry. Whitney's gin removed the fibers from the seed by means of small spike driven into a wooden cylinder . The spikes engaged the fibers and pulled them through narrow slots in a metal bar at the back of seed-cotton roll box . The slots, being too narrow for the seeds to pass, retained the seeds and allowed the fibers to be pulled free . A brush cylinder behind the slotted bar removed the fibers from the spikes . In 1796 , Hodgen Holmes improved Whitney's design by replacing the spikes with circular saws and by using flat iron ribs instead of the slotted bar. Holmes also opened up the bottom of the roll box for the discharge of ginned seed , These inventions by Whitney and Holmes were the origin of today's modern saw-gin stand which today has a capacity of up to 50 lb./in./hr, or more .

In 1840, Fones McCarthy's invention of the reciprocating-knife principle was the first major improvement in roller gin design . Its roller was made up of coarse leather, grooved to permit motes and other unyielding matter to pass the knife without damaging it . McCarthy roller gins have an average ginning capacity of 2 to 4 lb./in./hr. and have gained wide acceptance in many cotton producing areas of the world . In some countries , such as India and Egypt, roller ginning is the predominant method of ginning cotton regardless of the cotton staple length (Barker and Griffin, 1984) .

In 1956, an experimental rotary-knife gin stand was designed and constructed for the purpose of increasing ginning capacity . The first design employed a multiblade rotating knife which replaced the conventional reciprocating moving knife (Stedronsky, 1956) .

In 1958 , another experimental version of rotary-knife roller gin was developed--the flight-bar roller gin. That type of gin consisted of moving knives (flight bars) attached to endless chains which moved linearly over the gin roller and stationary knife .

During the 1960's , a major improvement was made to the roller gin. A rotary-kinife (rotary knife contained six edges) roller gin was developed which increased the ginning capacity of the roller gin to 10 to 13 lb./in./hr. This latest type of rotary-knife roller gin is now commercially available and used extensively in the Pima cotton areas of the United States .

Until 1940, hand picking was the main method of harvesting cotton in most cotton producing countries . The shortage of hand labor during WW II promoted the invention of machine harvesting . Stripper and spindle type pickers are the most common machines used today in harvesting cotton. Machine-harvested cottons, in general , have higher quantities of foreign matter (trash) than do hand-picked cottons . Therefore, in order to maintain an acceptable level of cotton quality , it became necessary to remove the foreign matter by the use of different types of cleaners . As more machinery was used in the ginning process , the number of neps in raw fiber increased .

Nep formation is a serious problem in the fiber, yarn , and particularly in the cloth . The definition of neps is not at all straightforward. The American Society for Testing and Materials (1978, D 123) defines nep in raw fiber as being " one or more fibers occurring in a tangled and unorganized mass. " Neps in yarn could be defined as short thick places less than 0.2 millimeter in length which in some percentage of cases , contain trash particles . Neps in fabric are dyeing imperfections rather than fiber tangles only . For most fabric end uses , neps produce an undesirable appearance . Neps are objectionable in fabric because of their adverse effect on appearance and dyeing . In white goods such as shirting, neps result in an unattractive appearance . Neps are particularly objectionable in fabric dyed as a solid color . Immature fibers in the nep dye to a different shade , and the nep itself reflects light differently to cause a color imperfection .

Neps in raw fiber are usually associated with immature or fine fibers and are thought to be primarily formed by mechanical forces which entangle the fibers during processing . In addition to the variability of varieties in forming neps , the most obvious possible causes of nep formation are the action of revolving spindles in the mechanical picker, the saws of the gin stand , the lint cleaners , and the transportation of cotton by air (Waters , 1980) .

Therefore, there are several unanswered questions involving problems with neps-what are the factors that contribute to nep formation in raw fiber , yarn , and cloth ? Is it effect of machine picking ; is it the variety ; is it the trash level in the lint ; is it the amount of lint cleaning ; or is it due to other causes ?

Thus, the objective of this study is to attempt to answer the previous questions by determining the relationship between dyeing imperfections (cloth neps) and cotton variety , gin stand type , and lint cleaning level for machine - and hand picked cottons . Also, to enlarge the scope of this investigation , the study was extended to the effect of the same ginning treatments on other fiber , yarn , and fabric properties in addition to neps .

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A - Brief history of ginning machinery :

1. Separators , distributors , and feeders :

The year 1884 ended about 90 years of rather primitive manually operated single-stand gins , and high lighted the advent of a new era of ginning equipment that had started in 1878 in the United States . This new era marked the beginning of mechanical-pneumatic-hydraulic systems which had several gin stands per battery and apparatus for supplying seed cotton to each ginning unit in the battery .

Early systems had seed cotton flowing from the wagon or storage area through a pneumatic pipe or telescope to a separator . From the separator, seed cotton was conveyed mechanically by a belt distributor, to screened , noncleaning , special boxes with flexible fabric legs known as " pneumatic elevators " . The separators , or blow boxes , wherein the seed cotton was separated from the conveying air , are now generally classified as " separators " or " droppers " . A large quantity of fine foreign matter is removed by all types of screened separators . Cleaning feeders and overhead bulk cleaners were developed rapidly after 1900 . The principal forms of mechanical distributors above the gin stands and gin feeders were developed between 1884 and 1961 .

The turn of the century , 1899 - 1900 , was a milestone in the introduction of overhead bulk air-line and gravity-type cleaners , as well as

improvements in feeders . The 1902 vertical , small-drum cleaning feeders clearly reflected the departure of the cleaning industry from flat to vertical cleaning features . From 1910 to 1930 , small drum feeders became popular , various front and rear attachments were devised to increase their effectiveness and also to compete with big-drum cleaning feeders that were coming into use .

2. Bulk cleaning and extracting :

Early roller and saw gins in the United States utilized whipper or beater cleaners with concave grids long before " system " ginning began. For system ginning , beater cleaners of air-sealed construction early came into use in the air line through which the seed cotton was conveyed from the bins or telescope to the separators . Seed-cotton cleaners positioned outside the air line became known as gravity cleaners , since they did not obtain air current assistance . By 1911 , gravity-type overhead bulk cleaners began to be developed to satisfy the demand for more cylinders than were than used in the air-line units . As gravity cleaners became popular , air-line cleaners were improved by placing their cylinders at right angles to the line of airflow .

There were many different designs of the cylinders and spikes , " Spider " cylinders with forward pitched , backward pitched , or straight tips , and fantype cylinders with straight blades have been successful . In areas where harvesting is rough , cleaners have employed a spider arm type of cylinder in the first position to break up and open the locks.

Other devices , known as traps , are placed in the suction line ahead of cleaning equipment to remove rocks, tramp iron , and green bolls for protection of the machinery . Manufacturers of ginning machinery have from time-to-time brought out variations in forms of gravity traps .

Until about 1926 , the harvests in the United States were usually handpicked . As rough harvestings increased , the gins across the cotton belt changed from simple to elaborate . Improvements of the gin-stand feeders since 1912 , and the use of seed-cotton dryers at the gins since 1932 , were contributing factors to the widespread development and use of large bulk seed-cotton cleaners and trash extractors (Bennett,1962) .

Burs and sticks are extracted from seed cotton by specially designed equipment generally classified as extractors . The ginning industry usually refers to extractors by type; i.e., bur machine , stick and green-leaf machine , and extractor-feeder . The bur machine was developed in the 1920's in response to hand snapping and mechanical stripping of cotton in Texas. The bur machine has been widely adopted by the ginning industry, especially in stripper harvesting areas (Garner and Baker, 1977) . The stick and green-leaf machine was developed by USDA in the early 1950's to meet the more stringent cleaning requirements imposed on gins of that era the rapidly expanding practice of harvesting cotton mechanically (Franks and Shaw , 1959) .

Early stick and green-leaf machines were sold as attachments for bur machines , but these attachments have been gradually replaced with individual

machines commonly referred to as stick machines , stick removers , sling-off machines , or stick and green-leaf machines . The principle has also been incorporated into modern high-capacity extractor feeders .

3. Lint cleaning :

Prior to 1947, the bulk of the cleaning in gins was done on the seed cotton . On October 2, 1951, U.S. Public Patent No. 2,569,501 was granted to Victor Stedronsky and C.Scott Shaw covering the " Flow Through Lint Cleaner ", which was manufactured thereafter by several companies .

Research on adapting lint cleaners to roller gins was carried on at the Southeastern Cotton Ginning Research Laboratory from 1954 to 1957 . The work on lint cleaning by the U.S. Cotton Ginning Research Laboratories became an incentive to the entire industry , and a number of private patents were issued a few years after the government research began . Among these were units for each gin stand called the Moss-Gordin Master Lint Cleaner to operate between the stands and the condenser . As of 1961, this was made for single-, double-, and triple-lint cleaning . The Moss-Gordin type of lint cleaner was quickly picked up and manufactured by other gin companies . This Moss-Gordin or saw-type lint cleaner is the principal type of lint cleaning that is currently used in United States gin plants .

Now, it is obvious that equipment used in gins such as separators , distributors , feeders, seed-cotton cleaners , extractors , and lint cleaners

have been developed and used in many different designs across years . Therefore , some of the following literature may have the same type of data taken on different equipment designs being used at that time . Thus, it is important to mention the previous history about ginning equipment developments to make clear the relation between the time the referenced research was done and the equipment type and model being used .

B - Effect of some ginning treatments on raw fiber and card web neps, lint grade and nonlint content, fiber , yarn , and fabric properties:

1. Raw fiber and card web neps :

The definition of nep in the ASTM (D-123-1978) is given as " one or more fibers occurring in a tangled and unorganized mass". Neps are found in the raw fiber as well as in the carded yarns , and in the fabric . Any mechanical process, machine condition , and machine adjustments affect nep formation . Also , trash content, moisture content (either in seed cotton or in the ginned lint), and other factors affect nep formation in raw cotton , carded yarn , and woven fabric . The following studies show the effect of many factors on nep formation in the raw fibers and card web.

USDA report (1943) mentioned that the somewhat greater nep content of the saw-ginned lint was selected to some extent in the appearance of the yarns .

Williams and Towery (1945) reported that roller ginning produced only about half as many neps as saw ginning in some varieties of American upland cotton .