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Research Paper

Rice genotypes (*Oryza sativa*) respond to varying planting dates and environmental conditions

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Abstract

Rice (*Oryza sativa* L.) is a vital food crop that plays an important part in the global economy. It is the third most produced crop in the world, after wheat and maize. Furthermore, rice provides the majority of the food for nearly two-thirds of the world's population. The timing of sowing significantly impacts the productivity of rice. However, planting rice too early exposes it to the cold, which can result in low vigor, poor germination, and possibly the seedlings dying. The rice grain's important growth stage occurs with the highest temperatures of the summer, so planting rice too late may result in lower yields and lower-quality grains. During the Kharif season of 2022, the field trial site was the SAU Tando Jam. The experiment was set up with a split plot design. Three planting dates have been selected for the main plots: June 30, July 15, and July 30. The subplot treatments included four rice genotypes: KSK-33 (control), N-M-11, N-M-8, and N-M-10. Conversely, the rice crops planted on June 30th significantly outperformed those planted on other dates. The crops measured 97.27 cm in height, with an average of 19.18 tillers per plant, a panicle length of 20.11 cm, a seed index of 29.82 g, a biological yield of 8964 kg/ha, a grain output of 5330 kg/ha, and an 84.11% harvest index. The genotype and sowing date interaction significantly impacted plant height, panicle length, number of shoots per plant, seed index, biological yield, grain yield, and harvest index. When planted on June 30, the genotype N-M-11 exhibited the highest values for these characteristics.

Introduction

Among the most important food crops in the world, rice (*Oryza sativa* L.) is vital to the global economy. In terms of yield, it comes in third place globally, right behind maize and wheat. Furthermore, roughly two-thirds of the world's population depends on it as their primary food crop (Abbade, 2021). Apart from its culinary application, rice holds significant functions in numerous other domains. The cottage industry uses rice because of its rice straw, which serves as an essential feed for livestock. In the soap industry, it also acts as a fuel source (Wang et al., 2021). Asia grows and consumes roughly 90% of the world's rice, which necessitates a semi-aquatic technique with significant water requirements. About 45% of Asia's total rice area is not irrigated, with the majority of rice farmed in lowland environments fed by rainfall. Pakistan's second-most important crop for consumption, rice, has recently become a major source of income for the nation. The number of people dependent on rice has increased due to population growth (Sudheer et al., 2018); with more than half of the world's population relying on it as a primary source of livelihood. Rice serves as a crucial food and financial resource. To reduce yield losses in lowland rain-fed areas and increase total rice output, there is a need for new rice cultivars with improved drought resistance (Kumar et al., 2021).

Agro climatic conditions have a major impact on rice farming in every region of the world, and crop improvement has always been essential to the selection and advancement of superior rice varieties. Planting dates is one of the most important elements affecting rice performance, among other aspects. Rice performance may suffer from late planting dates because the plants may not have enough time to mature before encountering harsh weather conditions like drought or cold. Furthermore, because plants may experience longer stress periods and greater temperatures, delayed seeding might result in poorer yields and lower-quality rice. When choosing when to sow different rice genotypes, it is important to take into consideration a number of aspects, such as the local environment and weather, potential hazards from pests and diseases, and the particular characteristics of the rice genotype in question (Ahmed et al., 2017). Despite not being a financial factor, sowing timing has a big impact on rice productivity. Several studies have shown that planting rice later in the monsoon season increases grain yields since there is less weed growth. But too late seeding can restrict rice's phase of vegetative and reproductive growth, which would ultimately reduce crop yields (Kumar et al., 2012). Among the many agronomic approaches available, choosing a high-yielding variety and determining the best time to sow are the easiest ways to get the required yield. This is due to the fact that various kinds respond differently to the unique environmental conditions present during the growing season in terms of growth processes, genotypic traits, input requirements, and adaptability (Hussain et al., 2019).

Materials and methods

The SAU Tando Jam served as the site of the field experiment in 2023's Kharif season. The experiment was set up as a split plot with four rice genotypes NUYT-M-11, NUYT-M-8, NUYT-M-10, and KSK-33 (check) as subplot treatments and three planting dates—June 30, July 15, and July 30 in the main plot. From each treatment, ten plants were chosen at random to gather information on yield and yield components.

Nursery Management

To manage the soil, plant the seedlings, control the density of the seedlings, prepare the nursery bed, add fertilizers, offer irrigation, and control pests. After 15 to 40 days after sowing, we remove the rice seedlings grown in nurseries and plant them in puddled, levelled fields (DAS).

Statistical analysis:

A factorial design analysis of variance was used to gather and analyse the experimental data for different wheat attributes. The analysis was carried out using the 2005 Student Edition of Analytical Software's computer application Statistix (SWX), Version 8.1. Moreover, we evaluated the significance levels among various combination means using a least significant difference (LSD) test, following (Gomez, 1984) methodology.

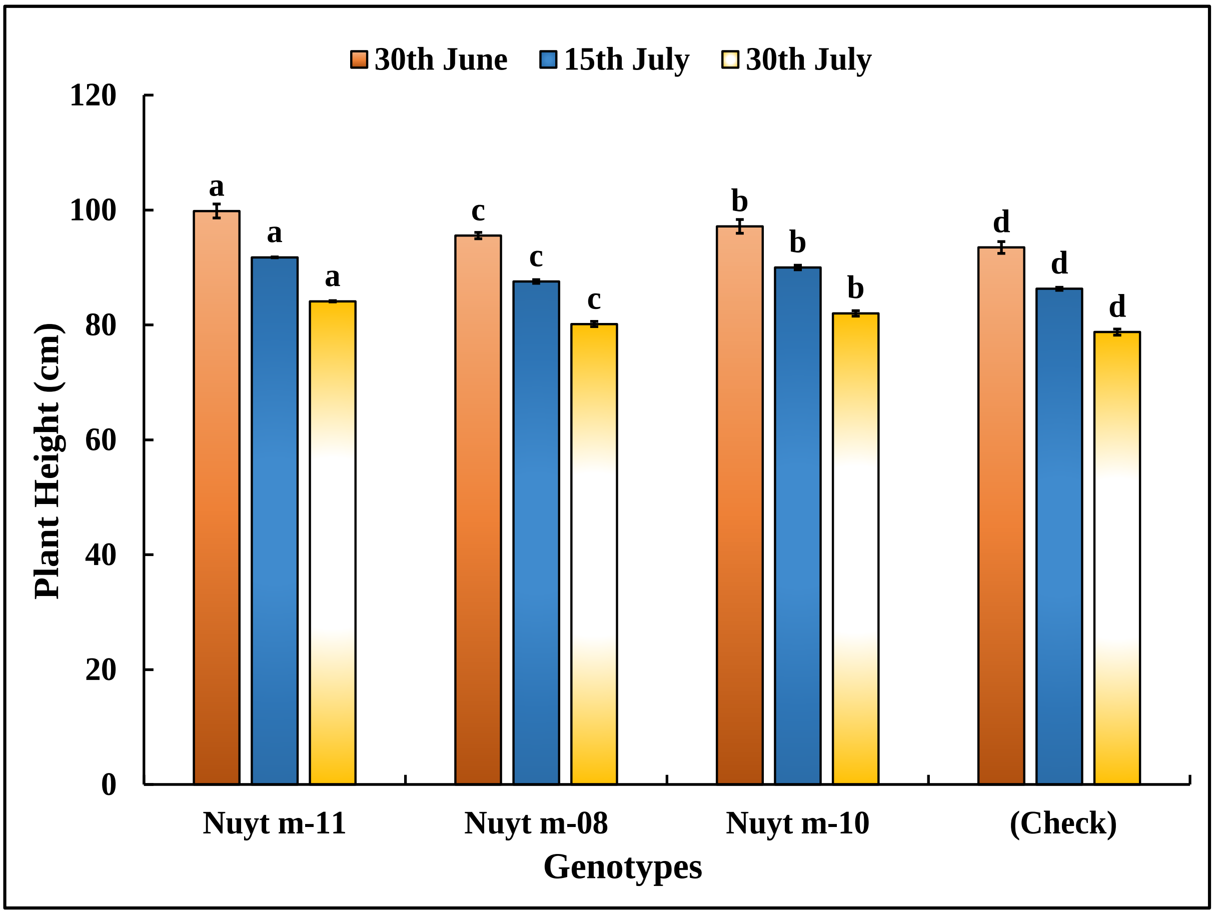
Results and Discussion

Plant Height cm

Figure-1 provides the data. The results indicated that there were significant differences between the genotype combinations and sowing dates, as well as their interactions. At a 5% probability level, the sowing date combination was significant. The crop was sown on June 30th, yielding the largest rice plant height (97.27 cm). The average height of the plants on July 15th was 82.36

cm. The crop reached its lowest average height of 82.36 cm when planted on July 30. Genotype N-M-11 recorded the highest plant height at 92.65 cm, followed by N-M-10 at 90.80 cm and N-M-8 at 88.93 cm. The KSK-33 (Check) genotype had the lowest plant height, measuring 86.96 cm. The genotype N-M-11 and the July 30th sowing date interaction created the highest plant height (100.05 cm), while the genotype KSK-33 (Check) and the same sowing date interaction produced the lowest plant height (29.22 cm). These results agree with those of Sahu et al. (2014) and Cordero-Lara et al. (2020) who discovered that planting rice crops later in the growing season resulted in taller plants.

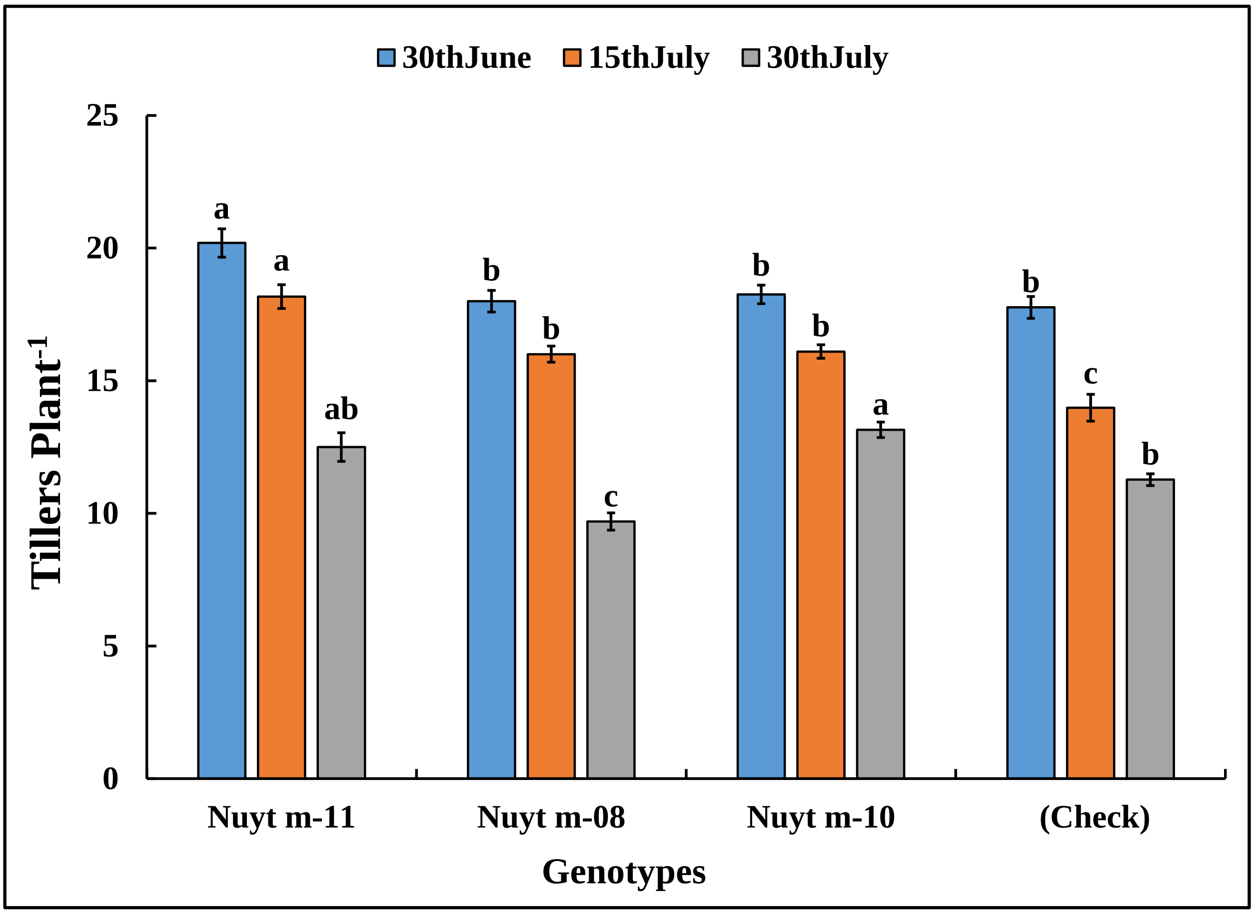
Figure-1 Shows the Variance Planting Dates Affect Rice Genotypes Plant Heights cm



Number of tillers plant^{-1}

Figure-2 reveals that on June 30, there was a report of the highest number of tillers per plant, specifically 19.18. Researchers noted an average of 15.80 tillers per plant on July 15. The KSK-33 (Check) genotype produced the fewest tillers per plant (14.87), while N-M-11 (17.21) recorded the highest, followed by N-M-10 (15.57) and N-M-8 (15.11). The genotype and sowing date interaction revealed that although the identical genotype sown on July 30 produced the lowest number of tillers per plant (10.42), N-M-11 sown on July 30 produced the maximum number of tillers per plant (20.23). These results are in line with those of Usman and Ayatullah (2016), who found that planting rice too early or too late has a detrimental effect on the quantity of rice tillers and total seed output.

Figure -2: Effects of Various Planting Dates on the Number of Tillers per Plant for Rice Genotypes

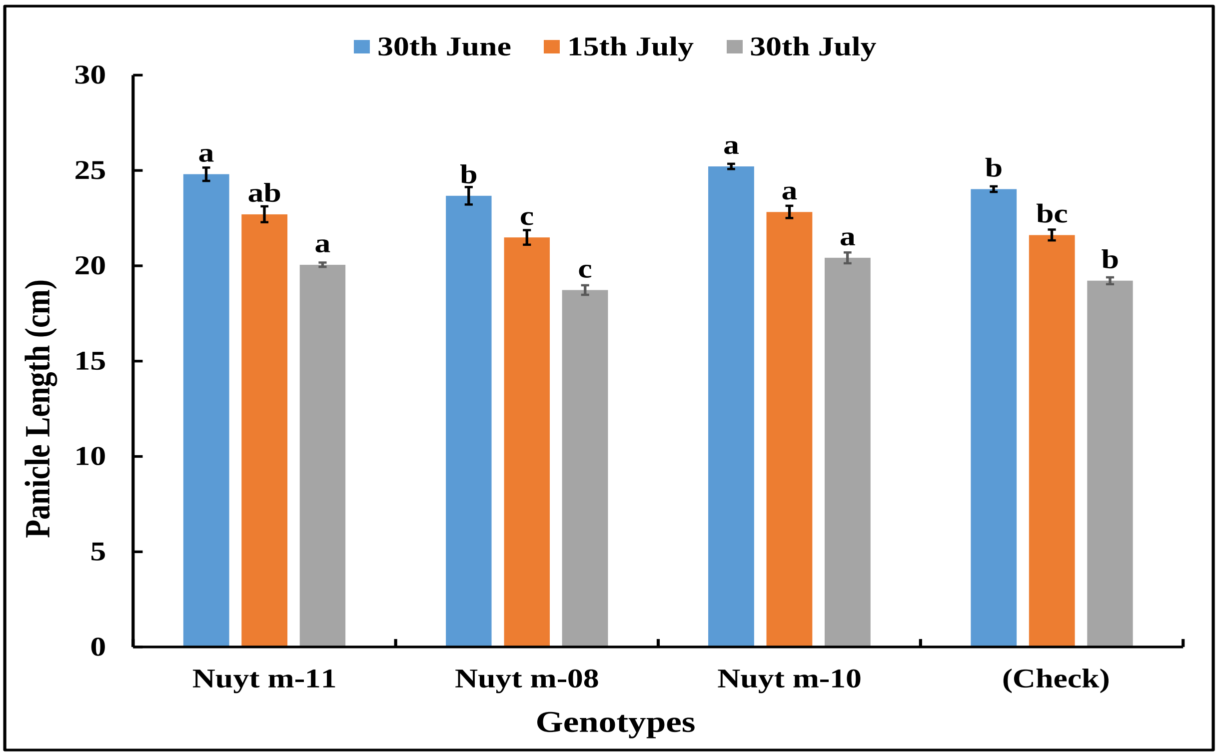


Panicle length cm

The variance analysis of the panicle length (cm) showed the planting date to be significant at the 5% probability level, with the planting time and its interaction demonstrating even greater relevance Figure-3 shows that we sowed the crop on June 30, when we recorded the longest panicle length of 20.11 cm. On July 15, we conducted the second sowing, resulting in an average ear length of 22.51 cm. From July 30, when the crop was sown, the shortest average (panicle length) of 24.77 cm was recorded. With a panicle length of 23.23 cm, N-M-11 was the genotype with the largest length, followed by N-M-10 at 22.81 cm and N-M-8 at 22.21 cm. The genotype KSK-33 (Check) had the smallest panicle length at 21.61 cm. The combination of the July 30th sowing date and the N-M-11 genotype produced the largest panicle length (25.27 cm). Conversely, the combination of the June 30th planting date and the KSK-33

(Check) genotype produced the minimum (Panicle Length cm) (19.21 cm). According to Zhu et al. (2021), there were notable variations in the nutritional content, physicochemical characteristics of starch, and fine structure of grains with different ear areas and lengths.

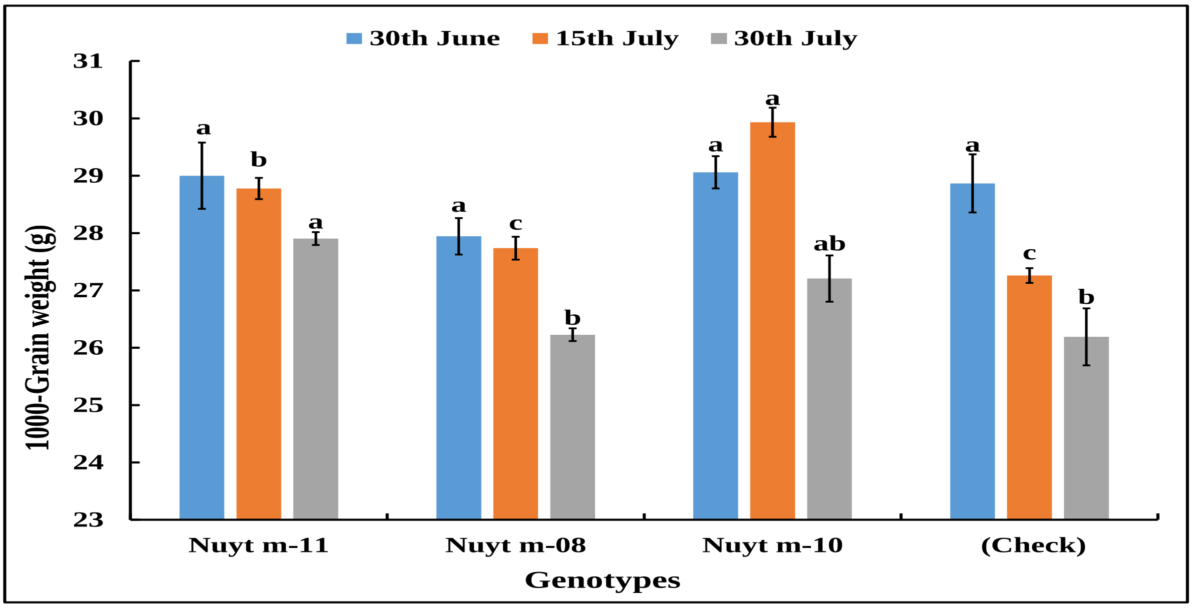
Figure -3: Shows How Different Planting Dates Affect the Panicle Length (cm) Of Different Rice Genotypes.



Seed index (weight in grains, 1000 g)

They examined the connection between planting dates and genotypes and the weight of 1000 grains, or the rice seed index Figure-4. On June 30th, at 29.82 g, the highest seed index was recorded, with an average weight of 1000 grains. The lowest seed index of 27.93 grams was noted on July 30, while the highest was 28.76 grams on July 15. The genotypes N-M-11 (29.15 g), N-M-10 (28.99 g), and N-M-8 (28.69 g) had the greatest seed index. With a weight of 28.52 grams, the genotype KSK-33 (Check) had the lowest seed index. The combination of N-M-10 and the June 30th sowing date produced the highest seed index (weight of 1000 grains) at 30.11 g, according to the genotype-planting date interaction results. On the other hand, the combination of KSK-33 (Check) and the July 30th sowing date produced the lowest seed index (weight of 1000 grains) at 27.61 g. The research findings presented are verified by Hussain et al. (2013), who discovered that perfect timing produced greater grain weight and higher rice seed quality.

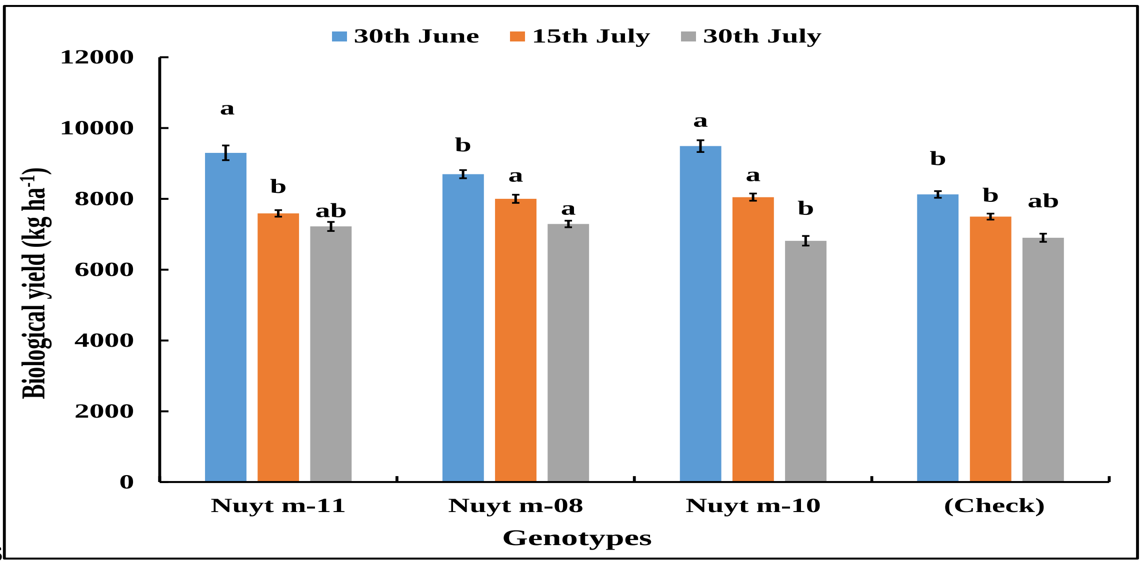
Figure-4: Differences in Planting Dates Effects on Rice Genotypes Seed Index (1000-Grain Weight, G)



Biological yield (kg ha^{-1})

Varying dates were used for the sowing of rice genotypes KSK-33 (Check), N-M-11, N-M-8, and N-M-10, all of which produced varying biological yields (kg/ha). At 8964 kg/ha, the crop planted on June 30th had the highest biological yield. Figure-5 indicates that as of July 15th, the average biological yield was 7820 kg/ha. The plants that were sown on July 30 had the lowest average biological yield, measuring 7107 c/ha. The KSK-33 (Chek) genotype had the lowest biological productivity with a yield of 7573 c/ha. The genotype with the highest biological yield is N-M-11, at 8071 c/ha; N-M-10, at 8221 c/ha; and N-M-8, at 7989 c/ha.

Figure-5: Shows the Impact of Various Sowing Dates on the Biological Yield (Kg/Ha) of several Rice Genotypes



The N-M-10 genotype, sown on June 30th, provided the maximum biological yield (9575 kg/ha) in the genotype and planting date interaction, while the KSK-33 (Check) type, sown on July 30th, produced the lowest biological yield (6913 kg/ha). Xu et al. (2021) and Rezaei et al. (2017) did experiments that supported these findings. They showed that longer sowing times resulted in lower grain yields and lower-quality grains with less starch and biomass production in low-quality grain cells.

Grain Yield per hector

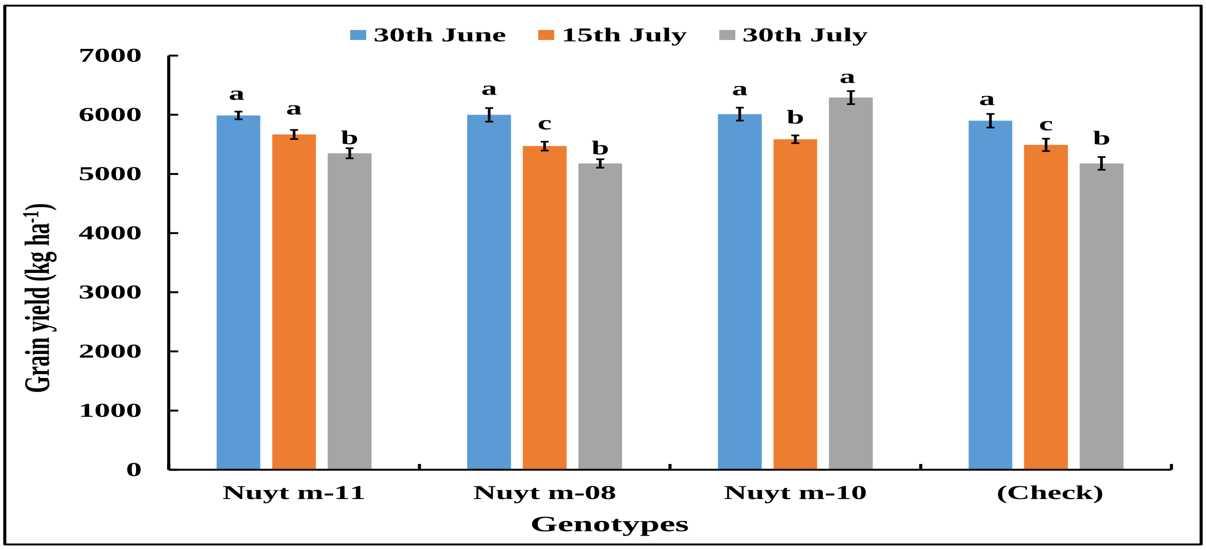
Figure-6 the relationship between various sowing dates and their combinations is crucial, according to a statistical analysis of the variation in grain yield kg/ha. At the 5% probability level, the sowing dates were significant. Sown on June 30, the grain yield was the highest (5330 cubic meters/hectare). As of July 15, the average yield was 5,715 m3/ha. The N-M-11 genotype has the highest yield (6015 c/ha); the second is N-M-10, with a yield of 5672 c/ha; and the third is N-M-8, with a yield of 5672 c/ha. Yield is 5623 m3/ha. -1. -1. At 5569 kg/ha, the KSK-33 (Check) genotype produced the least amount of grain. The N-M-11 genotype, sown on July 30th, had the highest yield of 70.34 kg/ha in terms of the interaction between genotype and sowing date; the KSK-33 (check) genotype, sown on June 30th, also produced the highest yield of 70.34 kg/ha. The highest grain yield ever measured was 70.34 kg/ha, while the lowest was 59.31 kg/ha. The results of an LSD test showed that there were statistically significant (P 0.05) differences in grain yield among different genotypes and planting dates. The results align with the experiments conducted by Zhu et al., 2021, and Singh et al., 2019, which determined the optimal planting time to maximize the yield of quality rice seeds. The data presented here, as well as these studies, emphasize how critical it is to choose the right planting dates in order to achieve maximum rice yield and yield potential (Yu et al., 2020), (Farooq et al., 2019), and (Ding et al., 2020).

Harvest index (%)

The following were the harvest indices for rice genotypes planted on various sowing dates: N-M-11, N-M-8, N-M-10, and KSK-33 (check). As indicated by Figure-7 the crop that was sown on June 30th had a maximum harvest index of 84.116%. On July 15th, after planting, the average harvest index was 69.99%. The crops sown on July 30th had the shortest harvest. The genotypes with the highest harvest index were N-M-11 (75.20%), N-M-8 (71.77%), and N-M-

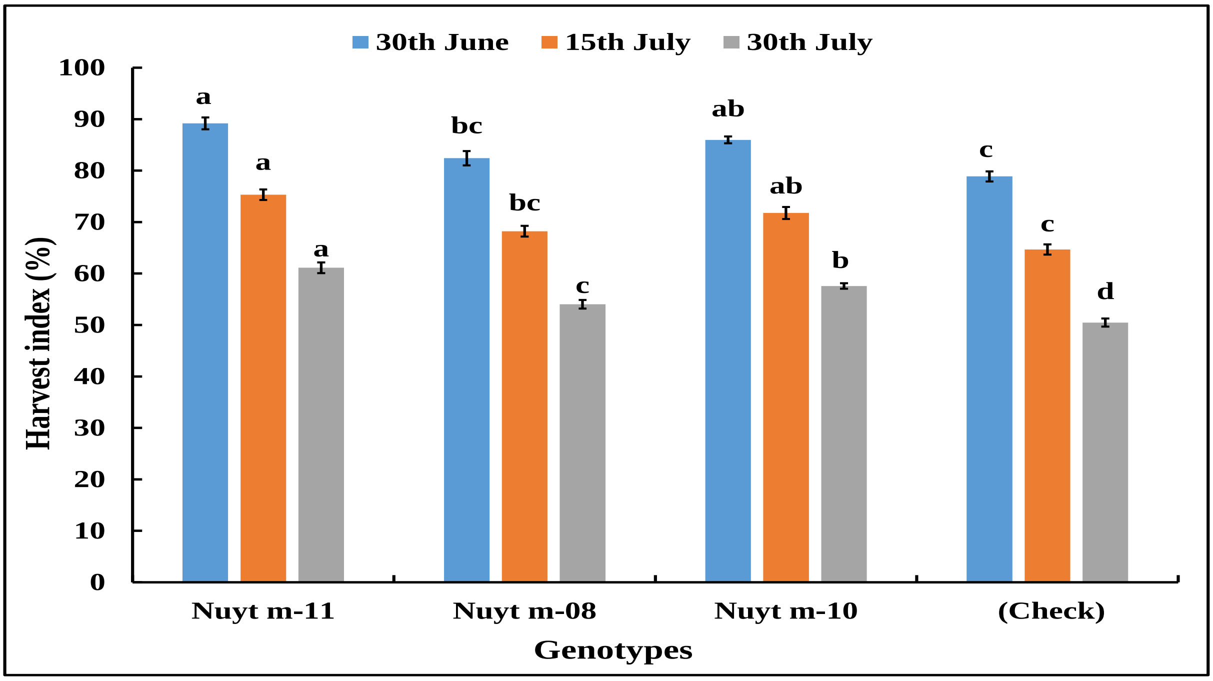
10 (67.22%). With a harvest index of 64.67%, the KSK-33 (Check) genotype had the lowest yield.

Figure-6: Displays the Effect of Different Planting Dates on the Yield (Kg/Ha) of Various Rice Genotypes.



The KSK-33 genotype planted on June 30th had the highest yield index (89.17%), whereas the KSK-33 genotype sown on July 30th had the lowest yield index (50.47%), according to the genotype and sowing date interaction analysis. Rice cultivars sown early have higher vegetative growth than those sown later (Dewi et al., 2021; Golam et al., 2019).

Figure-7: Harvest Index (%) For Different Planting Dates' Effects on Rice Genotypes



Conclusions

Based on the findings from the current study, the rice genotypes that were sown on June 30th performed the best, yielding 6000 kg of grain per hectare. The genotypes that were sowed on July 15th produced 5715 kg of grain per hectare, whereas the genotypes that were planted on July 30th produced 5330 kg.

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