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Effects of nitrophos, nitrogen, and FYM on yield, nutrient uptake, and climate response of cotton genotypes in Uthal, Balochistan, Pakistan

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ABSTRACT

Research on cotton in Pakistan has been remaining since from the time of past decades, resulting in the genetic enhancement and introduce various improved genotypes. However, the cotton seed yield and fiber quality remain quite low as compared with those of developed countries. An appropriate combination of chemical fertilizer and organic manure well selected based on the soil condition and according crops need and availability of resources not only enhancements the crop productions and quality but also maintain the fertility of soil, productivity and long term soil health conditions. Therefore, considering the beneficial effect of integrated and balanced fertilizer of nitrophos (NP) and individual application of nitrogen and farm yard manure (FYM), a field experiment was designed with the objectives to study the comparative impact on integrated application of nitrophos and single application of nitrogen and farm yard manure on cotton growth and seed yield and to evaluate the correlative performance of four different cotton genotypes. The treatments were design as T1: control (no fertilizer); T2: Single application of nitrogen (N) fertilizer, T3: nitrophos (NP) fertilizer and T4: Farm yard manure (FYM). About 4 cotton genotypes such as CRIS-683, CRIS-613, CRIS-543 and Cyto-545 were confirmed against the combined application NP fertilizer and individual application of fertilizer. The application of integrated NP fertilizer were increased the physiological traits of germination percentage, plant population, sympodial branches, monopodial branches, number of bolls plant^{-1}, plant height and seed cotton yield as compared to single application of nitrogen and FYM. Among the all genotypes, the CRIS-682 achieved better results by highest number of monopodial and sympodial branches, plant height, bolls plant^{-1}, seed cotton yield as compared to CRIS-543 and Cyto-545 however lowest results was obtained in CRIS-613.

Keywords: Nitrophos, nitrogen, farm yard manure, genotypes, lint yield and nutrient uptake.

INTRODUCTION: Cotton crop is one of world's leading commercial fiber crops, with global production expected at approximately 29.5 million tones about 135 million bales in each year. This widespread production develops approximately 60% of the world's cultivated land with underscoring its major performance in worldwide agriculture production (Tariq *et al*., 2023). Due to its wide application in textile matters, and bedding industries (fiber based industries), cotton is among the most deeply traded of imported and exported agricultural supplies in worldwide. Despite its importance on cotton cultivation is labor intensive and demands considerable with technical strength, particularly in managing cotton bolls. However, improvements in the cotton ginning process and increased use of machinery have significantly reduced labor requirements and improved productivity for growers (Hardin *et al*., 2018). The production of cotton is strongly influenced by genetic variation and makeup in nutrient uptake and utilization, so genotypes with particular fertilizer approaches are beneficial to maximize both yield production and environmental sustainability (Zhang *et al.,* 2018). Nitrogen consider for the most yielding controlling fertilizer for cotton however excessive of too much fertilizer and applying nitrogen fertilizer on the wrong time reduced fertilizer use efficiency and increase the environmental losses and motivating examination into optimized timing reduced N rates and breeding for nitrogen efficient genotypes 9 (Pu *et al*., 2025). However phosphorus availability and the optimal of P containing fertilizer also moderate the cotton growth and lint quality with integrated N-P management including sources such as nitrophos (NP) fertilizers can change the crop responses depending on the soil health condition and cotton genotypes (Iqbal *et al*., 2020). Green manures and organic fertilizer (Farm Yard Manure) also delivers a different and balancing nitrogen source that can improve soil conditions through supplying of nitrogen, increases soil physical and biological properties with particular method reduced the need for synthetic N responses without compromising fiber quality (Tadesse *et al*., 2013). Balanced and combine application of nitrogen (N) and phosphorus (P) supplying is important for cottons optimal growth and yield because cotton have long growth cycle period continuous flowering and boll formation demand adequate N and P throughout its developmental stages. Recent research demonstrates that NP based fertilization significantly enhances nutrient accumulation N and P especially in reproductive organs, resulting in increased boll number, boll weight, seed cotton yield and improved nutrient use efficiency compared to individual application of nitrogen fertilizer (Chen *et al*., 2024). In contrast when N and organic manure is applied in individual form the cotton often shows poorer P uptake, optimal boll development and lower yield potential because P deficiency limits key metabolic processes is critical for cotton crop during boll formation and development of fiber (Pu et *al.,* 2025). Therefore, integrated nitrophos fertilizer characterize an additional effective and efficient nutrient management methods for cotton to providing balanced of key mineral nutrients and increasing the cotton yield and fiber production under different genotypes and soil health conditions. Integrated nitrophos fertilizer (NP) playsa vital and better performance for enhancing cotton growth, boll development and nutrient use efficiency compared to individual application of nitrogen and farm yard manure fertilizer. By applying a balanced and combined source of nitrogen and phosphorus in form of NP achieve more identical for nutrient uptake and improved reproductive growth and higher cotton seed yield through different genotypes. However, this strategy not only increase yield production but also promotes to the sustainable nutrient management and eco-friendly by enhancing fertilizer use efficiency and reducing environmental losses and soil condition. Considering the availability among cotton genotypes in response to nutrient availability, objectives of this study to evaluate the impacts of combined application of nitrogen with phosphorus in the combination of Nitrophos (NP) fertilizer and individual nitrogen fertilizer and FYM with organic amendment, on the growth, seed yield,, lint quality and NP content by providing findings for genotypes and optimized nutrient management strategy.

OBJECTIVES: The study was aimed to evaluate the comparative effects of integrated Nitrophos (NP) fertilizer and individual applications of nitrogen (N) and farm yard manure (FYM) on the growth, physiological traits, and seed cotton yield of different cotton genotypes. It also sought to assess the correlative performance of 4 available cotton genotypes (CRIS-683, CRIS-613, CRIS-543, and Cyto-545) under these fertilizer treatments to identify the most responsive genotype for enhancing productivity and fiber quality under Uthal, Balochistan conditions.

MATERIALS AND METHOD: The field experiment was conducted at the research farm of Lasbela University of Agriculture, Water and Marine Science (LUAWMS), Uthal Balochistan. The area is considered one of the most important cotton producing region of Baluchistan. Soil samples were collected from the depth of 0-15 cm and 15-30 cm to measure the fertility level of soil, air dried, grinding and processed. The soil texture, saturation percentage, pH and ECe was recorded as described of the US Salinity Laboratory Staff (1954). Cotton was sown at a spacing of 30 cm between plants and 75 cm between rows. The field experiment was planned as randomized complete block design with 3 replications for each treatment. Nitrogen fertilizer and P fertilizer were purchased from standard market fertilizer Provider Company from the region. The FYM was obtained from a local livestock farm and used as the organic amendment. Four available cotton genotypes (CRIS-682, CRIS-613-CRIS-543 and Cyto-545) were selected. The concentration of nitrogen and phosphorus were measured in the applied fertilizers before applying fertilizer, however farm yard manures was applied directly without nutrient analysis. This study was designed with 4 treatments including a control T1: (control no fertilizer), T2: 100 kg N ha^{-1}, T3: 100 kg NP ha^{-1} (nitrophos) and T4: 10 tons FYM ha^{-1}. The recommended dose of N (100 kg ha^{-1}) and 100 kg NP were applied in the form of Urea contains (46%) and Nitrophos fertilizer which contains 22% nitrogen and 20% phosphorus in granular form. The calculation of fertilizer and FYM was applied according the rate of treatments.

Procedure for analysis and calculation: The seed of cotton was sowing with the combine cotton drilling machine. Thinning and hoeing were conducted twice by hand and three times manually by hand. A single herbicide application was used before sowing time and continuous insect monitoring indicated that no additional control was required during the crop season. The Irrigation were applied in all plots according their need during whole experiment time. For the data collections of physiological traits such as germination %, plant population, monopodial and sympodial branches, plant height, seed cotton weight per boll, number of bolls per plant, seed cotton yield, (g), lint percentage, lint yield and lint yield were observed during field experiment. The data of lint observed from each single sample was weight and percentage of lint was measured by according following formula: Lint % = lint weight / seed cotton weight x 100. For the determination of nutrients content, plant samples were oven dried at 75 °C for 48 h. The dried samples were subjected to wet digestions using a di acid mixture of HNO^3 and $HClO_4$ in a 2:1 ratio according Jones and Case. (1990). Concentration of nitrate nitrogen in the leaves was subsequently measured by the following method described by McGill and Figueiredo. (1993).

Statistical analysis: The analysis of treatments were compared using statistical analysis based on the two factors fertilizer and genotypes according factorial arrangement in a randomized complete block design (RCBD) according Steel *et al*. (1997) with the help of statistics 8.1 software.

RESULTS: After determining soil texture, the soil was described as soil clayey, with a saturation percentage of 52%, pH 7.47 and an ECe of 1.84 dS m^{-1}. The fertility assessment showed that the total nitrogen 0.049%, available phosphorus of 7.6 mg kg^{-1}, available potassium of 82 mg kg^{-1} and organic matter content of 0.56%.

Germination percentage (%) and plant population plot^{-1}: Results revealed that the impact of treatments on germination % and plant population was significant at (P< 0.05). In case of combined application of nitrophos fertilizer, and individual nitrogen and FYM application was significantly (P< 0.05) increased the germination % and plant population of all the genotypes. The highest germination percentage 72% and plant population 56 m^2 was observed in CRIS-682 and Cyto-545 genotypes, however the lowest germination percentage 40% and plant population 40 m^2 was observed in CRIS-613 and CRIS-543 genotype under control treatment (figure 1). In case of individual application of fertilizer, the maximum germination percentage 64% and 56% and plant population 54 and 51 m^2 was observed in CRIS-682 under single application of nitrogen and farm yard manure, however Lowest germination percentage 41% and plant population 41 m^2 was observed in Cyto-545 genotypes.

Number of sympodial and monopodial branches plant^{-1}: The monopodial and sympodial branches plant^{-1} application of together organic sources in combine and individual increased the monopodial and sympodial branches plant^{-1} of all the genotypes as compared to the control condition. Maximum monopodial branches plant^{-1} (21) and sympodial branches plant^{-1} (12) were observed in CRIS-682 cotton genotype while lowest sympodial (3) and monopodial branches plant^{-1} (2) was observed in Cyto-545 genotype under control treatments (figure 1). Combined application build a significant (P<0.05) difference in order of monopodial and sympodial branches plant^{-1} of all the genotypes. In comparison of CRIS-682 genotype produce maximum sympodial branches (21) through combined and balanced application of nitrophos however lowest sympodial branches (9) was observed in CRIS-543 and Cyto-545 genotype under organic fertilizer.

Plant height (cm) and seed cotton weight per boll: The nitrophos and individual application of fertilizers improved the plant growth and increased the plant height plant^{-1} of all cotton genotypes. The maximum plant height plant^{-1} (118 cm) and seed cotton weight of boll^{-1} (4.31 g boll^{-1}) was observed in CRIS-682 genotype, however the lowest plant height of plant^{-1} (65 cm) and cotton weight of boll (12.7) was observed in CRIS-613 and Cyto-545 genotype under control condition (figure 1). Application of combined and individual fertilizers significantly (P<0.05) increased the plant height and seed cotton weight of boll in genotypes of CRIS-682 and Ctyo-545. In order of single application of nitrogen and farm yard manure fertilizer, the highest plant height (109 and 106 cm) and seed cotton weight of boll (3.89 and 3.88 g boll^{-1}) was observed in Cyto-545 genotype, however lowest plant height (95 cm) and lowest cotton seed weight of boll (3.1 g boll^{-1}) was observed in CRIS-613 of genotype.

The bolls plant^{-1} and lint percentage (%): This trait of all the genotypes increased by combined application of fertilizer into the soil. The maximum bolls plant^{-1} (64.54) and lint percentage of (40.8%) was observed in CRIS-682 genotype while lowest bolls plant^{-1} (40) and lint percentage (31.3%) was observed in CRIS-543 genotype under control treatments (figure 1). Single Application of nitrogen and farm yard manure significantly (P<0.05) increased bolls plant^{-1} (58 and 52) and lint percentage (34.3% and 36.09%) in CRIS-543 genotypes. In order of combined application of nitrophos, maximum bolls plant^{-1} (46) and lint percentage (40%) was observed in CRIS-682 genotype while minimum bolls plant^{-1} (45) and lint percentage (36%) was observed in Cyto-545 genotype under farm yard manure.

Seed cotton yield (kg ha^{-1}) and lint yield: The yield and lint yield increased of all four cotton genotype by application of nitrophos fertilizer. The maximum seed cotton yield (38160 kg ha^{-1}) and lint yield (13356 kg ha^{-1}) was observed in CRIS-682 however lowest seed cotton yield (21765 kg ha^{-1}) and lint yield (7618 kg ha^{-1}) was observed in Cyto-545 genotype under control treatments (figure 1). A significant difference (P<0.05) was observed between the treatments and seed cotton yield and lint yield by applying of combined application of nitrophos (NP) and individual fertilizer of nitrogen and farm yard manure. In order of single application of nitrogen and farm yard manure fertilizer, the maximum seed cotton yield (34342 and 32134 kg ha^{-1}) and lint yield (1209 and 11001 kg ha^{-1}) was observed in CRIS-682 and Cyto-545 genotype however lowest seed cotton yield (25687 and 24879) and lowest lint yield (8995 and 11247) was observed in CRIS-543 and Cyto-545 genotypes under single application of nitrogen and farm yard manure.

Leaf N and P concentration: This study confirmed that the impact of treatments on N content was significant at (P< 0.05). Application of NP significantly increased the N content of selected cotton genotypes. The maximum N content (32.5 g kg^{-1} N) and P content (2.98 g kg^{-1} P) was observed in CRIS-682`genotype however the lowest N content (20.2 g kg^{-1} N) and P content (1.66 g kg^{-1} P) was recorded in CRIS-613 and Cyto-545 genotype of cotton (figure 1), respectively. In case of individual application of fertilizer, the individual application significantly (P< 0.05) increased the N content of all the cotton genotypes as compared to control treatment. The highest N content (28.4 g kg^{-1} N) and P content (2.81 g kg^{-1} P) was recorded in CRIS-682 genotype, however the lowest N content (21 and 25.5 g kg^{-1} N) and P content (1.75 g kg^{-1} P) was observed in CRIS-613 and Cyto-545 genotype. In case of combined application, the highest P content (2.98 and 2.96 g kg^{-1} P) was observed in CRIS-682 and Cyto-545 genotype, however the lowest P content 1.66 g kg^{-1} P) was observed in CRIS-543 genotype under control and farm yard manure treatments.

DISCUSSION: The chemical (N and P) and organic (FYM) fertilizers played a dynamic role for improving crop growth and productivity. The nitrogen is essential for vegetative development and chlorophyll synthesis, whereas combined nitrogen and phosphorus fertilizers develop both vegetative and reproductive growth by promoting plant growth, root development, flowering, and boll formation. The FYM, as an organic source of fertilizer, not only supplies essential nutrients but also improves soil structure, water maintenance, and cation exchange capacity (CEC), so improving nutrient availability and uptake. The combined use of N, NP, and FYM approves balanced nutrition, tolerate the soil fertility and enhances crop yield under variable environmental condition. Positive influence of NP and FYM application on plant height and cotton seed yield was due to improved carbon adoption in soil and supplementary enriched soil properties. Application of nitrogen, nitrogen + phosphorus and FYM could have booted cotton growth and yield production (Bole 2021; Appasaheb 2022; Khan *et al*., 2024). Application of nitrogen and NP fertilizer at the later stages caused the buildup of more N and NP which was found favorable.

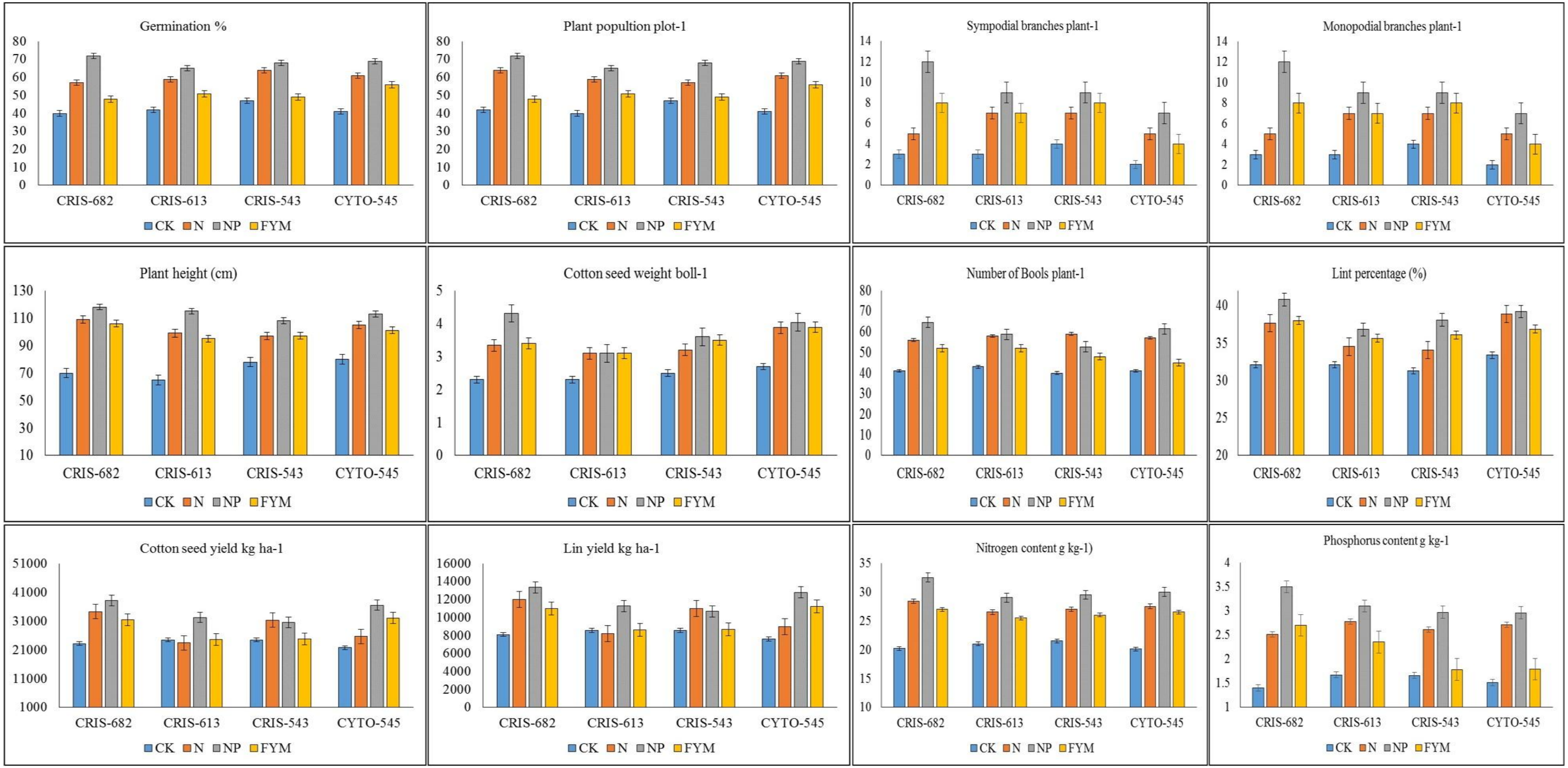

Figure 1: Effect of integrated Nitrophos (NP) fertilizer and individual application of nitrogen and farm yard manure (FYM) on germination (%), plant population plot^{-1}, sympodial branches, monopodial branches plant^{-1}, plant height (cm) and cotton seed weight boll^{-1}, number of bolls plant^{-1}, lint percentage (%) , cotton seed yield kg ha^{-1}, lint yield kg ha^{-1}, nitrogen content g kg^{-1} and phosphorus content g kg^{-1} lint yield kg ha^{-1} of cotton genotypes.

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A strong difference was observed through NP application then single application of Nitrogen and FYM regarding of boll producing branches. Similar findings were also observed by other investigators particularly in regarding of boll producing branches (sympodial and monopodial branches) and plant height through NP application (Sun *et al*., 2022). These outcomes are in contract with the findings of those who indicated by Ipekci *et al.* (2024) in regarding with the number of bolls plant-1 and monopodial and sympodial branches by Ahmad *et al*. (2019) and Zaman et al (2021) and boll weight and seed index by Modhvadia *et al*. (2012). The positive influence of balanced application of N + P and nitrogen fertilizer with organic fertilizer to cotton with regard of nutrient uptake are sustained by statement of Lin *et al*. (2024) and Iqbal *et al*. (2020). Integrated application of NP showed a significant impact on the size of cotton bolls as confirmed by Kashif *et al*., 2023. Longer boll produced more lint's % and cotton seed than the small size boll. The phenotypic and genotypic correlation analysis revealed that the lint yield was the main supplier for cotton seed yield and was followed by boll weight and lint percentage (Ali *et al*., 2016; Zeng *et al*., 2022). However other attributes remained create minor association towards the differences in cotton seed yield. Bechere *et al*. (2014) find out through their research of cotton that bolls plant^{-1} had a strong significant impact on lint yield. Variation in results described by previous studies on the cotton traits could be due to variances in genotypic and environmental conditions. The yield characters of cotton such as number of bolls plan^{-1} and boll weight have significantly impact on the cotton seed yield (Meena *et al*., 2017). The cotton seed yield and high lint yield achieved in the findings of with that (Pettigrew et al., 2004) who reported that lint percentage and cotton seed yield boll^{-1} were moderately greater under the application of integrated fertilizer (Nitrogen + phosphorus). In this research cotton seed yield improved moderately more than the lint yield in accordance with (Khan *et al*., 2017) who observed that the lint percentage and seed yield significantly more than the cotton seed yield. The application of combined (N+P) with Nano-fertilizer improve the soil physical condition and it's beneficial for the enhancement of cotton seed and lint yield (Zakzok *et al*., 2018). In the current study the highest N concentration was observed in CRIS-682 genotype where the combined application of NP fertilizer was applied while the application of individual nitrogen and FYM not improved the recovery and uptake of N.

CONCLUSION: The future of this technique will presumably lie in the generation of high-throughput gene function analysis systems for species highly susceptible to VIGS, like the *Solanaceae* or California poppy. Ligation-free vector systems are already available and inserting partial sequences of the target gene in VIGS vectors is sufficient for VIGS to be effective. Forward genetic screens may be achieved in non-model plants for which large insertion mutant collections and genome maps are unavailable, but EST sequencing projects have provided sufficient information on the transcriptome. High quality genome or transcriptome data provides an excellent foundation to select the most promising regions of a transcript to be silenced, either to avoid or to induce simultaneous silencing of genes closely related in sequence. Published examples of high throughput approaches include cloning of normalized or subtractive cDNA libraries in VIGS vectors and subsequent plant inoculation with the aims to reduce nicotine levels, to analyze genes required for Pto-mediated resistance in tobacco, and to screen for developmental defects in tomato. These high-throughput platforms would be particularly desirable for expanding our knowledge, and they will be useful for assessing target genes related to abiotic stress resistance, pathogen interaction, and yield improvement in crop breeding programs.

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