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EFFECT OF NUTRIENT MANAGEMENT AND PLANTING DENSITY FOR HIGH DENSITY PLANTING SYSTEM (HDPS) OF COTTON GROWTH AND YIELDS

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Abstract

A field experiment was conducted during the Kharif 2 season in 2024 at three Agro Ecological Zone namely Cotton Research, Training and Seed multiplication farm, Sreepur, Gazipur, Bangladesh, Cotton Research, Training and Seed multiplication farm Jagodishpur, Jeshore, Bangladesh and Cotton Research, Training and Seed multiplication farm, Sadarpur, Dinajpur, Bangladesh to evaluate the effects of HDPS under different nutrient management and planting density. The experimental unit was laid out with RCBD design with two factors where factor A: Nutrient management (F1: CDB recommended dose fertilizer i.e. RDF 100%, F2: 10% less of CDB recommended fertilizer dose i.e. RDF 90%, F3: 10% more of CDB recommended fertilizer dose i.e. RDF 110%) and factor B: Spacing (D1: CDB recommended spacing (90cm×30 cm) D2: (70cm×20cm) D3: (70cm×10cm)). So, total nine treatment combination with three replications comprises the whole experimental design. Therefore, plant density revealed significant difference of plant population per hectare and seed cotton yield and there is no significant difference of plant population per hectare on nutrient management but there is interaction effect of plant density and nutrient management on plant population. Therefore, highest seed cotton yield 4.12ton per hectare found in F3×D3 and lowest 3.46 ton in F1×D3.





Keyword: HDPS, RDF, Nutrient Management, Planting density, seed cotton yield.

INTRODUCTION:

The increasing population and decreasing land availability pose new challenges for agriculture in Bangladesh. Our primary priority is to feed people with safe and nutritious food. With cropping intensity nearing 200% and projected to reach 211% by 2030, continuous cropping is likely to harm land fertility and reduce crop productivity by 2050. Horizontal expansion of agricultural land is not feasible due to the shrinking cultivable area. In response, we need to explore and implement vertical expansion like high density planting system, increase yield per unit area in certain regions. Apart from food, clothing is a fundamental necessity and cotton is the main raw material of textile industries of Bangladesh. Cotton (*Gossypium hirsutum* L.) belongs to the malvaceae family is the predominant fiber and multipurpose industrial crop of the whole world. In Bangladesh, cotton has an area of 46760 ha with a production of 2,19 lacs bales and productivity of 3 ton seed cotton ha⁻¹ during 2024-25 and have taken a target an area of 200000 ha with a production of 19 lacs bales in 2050 (Anon 2024-25). Presently we meet only 18-20%

of our country demand, but we have a big business demand and every year we imported about 80-85 lakh of raw cotton per year is needed for feeding our large number of spinning and textile mills and with huge amount of foreign currencies.

Historically a perennial crop, cotton is cultivated annually, with a growing season from mid-July to December, lasting almost six months at previously but recently growing season have prolonged seven to eight month due to climate change and lack of appropriate varieties and production technologies. The cotton farmers are not satisfied with the yield performance and duration of the existing cultivars. High density planting System (HDPS) with suitable varieties with proper management practices may be is now understand as an alternative production system for enhancing the productivity and profitability of cotton. Cotton production with high densities is considered as a potential strategy for reducing production cost by shortening the growing season, less number of cotton picking and leave the land for high value Rabi crop cultivation. Given the high demand and profitability of cash crops and the decreasing land availability, adopting a





high density planting system (HDPS) with suitable cotton varieties and proper management is a viable approach to improving cotton yield and production in Bangladesh. Among the different constraints maintenance of plant density is the major problem which results in 20-30 per cent seed cotton yield loss. High Density Planting Systems (HDPS) are commonly followed to obtain high yields with straight varieties across world, especially in the major cotton growing countries such as USA, Australia, China, Brazil, Turkey, India and Uzbekistan. High Density Planting Systems (HDPS) is more relevant to Bangladesh to establish sustainable production system. So, it was necessary to conduct experiment to know the Effect of nutrient management and planting density for high density planting system(HDPS) of cotton (*Gossypium hirsutum* L.) growth and yields,

MATERIALS AND METHODS:

A field experiment was conducted during the Kharif 2 session in 2024 at three location namely Cotton Research, Training and Seed multiplication farm,Sreepur, Gazipur, Bangladesh , Cotton Research ,Training and Seed multiplication farm Jagodishpur,Jeshore ,Bangladesh and Cotton Research ,Training and Seed

multiplication

farm,Sadarpur,Dinajpur,Bangladesh. The experiment was laid out with RCBD design with two factors where factor A: Nutrient management (F1: CDB recommended dose fertilizer i.e. RDF 100%, F2: 10% less of CDB recommended fertilizer dose i.e. RDF 90%, F3: 10% more of CDB recommended fertilizer dose i.e. RDF 110%) and factor B: Spacing (D1: CDB recommended spacing (90cm×30 cm) D2: (70cm×20cm) D3 :(70cm×10cm)). So, total nine treatment combination with 03 replications comprises the whole experimental design. Cotton cultivars CDB-Tula M1 (*Gossypium hirsutum* L.) will be selected for the study. These cultivars will be chosen based on their known adaptability to the region and potential for high yield in high-density planting systems. The optimum time of sowing of cotton in Bangladesh is from the month of July to 15th of August. Cotton was sown in all three locations like Sreepur, Sadarpur and Jogodishpur from 25 July to 14 August respectively as per spacing in treatments. Later all other management like agronomic practices, fertilizers application, crop protection measures and inter cultural operations were done as per farm standard. The soil of the experimental site were red brown in color with clay loam soil texture and low to





medium nutrient condition in Sreepur, Gazipur, dark brown in color with clay loam to sandy loam soil texture and medium nutrient in Sadarpur, Dinajpur and dark grey in color with silt loam and medium nutrient in Jagadispur, Jashore. Meteorological data, including temperature, rainfall, and relative humidity, will be recorded throughout the growing season from a nearby weather station to analyze their impact on the growth and development of the cotton plants. For comparison of the performance of HDPS, ten plants were selected randomly from each plot. Then, number of monopodial branch/plant, sympodial branch/plant, bolls/plant, single boll weight and yield, population per hectare were recorded from those plants. Yield and yield contributing data were analyzed using statistics 10 software by calculating Least Significant Differences (LSD) with 5% level of significance.

RESULTS AND DISCUSSION:

Effect of plant height over time by Fertilizer and Plant density:

In present investigation, the plant height characters were not significantly (Figure-1&2) influenced level of plant density and fertilizer application. Plant height were recorded at 45 DAS, 90DAS and 135 DAS respectively. Plant height were 59.463cm, 61.348 cm, 62.53cm after 45 DAS in F1, F2 and F3 fertilizer levels and 94.267cm, 96.622cm, 99.353cm after 90 DAS in F1, F2 and F3 fertilizer levels and 106.06cm, 103.21cm, 112.32cm after 135 DAS in F1, F2 and F3 fertilizer levels and similarly Plant height were 58.581cm, 61.274 cm, 63.485cm after 45 DAS in D1, D2 and D3 plant density levels and 95.537cm, 97.815cm, 96.896cm after 90 DAS in D1, D2 and D3 plant density levels and 105.76cm, 107.67cm, 108.16cm after 135 DAS in D1, D2 and D3 plant density levels respectively. This findings indicates that plant height over time by fertilizer and plant density has not been influenced as seen by the non-significant difference in plant height under the different levels plant density and nutrient management.



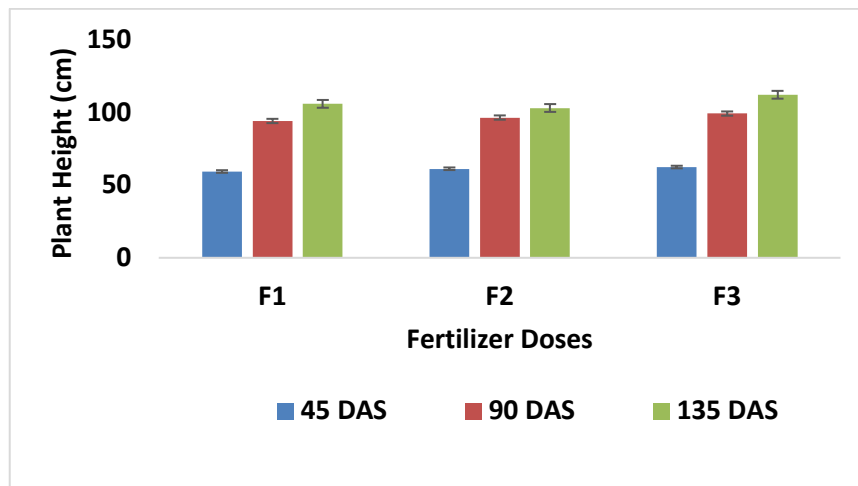


Figure 01: Variations in Cotton Plant Height over Time under Different Fertilizer Doses.

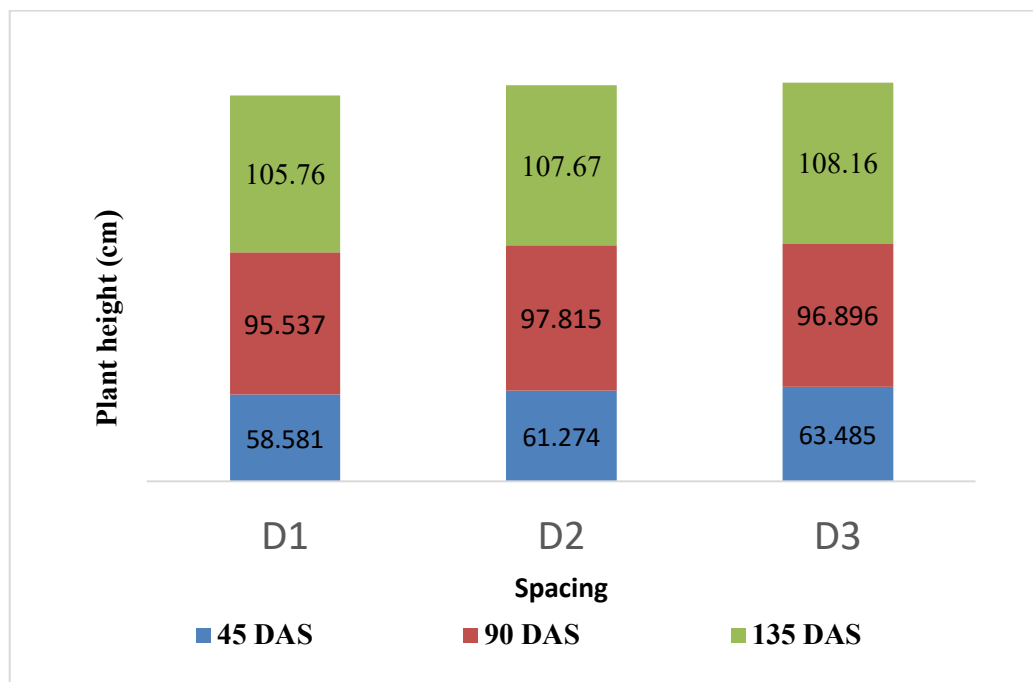


Figure 02: Variations in Cotton Plant Height over Time under Different Plant density.

Effect of plant population over time by Fertilizer and Plant density:

In present investigation, the plant population characters were not significantly (Figure-3) influenced over time by nutrient

management. Plant population were 65000, 70000 and 68000 in F1, F2 and In F3 respectively. This findings indicates that plant population over time by fertilizer has not been influenced under the different nutrient management. But the plant



population characters were significantly (Figure-4) influenced over time by plant density. Plant population were 35000, 60000 and 110000 in D1, D2 and in D3 respectively.

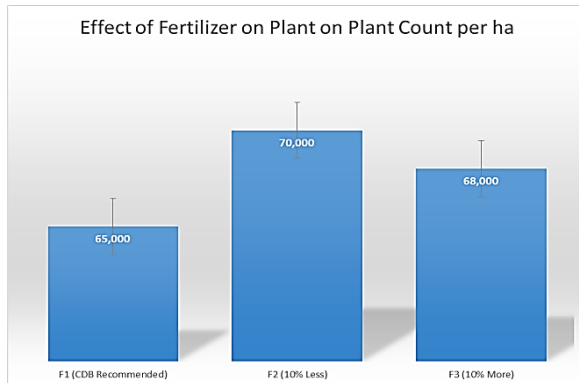


Figure 03: Effect of Fertilizer on plant on plant count per hectare

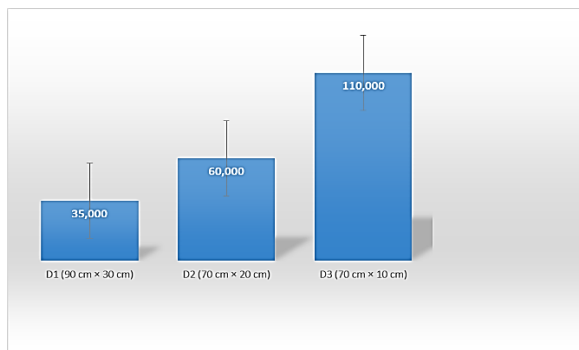


Figure 04: Effect of plant density on plant on plant count per hectare

Interaction between Fertilizer and Spacing on Plant count per hectare:

Interaction effects between spacing and fertilizer levels were found to be significant for plant count per hectare. Spacing of 70 cm x 10 cm with application of 90 per cent RDF recorded significantly higher plant population (115000 ha⁻¹) when compared to other treatments combinations and it was on par with 70 cm x 10 cm with 110 per cent RDF (112000 ha⁻¹) and Lower plant population was recorded in 90 cm x 30 cm spacing with 100 per cent RDF (35000 ha⁻¹) Fig05. The differences in plant population due to planting density and nutrient management of this study.



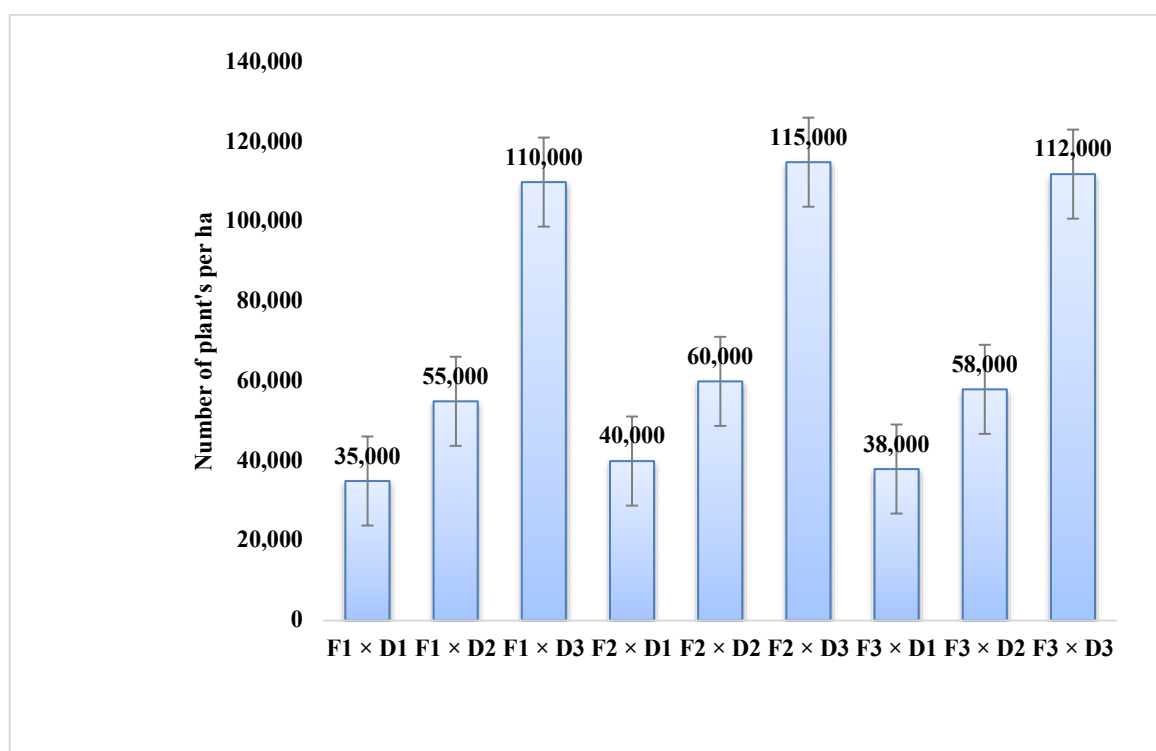


Figure 05: Interaction Between Fertilizer and Spacing on plant count per hectare

Interaction effects between spacing and fertilizer levels:

Interaction effects between spacing and fertilizer levels were found to be significant for seed cotton yield. Spacing of 70 cm x 10 cm with application of 110 per cent RDF recorded significantly higher seed cotton yield (4.12ton ha⁻¹) when compared to other treatments combinations and it was on par with 70 cm x 20 cm with 110 per cent RDF (3.96ton ha⁻¹) and Lower seed cotton yield was recorded in 70 cm x 10 cm spacing with 100 per cent RDF (3.48 ton ha⁻¹) Fig06. The differences in seed cotton yield due to planting geometry and fertilizer can be related to their differential

responses of growth and yield contributing characters. Tomar et al. (2000) [11] found that closer intra row planting gave numerically higher seed cotton yield than wider intra row spaced crop. Significant differences in the seed cotton yield under different spacing was because of variation in growth and yield components viz., dry matter production and its distribution into different plant parts, number of sympodial branches per plant, number of bolls per plant, boll weight and yield per plant. The variation in seed cotton yield in various treatments combination can be traced back to variation in growth and yield attributes like number of sympodial branches per



plant, leaf area, dry matter production, higher number of bolls per plant, higher number of good opened bolls per plant and boll weight could be most relevant cause for achieving higher seed cotton yield per hectare which might be due to higher plant population per unit area and higher levels of fertilizer dose. Higher number of bolls per plant and mean boll weight may be responsible for increased seed cotton yield per plant under 70 cm x 10 cm spacing with 110 per cent RDF. However, yield components like seed cotton per plant, number of bolls per plant, number of good opened bolls per plant and higher boll weight were significantly higher under 90 cm x 30 cm spacing with 110 per cent RDF as compared to rest of treatment

combinations but this treatment combination failed to compensate significant yield per hectare due to lower plant population per unit area. The number of bolls and boll weight were increased significantly with increased plant spacing and increased fertilizer levels which could be due to less competition between the plants and availability of resources. Moola Ram and Giri (2006) opined that increased growth and yield components with applied higher levels of fertilizers. Lower seed cotton yield and seed cotton yield per plant at closer spacing and with lower levels of fertilizers was probably due to less space available for light, moisture and nutrient (Pandagale et al., 2009).

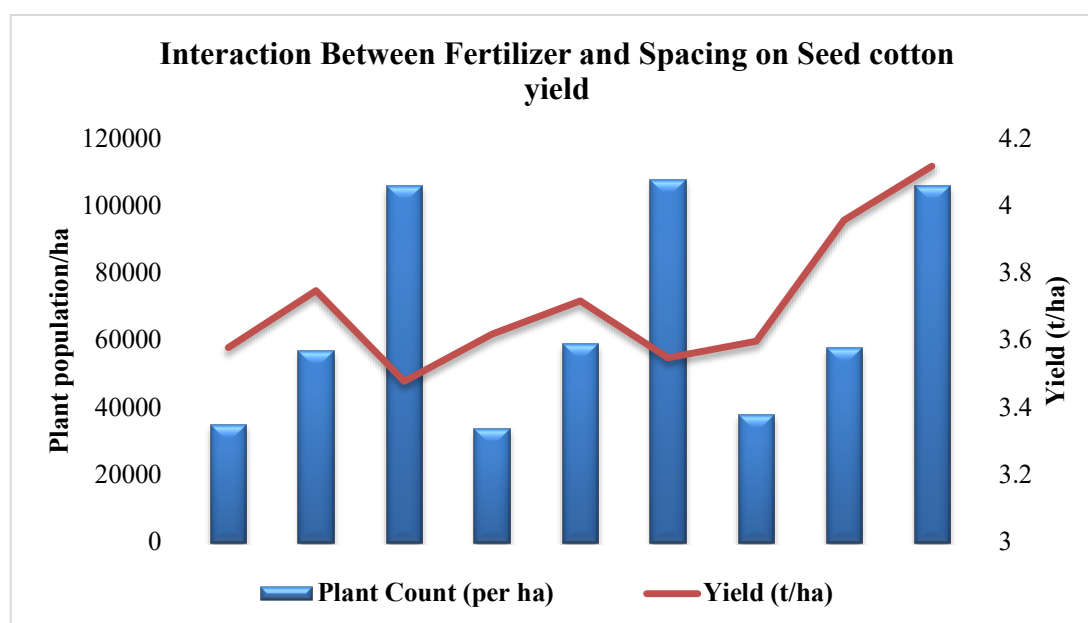


Figure 06: Interaction Between Fertilizer and Spacing on seed cotton yield per hectare.



Conclusion:

Based on the results, it can be concluded that spacing of 70 cm x 10 cm with application of 110 per cent RDF are suitable for High Density Planting System in Bangladesh. Among the different population levels, 115000 plants ha⁻¹ at 70 cm x 10 cm spacing was found to be optimum over 70 cm x 20 cm and 90 cm x 30 cm spacing's. More experiments should be conducted for better understanding and getting the best result.

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Transforming Garment Cutting Waste of Cotton into OE yarns and fabrics Toward Sustainable Textile Production

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Abstract

The global textile industry generates substantial volumes of pre-consumer waste during garment production, particularly in the cutting stage, where cotton fabric offcuts are discarded. These wastes often end up in landfills or are incinerated, contributing to environmental degradation and resource depletion. This research aims to investigate the feasibility of mechanically recycling garment cutting waste into new yarn using open-end rotor spinning, followed by fabric production, as a pathway toward sustainable textile manufacturing. The study adopts an experimental approach involving the collection, sorting, mechanical shredding, and cleaning of cutting waste, followed by blending trials with virgin fibers(such as: cotton, flex and polyester) with different ratio to optimize yarn quality. All the blends were spun to 12s, 16s, and 20s at a constant twist multiplier "4.4, using the open-end spinning and subsequently woven into fabrics. Physical and mechanical properties of the yarn (evenness, tensile strength, hairiness) and fabrics (Water permeability, thermal resistance, abrasion resistance) will be assessed. This research is expected to provide insights into the technical viability and sustainability benefits of recycling pre-consumer textile waste, with implications for circular economy practices in the apparel sector.

Keywords: garment cutting waste, mechanical recycling, open-end spinning, and sustainability.

1. Introduction

1.1 Background

The textile and apparel industry is among the most resource-intensive sectors

globally, consuming vast amounts of water, energy, and raw materials. According to recent reports, the industry generates millions of tonnes of waste annually, much



of which is discarded at the pre-consumer stage, particularly during the garment cutting process. Cutting waste comprising offcuts of cotton fabrics represents a significant and underutilized resource that could be reintegrated into production cycles through recycling by blend it with cotton, linen, and polyester fibers.

1.2 Problem Statement

While numerous initiatives focus on post-consumer textile recycling, pre-consumer cutting waste remains largely overlooked, despite its high purity and lack of contamination. This oversight results in unnecessary waste of high-quality fibers and increased environmental pressure due to landfill accumulation and incineration. The mechanical recycling of such waste into new yarns offers a promising solution, yet challenges remain in achieving acceptable yarn and fabric quality, particularly when using short fibers derived from shredded fabric.

1.3 Research Aim and Objectives

This research aims to explore the mechanical recycling of garment cutting waste from cotton fabrics and blend it with cotton, linen, and polyester fibers and transforming into new yarn using open-end rotor spinning, followed by fabric production. The specific objectives are:

1. To collect, sort, and prepare garment cutting waste for recycling.
2. To mechanically shred and clean the waste to recover spinnable fibers.
3. To evaluate different fiber blends (recycled–virgin blends) for yarn production.
4. To produce and test yarn via open-end spinning for mechanical and physical properties.
5. To produce fabrics from recycled yarn and assess their performance.

1.4 Significance of the Study

The study will provide an applied framework for recycling pre-consumer textile waste, bridging the gap between waste generation and sustainable production. It will also contribute to the growing body of research on circular economy models in textiles, offering practical guidelines for industry adoption.

2. Literature Review

The textile industry is one of the world's largest generators of solid waste, producing approximately 92 million tonnes annually (Ellen MacArthur Foundation, 2017). Pre-consumer waste—generated during manufacturing stages such as fabric cutting, sewing, and finishing—accounts for a significant proportion of this total. Unlike post-consumer waste, which is often





contaminated and degraded, pre-consumer waste maintains a relatively high fiber quality, making it a prime candidate for recycling (Shah et al., 2020). The concept of a circular economy promotes the recovery and reuse of such materials, aiming to keep resources in use for as long as possible while minimizing environmental impact. Mechanical recycling involves shredding textiles into fibers, which are then cleaned, carded, and spun into new yarn. Cotton and linen—both natural cellulosic fibers—can be effectively recovered through mechanical processes, although fiber length is typically reduced, impacting yarn strength and evenness (Blackburn et al., 2020). Studies have demonstrated that cotton cutting waste can be processed into open-end spun yarns with acceptable quality for specific applications such as denim or workwear (Bandyopadhyay, 2018). A recent investigation by Demir and Uçar (2024) on recycling single-jersey cotton and linen fabrics reported that 100% recycled fibers could be spun into rotor yarns, though with increased unevenness (U%) and decreased tensile strength compared to virgin yarns. Blending recycled fibers with virgin cotton improved yarn performance while maintaining sustainability benefits. Polyester's synthetic nature complicates

mechanical recycling, particularly in blended fabrics such as cotton–polyester, where separation is required before re-spinning. Advanced mechanical and chemical separation methods, including enzymatic hydrolysis of cellulose or alkaline hydrolysis of polyester, are under investigation (Choudhury et al., 2024). Mechanical recycling of pure polyester cutting waste has been successfully demonstrated in initiatives such as Project Reclaim in the UK, which converts post-consumer and pre-consumer polyester into new granules for spinning (The Guardian, 2024). However, recycling blended fabrics without separation often results in compromised yarn quality due to the differing fiber properties. Open-end (rotor) spinning is particularly suited for recycling short fibers derived from mechanically shredded textiles (Ramesh et al., 2019). Unlike ring spinning, rotor spinning can handle higher levels of fiber irregularity, contamination, and short staple length. The process involves feeding cleaned fibers into a rotor, where centrifugal force twists them into yarn. While rotor yarns generally exhibit lower strength and a coarser hand compared to ring-spun yarns, they are adequate for many applications, including upholstery, towels, and certain apparel products (Hasanbeigi & Price, 2015).





Open-end spinning also offers higher productivity and lower operational costs, making it economically attractive for recycling operations.

Recover Textile Systems in Spain mechanically recycles pre- and post-consumer cotton waste into new yarn, achieving up to 50% recycled content in commercial fabrics without significant loss in consumer acceptance (Recover, 2020). HKRITA's "Green Machine" uses a hydrothermal process to separate polyester and cotton in blended fabrics, enabling both fibers to be recycled independently (HKRITA, 2021). Sezgin et al. (2023) produced thermal barrier fabrics from

cotton cutting waste, reporting improved thermal resistance and comparable comfort properties to virgin equivalents. Uçar and Demir (2024) demonstrated that incorporating up to 40% mechanically recycled cotton or linen into virgin blends maintained yarn quality within acceptable limits for knitting applications.

3. Materials and Methods

3.1 Raw Materials

Garment cutting waste: Pre-consumer offcuts collected from local garment manufacturing facilities. We adding recycled fibers with different ratio to blend with virgin fibers such as: cotton, flex and polyester.

Table (1) indicate different blend ratio

	Blend (1)	Blend (2)	Blend (3)	Blend (4)	Blend (5)	Blend (6)	Blend (7)	Blend (8)	Blend (9)
O.E	Waste (20%)	Waste (30%)	Waste (40%)	Waste (20%)	Waste (30%)	Waste (40%)	Waste (20%)	Waste (30%)	Waste (40%)
	Cotton (40%)	Cotton (35%)	Cotton (30%)	Cotton (40%)	Cotton (35%)	Cotton (30%)	Flax (40%)	Flax (35%)	Flax (30%)
	Polyester (40%)	Polyester (35%)	Polyester (30%)	Flax (40%)	Flax (35%)	Flax (30%)	Polyester (40%)	Polyester (35%)	Polyester (30%)

The flax fibers were cut into short staple length on a staple cutter machine to produce cottonised flax. The cottonised flax fiber samples were evaluated for fiber length (28 mm), fiber fineness (300 mtex) and fiber

strength (50 g/tex) in the laboratories of Al-Sharkia for for spinning and weaving company-zagzig, cottonised flax was blended with long staple Egyptian cotton Giza 95, measured by HVI spectrum





instrument having Upper Half Mean length of (30.2 mm), uniformity ratio of (85%), micronaire value of (4.2), fineness of (154

mtex), strength of (37.8 g/tex), elongation (7.9 %), maturity ratio of (0.91).

Table (2): polyester fiber properties

Length Mm	Fineness denier	Strength cN/tex	Elongation %	Numb./ Crimps (cm)	Crimp Ratio%	Oil Content	Moisture Content
38±1	1.35	55	25%	6	20	0.12%	0.4%

The polyester fibers have low pilling property antistatic treated, staple fiber row white, semi-dull to be blended with Egyptian cotton

Different blend ratios were made at Opening and Cleaning Machine. All the blends were spun to 12s, 16s, and 20s at a constant twist multiplier "4.4, using the open-end spinning.

Yarn tenacity (cN/Tex) and elongation at break (%) were measured on a statimat ME with 120 breaks per sample. Yarn evenness (CVm %) and imperfections values were measured on Uster Tester 5 (UT5 – S800 / A, 2007) The measurement length was 100 m/bobbin. For the statistical analyses, the trials were designed as analysis of variance experiment as factorial

analysis with three replications, (Draper and Smith 1966).

Weaving

Further, all yarn samples were separately used as weft to produce plain 2\1 woven fabrics on a Texmaco shuttle loom by Al-Sharkia for spinning and weaving company-zagzig. The construction of the sets of fabrics was kept constant at 18 ends and 18 picks per centimeters

4. Results & Discussion

Results and discussion of this study are presented in the following 2 main parts which applied on waste with primary raw material, (Cotton, Flax, and Polyester) under study and its blends:

- 1- Effect of blend ratio on yarn properties.
- 2- Effect of yarn count on yarn properties.





Tables (3): The effect of blend ratio on yarn properties listed in

O.E	Strength	Elongation	C.V	Thin places	Thick places	Neps	H
Blend (1)	14.57	8.10	17.94	81	48	46	5.65
Blend (2)	13.76	7.25	18.58	567	43	41	5.96
Blend (3)	12.44	6.37	19.39	73	48	50	6.33
Blend (4)	9.36	4.94	25.09	80	60	550	7.20
Blend (5)	8.10	4.53	26.10	70	53	45	8.21
Blend (6)	7.85	3.94	27.06	80	61	55	9.28
Blend (7)	11.37	7.68	25.40	68	55	43	7.31
Blend (8)	8.58	5.42	26.79	75	60	56	7.91
Blend (9)	8.21	4.55	28.54	77	63	61	8.31
L.S.D	0.372	0.332	0.319	4.87	4.76	4.93	0.35

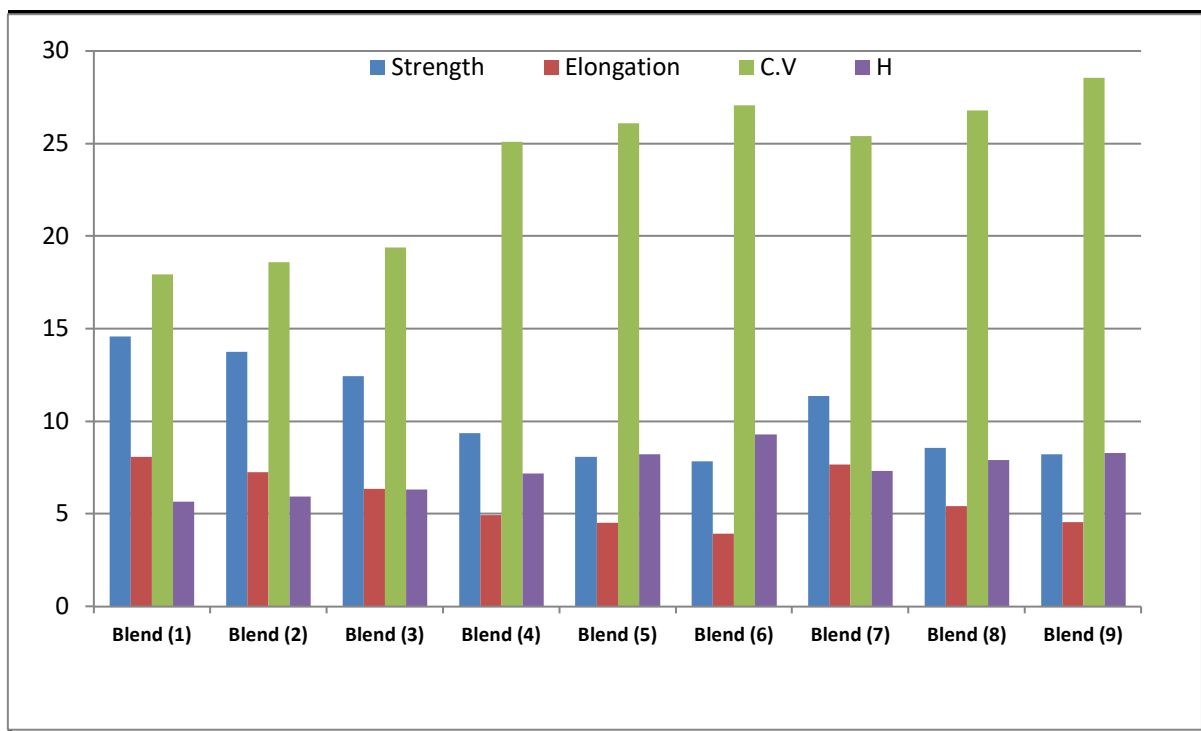




Fig. (1) The effect of blend ratio on yarn properties

On the basis of the data presented in Tables 3, the results illustrate the differences between the values of the quality parameters of the open end spun yarns.

It was recognized that the strength of the blend yarns decreases continuously with increases in the waste cotton cloth minced ratio while the C.V% and the hairiness of the blend yarns increases continuously with increases in the waste cotton cloth minced ratio.

It was recognized that the elongation of the blend yarns increases continuously with increases in the polyester ratio, also the

evenness yarns are increases when polyester ratio increases.

Yarns spun of polyester blended showed better results than corresponding cotton, flax, and waste cotton cloth minced yarns; this is referred to the polyester fibers properties because it has the highest tenacity value.

The results are expected to confirm that increasing virgin fiber content improves tensile strength and reduces unevenness, as reported by Demir & Uçar (2024) and Sezgin et al. (2023).

Tables (4): The effect of yarn count on yarn properties listed in

O.E	Strength	Elongation	C.V	Thin places	Thick places	Neps	H
Count (12)	11.58	6.99	20.80	41	64	41	6.69
Count (16)	10.43	6.03	22.99	55	76	50	7.29
Count (20)	9.40	5.24	24.84	67	83	60	8.03
L.S.D	0.645	0.576	0.553	8.446	8.245	8.5454	0.595



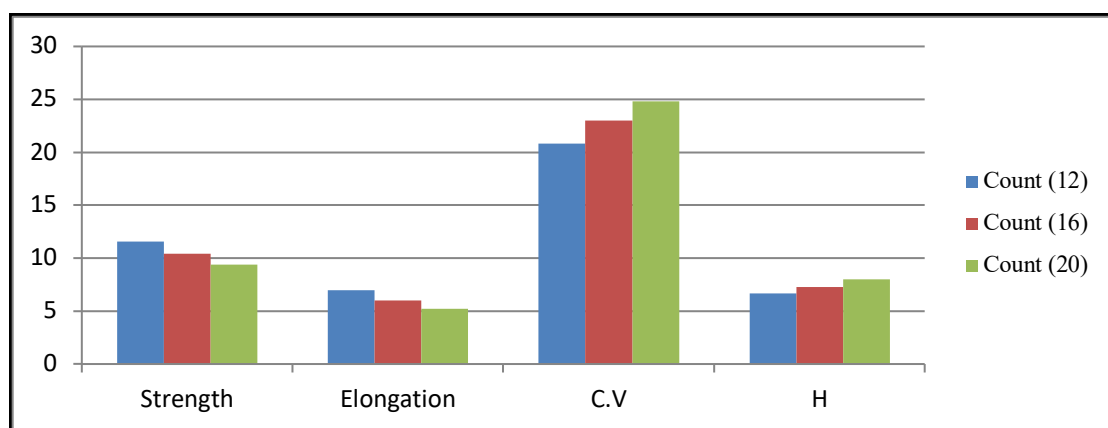


Fig. (2) The effect of yarn count on yarn properties

Yarn count of open-end spinning system had negative significant effect on yarn strength cN/tex and elongation %, The change in yarn strength and elongation % decrease as yarn count is increase from 12s, to 20s corresponding the number of fibers

in the cross-section. The change in yarn unevenness (cv%) and the hairiness were increase as yarn count increased from 12s, to 20s.

4.1 Fabric Performance Analysis

Tables (5): The effect of blend ratio fabrics properties listed in

O.E	Tear (gm)	Water permeability (cm ³ /cm ² /s)	Tensile strength (kgf)	Elongation (mm)	Abrasion cycles
Blend (1)	10283	0.382	39.8	27	1538
Blend (2)	9500	0.482	34.9	25	1206
Blend (3)	8657	0.546	29.9	23	920
Blend (4)	8827	0.476	31.6	19	1250
Blend (5)	8144	0.513	27.9	17	1040
Blend (6)	7453	0.556	25.2	13	822
Blend (7)	9500	0.419	36.2	24	1697
Blend (8)	8743	0.500	31.7	23	1357
Blend (9)	8330	0.530	28.2	21	1050
L.S.D	143.641	0.0109	1.0063	0.3178	11.23

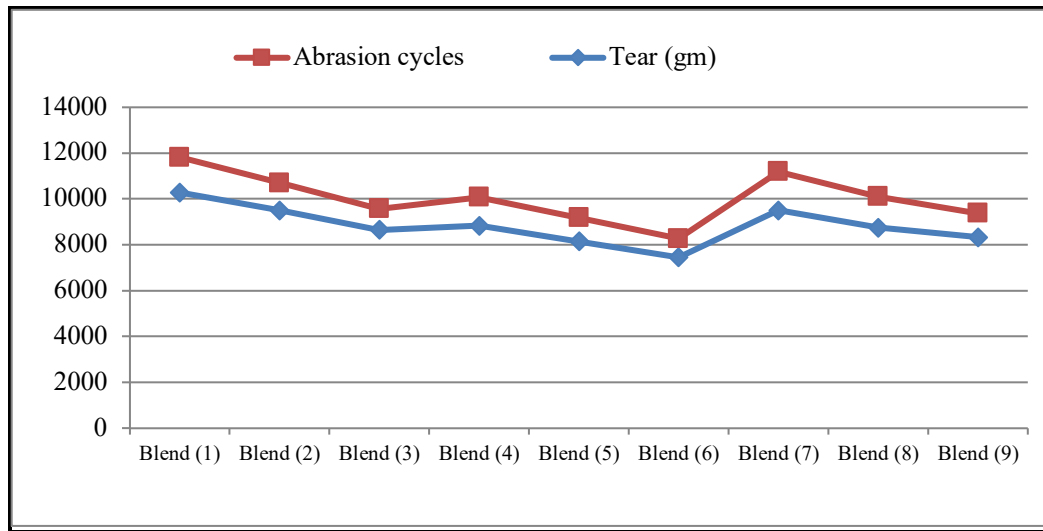


Fig. (3) The effect of blend ratio on fabrics Abrasion cycles and Tear properties

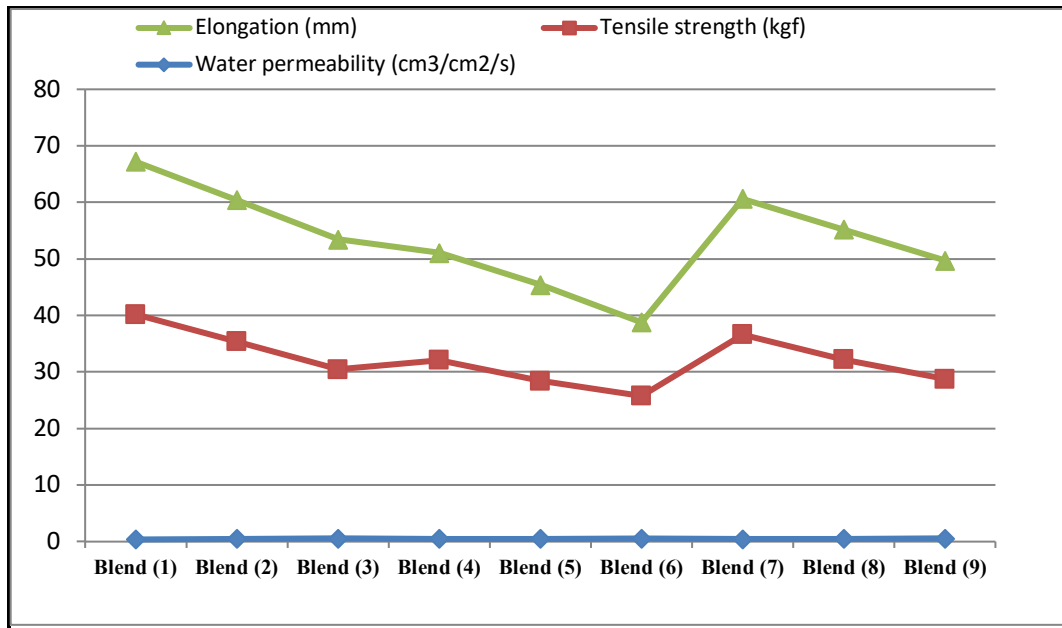


Fig. (4) The effect of blend ratio on mechanical fabrics properties and water permeability

- ❖ Fabrics woven from the recycled yarns are expected to show acceptable performance for specific applications, though with some trade-offs in strength and abrasion resistance.

Table (6): Showed the blend ratios of open-end spinning system yarns:

Blend ratios	Blend (1)	Blend (2)	Blend (3)	Blend (4)	Blend (5)	Blend (6)	Blend (7)	Blend (8)	Blend (9)
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	2.07878	1.82106	1.53597	1.5326	1.3148	1.101359	2.0126	1.7334	1.46791
	1	3	5	6	8	9	2	4	7
	best					worst			

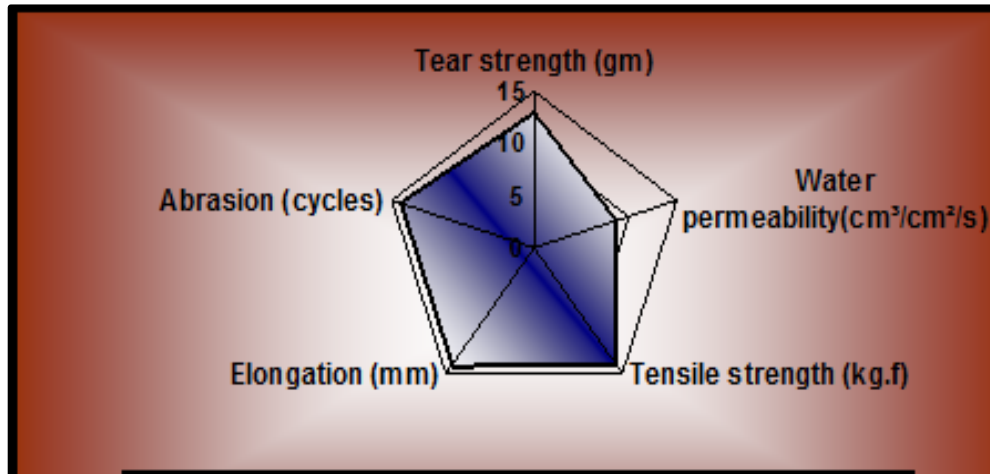


Fig. 5. The best blend ratios of open-end spinning system fabrics

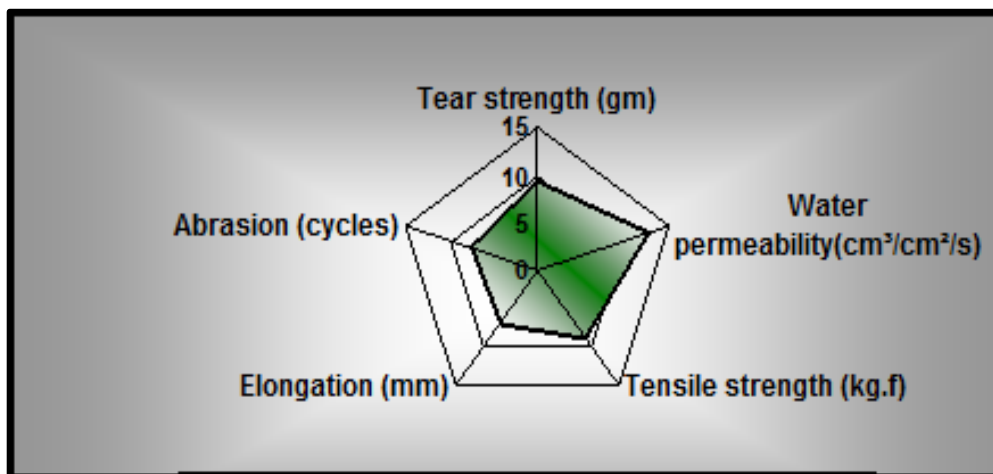


Fig. 6. The worst blend ratios of open-end spinning system fabrics.

The blend ratio blend (1) of open-end spinning system had found the best one for all fabrics properties and followed by blend (7), blend (2), blend (8), blend (3), blend (4), blend (9), blend (5), and the worst one is blend (6).

These expectations align with findings by Sezgin et al. (2023), who observed that fabrics made from recycled cotton cutting waste had better thermal insulation but reduced abrasion resistance compared to virgin fabrics.



4.2 Influence of Fiber Type

Cotton: Produces soft, breathable yarn but is sensitive to fiber shortening during recycling, leading to lower strength in recycled form.

Linen: Stronger in virgin form and blending is essential for acceptable performance.

Polyester: Retains staple length better during blended with cotton or linen.

These trends are supported by Choudhury et al. (2024), who note that synthetic fibers generally better when blend with mechanical recycling of natural fibers.

4.3 Comparison with Previous Studies

Demir & Uçar (2024): Achieved acceptable rotor yarn quality with up to 40% recycled cotton/linen in blends; beyond this, yarn unevenness increased significantly.

Sezgin et al. (2023): Reported enhanced thermal resistance in fabrics made from recycled cotton cutting waste, suitable for protective clothing applications.

Recover (2020): Industrial-scale recycling of pre-consumer cotton achieved substantial environmental savings while maintaining commercial fabric quality.

The expected results of the present study are in line with these findings, but also aim

to fill a gap by systematically comparing cotton, linen, and polyester under identical open-end spinning conditions.

5. Conclusion

This research highlights the technical and environmental feasibility of mechanically recycling garment cutting waste cotton and blend it with linen, and polyester fabrics—into new yarn via open-end rotor spinning. The experimental framework demonstrates that:

1. Fiber recovery through mechanical shredding produces usable staple fibers, though with a reduction in length and strength, particularly for natural fibers.
2. Open-end spinning is well-suited for short recycled fibers, enabling yarn production at commercial rotor speeds while accommodating fiber irregularities.
3. Blending recycled fibers with virgin fibers significantly improves yarn quality. Optimal performance is expected at Waste (20%) Cotton (40%) and Polyester (40%) or Waste (20%) Flax (40%) Polyester (40%), balancing sustainability with acceptable tensile strength and evenness.





4. Fabrics produced from recycled yarns exhibit higher thermal resistance and air permeability, but reduced abrasion resistance compared to virgin equivalents.

Overall, the study confirms that pre-consumer cutting waste, due to its high purity and lack of contamination, represents a prime feedstock for sustainable textile manufacturing in line with circular economy principles.

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