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Impact of Different Methods of Sowing and Seed Priming on Yield Attributed Characters of Rice (*Oryza sativa* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Agronomy farm, Khalsa College, Amritsar (Punjab) during Kharif season of 2021, to study effect of different Sowing methods F_D (Flat dry sowing), B_D (Beds dry sowing), F_w (flat wattar sowing), B_W (beds wattar sowing) and priming methods (No priming, hydropriming and halopriming (Potassium nitrate)) on yield attributing character of rice. We concluded that maximum grain yield (72.7 q ha^{-1}) and biological yield (167.9 q ha^{-1}) was recorded at F_W which was at par with F_D. Maximum straw yield was recorded at F_D *i.e.,* 97.1 q ha^{-1} which was at par with F_W. Maximum harvest index was recorded at F_w *i.e.,* 43.1 which was comparable with other treatments. On the other hand, result showed that progressive increase in the grain yield (72 qha^{-1}) was recorded at P_N*i.e.,* Potassium nitrate which was significantly higher than others. The straw yield (95.5 qha^{-1}) and biological yield (167.9 qha^{-1}) were highest at P_N which was significantly higher over P_0 (Control) but at par with P_w (hydropriming). The maximum harvest index (42.4) was recorded at P_N but at par with P_w and control. Result obtained that maximum yield attributes are recorded by using F_W as a sowing method and P_N as a seed treatment in rice cultivation.

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1. INTRODUCTION

More than half of the world's population gets their nutrition from rice (*Oryza sativa* L.), a staple cereal crop of great importance. A total of 158 million hectares of rice are grown each year in Asia. The primary method of cultivating rice is by transplanting nursery seedlings into puddled soil. But due to a lack of irrigation water and rising labour costs, academics have recently turned their attention to other techniques for growing rice. In order to address labour and water problems, direct seeded rice (DSR) has become a viable alternative establishment method. DSR is more widely used by rice farmers who want to optimise financial returns due to its lower planting cost. By eliminating nursery raisings, seedling uprooting, puddling, and transferring, direct seeding helps cut down on water usage by roughly 30% while also requiring less manpower [1]. Three techniques are available for direct planting rice: Wet seeding (planting pre-germinated seeds over wet puddled soil), water seeding (planting seed into standing water), and dry seeding (sowing dried seeds on dry soil) are the three methods of seeding. However, in many parts of the world, drought is a major abiotic factor that affects rice productivity and growth. As a result, crop loss due to drought has garnered more attention than crop loss from other environmental causes [2]. A drought during the first stages of crop development results in uneven and delayed seedling emergence and establishment [3]. Reduced water intake during the imbibition stage is the primary factor causing a drop in seedling emergence [4]. Seed priming was introduced to solve the issue of seed germination. Since seed priming is predicated on the behaviour of imbibition, a crucial step in the germination and development of seeds is the assimilation of water by the seeds. Better germination and establishment in a variety of crops, including canola, wheat, rice, and maize, can result from seed priming treatment. According to Farooq et al. (2019), seed priming has positive effects on germination rate, germination percentage, uniformity, and speed of germination in addition to boosting plant growth, speeding up plant flowering, and boosting yield [5]. According to Bradford, seed priming strategies increase germination rate and speed and are low risk/ [6] low cost solutions for poor stand establishment [7]. To increase germination and emergence in the seeds of numerous field and horticultural crops under both ideal and suboptimal circumstances, a variety of seed priming techniques based on priming solution are employed, including hydropriming, osmopriming, hormonal priming, nutrient priming, and biopriming [8,9,10,11]. Using salts (KNO3, NaCl, CaSO4, and CaCl2) to soak seeds is known as halo priming. This method enhances seed germination in both normal and salt-affected soils. For this reason, seed priming with KNO3 is seen to be a viable method for improving rice seed germination. A macronutrient, potassium (K) is required for the synthesis of proteins, the activation of enzymes, the movement of stomata, and it can either directly or indirectly affect osmotic adjustment [12,13]. Rice seed priming with nitrate salts (Mg (NO3)2 and KNO3). enhanced plant height, leaf count, leaf area, number of fertile tillers, grain output, and quality of panicles. This could be because nitrate salts acted as growth regulators for crops, transferring more photosynthetic units to areas that contribute to yield and raising overall yield. However, hydro-priming, which involves soaking seeds in water prior to sowing, may enhance germination and emergence in both normal and salinized environments [14]. Farmers can simply apply and adopt this inexpensive and straightforward strategy of seed priming with water to improve seedling emergence homogeneity and germination percentage under water stress (drought) circumstances. Plant weight, root length, number of roots, shoot length, vigour index, and duration to 50% emergence are all greatly impacted by hydro-priming. Seeds that are primed undergo several physiological and biochemical alterations and emerge from dormancy. â-mannanases' activity was enhanced and their dormancy was broken by priming. Treating seeds with different organic and synthetic compounds is known as seed priming. The main objective of this study to evaluate the effect of different sowing method and seed priming on yield attributes of rice. This experiment provide optimization to farmer regarding which method of sowing and seed priming is best for rice.

2. MATERIALS AND METHODS

The experiment was conducted in Agronomy farm of Khalsa College, Amritsar during *kharif* 2021. The experiment site was located at 31.63º N latitude and 74.87º E longitude, representing the Indo-Gangetic alluvial plains, in the Trans-Gangetic Agro-Climatic zone. The elevation above mean sea level was 234 meters. The soil was sandy loam, with moderately saline in nature, low in organic carbon, available nitrogen, available phosphorus with high available potassium. PR 126 variety of rice was used in the experiment. The experiment was carried out in Factorial Randomised Block design consisting of twelve treatments with three replications. In main plot, there are four treatments of sowing of rice viz., F_D (Flat dry sowing), B_D (Bed dry sowing), F_w (Flat wattar sowing) and B_w (Beds wattar sowing). In sub plot, the treatments consisted of priming with different priming substances followed by re-drying for 12 hours. The treatment used were control (No priming), hydro-priming (soaking of seeds for 12 hours) & KNO_3 (soaking seeds for 12 hours followed by 12 hours drying). The land was given irrigation before its final preparation. It was then given 3-4 ploughing (including operation with disc plough, cultivator and rotavator). Fertilizers were applied @ 120:90:60 NPK kg ha^{-1}. All phosphorus, potash and half nitrogen were applied at the time of sowing while the nitrogen was applied in splits at four, six and nine weeks after sowing. Data were collected on harvest index (%), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and biological yield (q ha^{-1}). Observations were taken regularly for germination & counting was done regularly until final germination was recorded. All the recorded data were tested for normally homogeneity and analysed using SPSS. The mean separation was done using LSD (at 5% level of significance).

3. RESULTS AND DISCUSSION

3.1 Effect of Different Sowing Method on Yield Attributes

Data (Table 1 and Fig. 1) concluded that maximum grain yield i.e., 72.7 q ha^{-1} was recorded at flat wattar sowing which was comparable with flatbed sowing but 7.7% and 11.6% more obtained under B_D and B_w. However, it was found at par with F_D (69.8 q ha^{-1}). Similar result was given by Javaid et al. [15] concluded that flat sowing showed higher paddy yield. It might be due to production of comparable number of seedlings, spikelets per panicle, grain weight and higher number of panicles per unit areaFurther, data indicated that straw yield was higher at F_D which was at par with F_w but significantly differ from others. It recorded 97.1 q ha^{-1} straw yield which was 6.90% and 7.62% higher than B_D and B_w. The reasons were well developed plants with more tillers and leaves. Which in turn lead to more straw from the plants. The plants developed well in line sowing due to better growing conditions [16]. While biological yield was highest at F_w which was significantly differ from others. It recorded 167.9 q ha^{-1} biological yield which was 5.5% and 7.9% higher than B_w and B_D. However, it was found at par with F_D (167.0 q ha^{-1}). Moving further, highest harvest index was recorded at F_w which was significantly differ from others. It recorded 43.1 harvest index which was 1.3%, 3.2% and 4.1% more obtained under B_w, F_D and B_D. It might be due to production of a smaller number of tillers per unit area, which facilitated translocation of solutes throughout the grain developmental stages and eventually activated the florets to absorb nutrients to their fullest extent and develop heavy kernels in soaked seed broadcast technique [17].

3.2 Effect of Seed Priming on Yield Attributes

In case of yield attributes, the data showed that P_N (Potassium nitrate) gave a maximum grain yield. It recorded 72 q ha^{-1} yield which was 5.4% & 9.3% more obtained under P_w and P_0. Primed seeds grow faster with rapid & uniform emergence with better crop growth & net assimilation rate as well as proper dry matter partitioning which resulted in greater yield potential. The highest effect was derived from NO_3 when present with to developing grains for proper filling by increasing leaf nitrogen content and chlorophyll synthesis. The rice yield in halo priming (2000 ppm potassium nitrate) is attributed to rapid emergence, higher establishment, better root and crop growth [18]. Further, data indicated that straw yield was higher at P_w which was significantly higher than other levels. It recorded 93.5 qha^{-1} straw yield which was 3.6% more than obtained under control. However, it was found at par with P_N (95.5 q ha^{-1}). Seed priming with KNO_3 increase root length which increases shoot biomass hence increasing straw yield. Similar results were seen in Das et al. [19],[20]. While, biological yield was highest at P_w which was significantly differ from control. It recorded 162.4 qha^{-1} biological yield which was 4.18% more obtained under control. However, it was found at par with P_N (167.9 qha^{-1}). Genotype with greater yield potential recorded higher biological yield & harvest index. Harvest index didn't show any type of variation in values but highest was recorded at 42.4% which was 0.9% higher than P_w and control.

Table 1. Effect of method of sowing and seed treatment on yield attributes

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
Method of sowing				
F_D (flat dry sowing)	69.8	97.1	167.0	41.7
B_D (beds dry sowing)	64.2	90.4	154.6	41.3
F_W (flat wattar sowing)	72.7	95.0	167.9	43.1
B_W (beds wattar sowing)	67.1	89.7	158.5	42.5
CD (0.05)	**4.3**	**4.7**	**8.9**	**0.4**
Seed treatment				
P_N (potassium nitrate)	72.0	95.5	167.9	42.4
P_W (hydrorpriming)	68.1	93.5	162.4	42.06
P_0 (non-priming)	65.3	90.1	155.6	42.0
CD (0.05)	**3.7**	**4.1**	**7.7**	**0.4**
Interaction	**NS**	**NS**	**NS**	**NS**

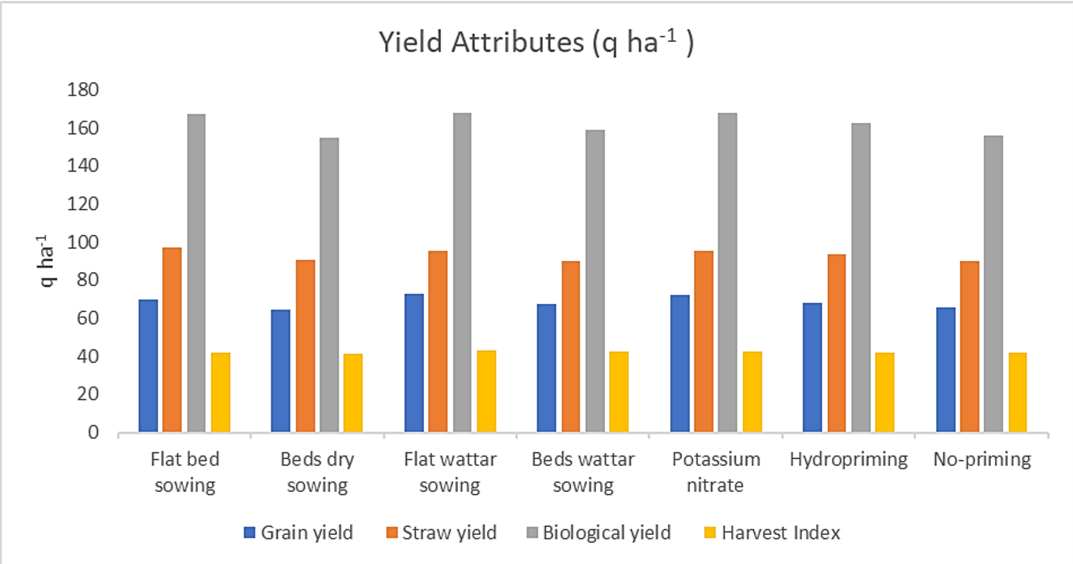

Fig. 1. Effect of method of sowing and seed treatment on yield attributes

4. CONCLUSION

The study illustrated how various seed priming techniques and sowing techniques affected yield variables in rice cultivation, such as grain yield, straw yield, biological yield, and harvest index. The results showed that using the flat wattar sowing method and potassium nitrate-treated seed produced the maximum grain yield. The main problem with rice is seed germination, yet potassium nitrate treatment increases the viability of the seed. However, when it comes to sowing techniques, flat wattar sowing offers the best nutrition for seeds and promotes greater root establishment. Therefore, from an economic perspective, these techniques are optimal for farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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