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## IMPACT OF SOME AGRONOMICAL TECHNIQUES ON THE RISING OUTPUT OF MAIZE IN MALWA REGION OF INDIA

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### ABSTRACT

Low grain yields and less production is commonly due to low plant densities of maize in India, which are frequently found in the fields of farmers that practice no-till agriculture. Research needs to be focused on finding a solution to this issue in order to increase maize production given the countries growing population and rising maize consumption. The present research was conducted to determine the impact of agronomical practices to increase the production of maize in Malwa region of India. In order to determine the optimum techniques for maize production, a factorial experiment in randomized full block design with 4 replications was conducted in Field Research Center, Oriental University, Indore, Madhya Pradesh during the main season of 2023. The study aimed to ascertain the optimal time frame for replenishing a maize field and the relative impact of replenishing with seed and seedlings on the development, ideal population density, and yield of maize. The variables were when to refill—five, ten, or fifteen days after planting and the material for refill, which could be either seeds or seedlings. Refilling with seedlings also made a greater contribution to the ideal plant population density. When seedlings were utilized as refilling material, the total grain output was 967 kg/hectare more than when seeds were used. Conversely, plants grown from seed refills were weaker, more likely to lodge, and had a higher ground penetration rate of solar radiation. The percentage of grain yield from seed refill plants was 6%, whereas the percentage of grain output from seedling refill plants was 34%. Greater growth was produced by refilling five days after planting as opposed to ten or fifteen days later. The results show that employing seedlings instead of seeds is a more effective way to replenish maize fields, as this approach contributes more.

**Key words :** Population, Yield, Maize, Grain, Refill, Seedling.

### Introduction

Maize (*Zea mays*. L), is a major staple grain crop that is grown all over the globe for food, feed and the generation of biofuel (Miao *et al.*, 2017). After rice and wheat, it is the third most significant crop that is sown (Miao *et al.*, 2017). Studies have shown that maize output needs to increase, particularly in emerging countries, to fulfill the growing need for food for humans and animals. According to Xie *et al.* (2017), the ideal temperature range for increased maize production is between 28°C and 32°C and the crop needs 500–800 mm of water to complete its life cycle. The state of the environment is crucial to agricultural productivity. The environmental

circumstances have a significant impact on the yield and other properties of plants, in addition to their genotypes. Plants go through several stages in order to finish their life cycle in the natural conditions. Climate variables like temperature and precipitation have become increasingly erratic in recent years, which has led to extended droughts and temperature changes that are above and above ideal levels. Crop productivity has been put to the test by these changes (Mao *et al.*, 2015).

Maize has been planted in India in around 26.42 lakh hectares. The major maize growing states are Himachal Pradesh 2.38 lakh ha (5.88 lakh acres), Uttar Pradesh 1.70 lakh ha (4.19 lakh acres), Jammu & Kashmir 1.49

lakh ha 3.67 lakh acres), Karnataka 1.20 lakh ha (2.97 lakh acres), Punjab 0.51 lakh ha (15.15 lakh acres), Telangana 0.35 lakh ha (0.87 lakh acres), Arunachal Pradesh 0.34 lakh ha (0.84 lakh acres) and Uttarkhand 0.17 lakh ha (0.042 lakh acres). The 3rd Advance Estimates of Food Grain Production for 2022–2023 estimated that 35.91 million tonnes of maize will be produced nationwide in India (Maize Outlook, 2023). The technique of shifting cultivation, which was formerly widely used by farmers as a way to preserve the soil and sustain production, is under jeopardy due to factors including the growing human population, slash and burn methods, and the growth of surface mining (Ekboir *et al.*, 2002). In addition to using the slash and burn technique, which has contributed to the growing land degradation, farmers continue to produce maize on the same plot of land year after year for the reasons listed above. In order to help farmers produce in a sustainable manner, safe interventions are thus necessary. No-till farming reduces soil temperature changes, promotes water infiltration, and reduces evaporation and runoff, all of which contribute to moisture conservation. Furthermore, it increases soil faunal activity and provides minerals and organic matter from decaying mulch (Goddard *et al.*, 2008). Boahen *et al.* (2007) described the no-till concept as a resource-saving method of agricultural production that seeks to protect the environment, produce large amounts of food consistently, and earn a reasonable profit. Bonsu (2001) stated that residues left on the field during no-till serve as mulch which protects the soil from soil erosion and limit weed growth throughout the growing season.

Traditionally, farmers try to reseed in the same location or on the same hill of dead plant(s) in an attempt to replace the un-germinated corn. However, there are several adverse growing circumstances that these late-germinated plants must deal with (Asiedu *et al.*, 2001; Van Gassel *et al.*, 1996). Some people and organizations have tried to increase the density of plants in no-till fields by varying the planting date, adding more seed maize, planting depth, treating the area with insecticides and fungicides, firming the planting location, and applying mulch. Despite the fact that they were created to keep rodents away from planting spots, farmers still experience plant stand loss in their maize fields due to rodent- and disease-borne-seed damage. The purpose of this study was to compare the effects of seed and seedling refilling, as well as the timing of refilling, on the growth, optimum population density and grain production of maize.

## Materials and Methods

The experiment was conducted at Research Center Oriental University Indore Madhya Pradesh, India. The research area's general soil qualities range from poorly drained and low in organic matter to well drain and high in organic matter. The medium-black soil has a density range from 1.5 to 1.8 and is well-drained. The range of annual precipitation is 945 mm to 1062 mm (Climate Chart – Indore, Madhya Pradesh 2022).

### Land preparation

The experiment was 2x3 factorial with treatments arranged in a randomized complete block design. Refilling materials were seeds and seedlings and time of refilling at 6, 12 and 16 days after initial planting. A post germination herbicide (mesotrione) was used to spray the weeds, with the use of knapsack sprayer fitted with a low volume nozzle at the rate of 200 ml per 15 litres of water. The plant residues were left on the soil surface without burning for 6-7 days before planting.

### Planting

The experimental plot was seeded on April 08, 2023, with two seeds per hill, separated by 40 cm; the seeds were put straight through the mulch. Maize seed was protected from predators by applying seed plus (Imidacloprid 20%, Metalaxyl 20% and Anthraquinoneb 4%), at a rate of 10g active ingredient per 1kg seed. Each allotment included twelve hills and six rows, for a total of 144 plants. Five days after sowing, a random uprooting of 36 out of 144 plants resulted in a 25% loss of seedlings that had germinated. A plot was restocked with seed and a second plot was planted with seedlings in each replication. The seedlings' seeds were sown on the same day as the experimental plot in order to reduce competition between the developing plants. This made it possible to employ identically aged seedlings. To reduce transplant shock, seedlings were planted in a ball of earth at their base. Ten days later, on May 18, and fifteen days later, on May 23, the process of refilling the experiment with maize seeds and seedlings was repeated. For this experiment, a 15-day refilling period—specifically with maize seedlings—was used. At planting, 125 kg/ha of starter fertilizer (NPK) was applied and 4 weeks later, 62.5 kg/ha of urea fertilizer was added. Two days after planting, pre-emergence herbicide (Atrazine WP) was sprayed. Seven days after planting, secondary weeds, primarily *Panicum maxima*, were manually removed.

### Data collection and analyses

The number of leaves per plant, leaf length, leaf breadth, plant height, stem girth, sun fleck using a

ceptometer and the establishment of refilling plants were among the parameters that were measured at tasseling. Measured at harvesting the parameters plant population, grain yield and % contribution of grain yield from refilled plants. The MSTATC statistical program and the Analysis of Variance approach were used to examine the data. Treatment differences were determined by calculating the least significant difference at 5% probability.

## Results

Table 1 shows how refilling and refilled material impact the number, length and width of leaves on maize plants. The results showed that after replacing with seedlings, each plant produced 11.40 leaves, which was a significant increase above the number of leaves produced when replacing with seeds. The timing of refilling had a significant ( $P < 0.05$ ) influence on leaf production. The majority of leaves were generated by plants that were refilled 5 days after planting—much more than by those that were refilled 10 or 15 days later. Plants that were refilled after 10 days also produced a much greater number of leaves than those that were refilled after 15 DAP. A significantly ( $P < 0.05$ ) longer leaf (83.0 cm) was produced when seedlings were employed for replenishing as opposed to seed (Table 1). The refilling at 5 days had a substantially larger treatment effect than all other treatment measures. The refilling time also had a significant ( $P < 0.05$ ) influence on maize leaf length. However, there was no substantial difference in the treatment effects between refilling at 10 and 15 DAP. The leaf width reached its maximum (8.21 cm) when seedlings were used for refilling and this effect was significantly larger than when seeds were used (Table 1). Additionally, plant leaf width was significantly impacted by the timing of refilling. Refilling at 5 DAP showed a greater effect than any other treatment, and refilling at 10 DAP produced considerably more leaves than refilling at 15 DAP.

### Sun fleck, plant height and stem girth

Table 2 shows the effect of refilled material and refilling time on the sun fleck, plant height and stem girth of the maize plants. The material used to measure sun specks—the amount of sunlight that can penetrate the canopy—showed that using seeds rather than seedlings resulted in a significant reduction in solar radiation. As a matter of fact, 40% of the sunlight that the plants might have used was squandered. However, the time of refilling had no significant impact on the assessment of sun specks ( $P > 0.05$ ). The mean height of the plants was much higher ( $P < 0.05$ ), when seedlings were used as replacement material than when seeds were used. The timing of filling

**Table 1 :** Effect of refilled material and refilling time on number of leaves, leaf length and leaf diameter of maize plants.

Treatment	Leaf Number Plant <sup>-1</sup>	Leaf Length (cm)	Leaf width (cm)
<b>Refill material</b>			
Seed	8.57	24.3	5.58
Seedling	11.40	83.0	8.21
<b>LSD (5%)</b>	<b>0.67</b>	<b>7.36</b>	<b>0.69</b>
<b>Time of Refilling</b>			
5 days	13.27	94.1	8.21
10 days	12.24	84.2	7.93
15 days	10.00	80.6	6.73
<b>LSD (5%)</b>	<b>0.85</b>	<b>9.0</b>	<b>0.85</b>
<b>CV (%)</b>	<b>7.0</b>	<b>9.8</b>	<b>9.90</b>

**Table 2 :** Effect of refilled material and refilling time on Sun flecks, plant height and stem girth of maize plants.

Treatment	Sun fleck	Plant height (cm)	Stem girth (cm)
<b>Refill material</b>			
Seed	12.47	95.2	1.41
Seedling	7.01	153.6	2.00
<b>LSD (5%)</b>	<b>3.79</b>	<b>14.5</b>	<b>0.2</b>
<b>Time of Refilling</b>			
5 days	8.56	156.0	1.98
10 days	11.09	149.0	1.66
15 days	10.54	111.1	1.48
<b>LSD (5%)</b>	<b>NS</b>	<b>18.8</b>	<b>0.25</b>
<b>CV (%)</b>	<b>44.8</b>	<b>13.4</b>	<b>14.1</b>

has a significant impact on the height of maize plants. While refilling at 5 DAP resulted in the tallest plants (156.0 cm), the treatment impact at 10 DAP was statistically equal to that of refilling; still, both effects were considerably greater ( $P < 0.05$ ) than refill. Compared to plants grown from seeds, plants grown from replenishing seedlings had a much larger girth ( $P < 0.05$ ). Refilling at 5 DAP produced a significantly larger treatment effect than any other time, and this timing also had a significant influence on stem girth. Treatment-wise, refilling at 10 and 15 DAP did not differ substantially.

### Plant establishment, lodging and plant population

Table 3 shows the effects of refilled material and refilled time on plant establishment, lodging and plant population of the maize plants. Refilled plants with

**Table 3 :** Effect of refilled material and refilling time on plant establishment, lodging and plant population of maize plants.

Treatment	Plants established (ha <sup>-1</sup> )	Plants lodged (ha <sup>-1</sup> )	Plant population (ha <sup>-1</sup> )
<b>Refill material</b>			
Seed	10938	294	53438
Seedling	14354	132	59354
<b>LSD (5%)</b>	<b>1715.1</b>	<b>0.02</b>	<b>2355</b>
<b>Time of Refilling</b>			
5 days	13375	190	58417
10 days	13125	204	53906
15 days	11438	196	55781
<b>LSD (5%)</b>	<b>NS</b>	<b>0.03</b>	<b>NS</b>
<b>CV (%)</b>	<b>15.6</b>	<b>12.0</b>	<b>4.8</b>

**Table 4 :** Effect of refilled material and time of refilling on total grain yield and grain yield from refilled material.

Treatment	Total grain yield (kg/ha)	Grain yield from refilled material (%)
<b>Refill material</b>		
Seed	7,469	6.6
Seedling	8,436	34.3
<b>LSD (5%)</b>	<b>712</b>	<b>NS</b>
<b>Time of Refilling</b>		
5 days	7,820	
10 days	8,037	16.4
15 days	8,001	36.5
<b>LSD (5%)</b>	<b>NS</b>	<b>8.5</b>
<b>CV (%)</b>	<b>10.3</b>	<b>NS</b>

seedlings showed a far higher success rate than plants with seeds. When seeds were utilized for refilling, the difference was about 30% greater. The period of refilling did not significantly ( $P > 0.05$ ) affect plant establishment. When plant lodging was refilled with seeds, the amount grew considerably. Refilling time also had a significant effect on plant lodging. Refilling at 10 DAP had the most effect, which was record to be substantially more than all other treatment effects. Additionally, lodging was substantially higher when replenishing at 15 DAP compared to 5 DAP. When seedlings were used instead of seeds, the number of plants increased dramatically (59354.0 plants/ha) to a higher level. Plant population was not significantly affected by the time of refilling;

however, refilling at 5 DAP had the most effect, with 58417.0 plants/ha.

### Grain yield

The impact of refilled material and refilling time on the overall grain production of the maize plants is displayed in Table 4. The total grain yield differential of around 30%, or over 1t/ha, was recorded between refilling with seedlings and seed. The timing of refilling, however, had no impact on the yield of maize grains. The grain output from refilled plants was not substantially affected ( $P > 0.05$ ) by the kind of material or time of refilling; however, 34% of the grain was generated when refilling with seedlings, and only 6% was contributed when refilling with seeds. Similar results were found by Mega (2019).

### Discussion

Based on the results, plants that were replaced with seedlings had 30% more leaves than plants that were refilled with seeds (Table 1). Furthermore, when plants were refilled with seedlings rather than seeds, the length of their leaves increased by 20%. Additionally, compared to employing seeds as refilled material, the leaf width from seedling refill was almost 30% larger. The capacity to sustain increased leaf production suggests that growth and output would be improved if growth resources were accessible all during the growing season. This is due to the fact that such plants would have more photosynthesis. Gardner *et al.*, 1985; Agyei-Wiredu, 1996; Hopkins, 1993). Sun fleck (Table 2) indicates that plants that were refilled with seeds had more light penetration than seedling plants. Given that plants from seed refill had smaller leaves and lower source capacities than plants from seedlings used for refill, this is not surprising. This is a disadvantage for crop production since it would result in a loss of solar energy and lower grain yield (Gardner *et al.*, 1985; Hopkins, 1999).

Plant lodging (Table 3) was likely lessened by the larger stem girth of plants from seedling filling (Table 2). Plants that used seeds rather than seedlings for replenishing showed higher lodging rates—indeed, above 100%. The latter treatment resulted in higher plants, although lodging was still reduced (Table 2). It is impossible to overstate the significance of decreased lodging in maize yields. Plants that are lodged are less able to absorb sun energy and produce photosynthates, which lowers grain output. More lodging also entails cultivation, which may be costly and risky when it comes to weed and insect management and fertilizer application (Boa-Amponsem, 2000). Restocking supplies had a major impact on plant life as well (Tables 3). When replenishing with seedlings as opposed to seeds, the overall plant population increased

by more than 40%. The contribution of each individual plant matters in crop yield. Therefore, if using seedlings for refilling in maize production can be so beneficial, farmers' yields would improve with little effort and possibly no additional expense.

The refill materials had a considerable impact on the overall grain output of maize (Table 4). When compared to utilizing seed, employing seedlings as refill material provided a considerably higher ( $P < 0.05$ ) grain production. In fact, the older treatment produced over 1000 kg more grain per hectare than the latter treatment. Additionally, the grain output from refilling seedlings accounted for more than 34% of the total.

### Conclusion

The results showed that it is possible to fill up the spaces left in maize fields by insect damage or unsuccessful seedling germination. It appears that this approach is more profitable than using seeds the traditional way since the plants produced from it performed better in a competitive environment and significantly increased grain yield overall. Furthermore, the results showed that the plants grew more when refilling was done five days after planting.

### Declaration

This submitted work has not been published previously (except in the form of an abstract and an academic thesis) and is not under consideration for publication elsewhere, it's publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright holder.

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