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Enhancing spring season maize

(*Zea mays*) productivity through ridge-furrow reversal technique

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Worldwide climate change and declining availability of water has led to increasing abiotic stress in crop production. Higher input use efficiency is crucial for obtaining optimal growth and yield of a crop and for that moisture content of the root zone is the key to accelerate utilization of other inputs. One of the ways to ensure higher water use efficiency is applying water directly into the root zone, thereby curtailing unproductive losses and ensuring access of water to the plant for longer time. During dry season, sowing a crop in the furrow is able to utilize the moisture available in the deeper soil layer for germination purpose. When irrigation is applied directly into the furrows, it concentrates directly in the root zone. In addition, earthing, a process of mounding soil around the plant base, provides better physical support as well as anchorage to the roots. By removing soil from the ridges and placing along the stems of the furrow sown maize crop, gets benefited from high volume of soil around the stems and reduces the incidence of lodging.

Keywords: Dry season, Earthing, Maize, Furrow sowing, Water use efficiency

MAIZE is a versatile crop, being grown around the year and across different agro-climatic zones. In the northern plains of India, the cultivation of spring maize has become popular owing to high market demand and industrial needs. It is a multipurpose crop that has high productivity which makes it a high-value cash crop. In northern India with the introduction of hybrid varieties of maize, the productivity during spring season can be as high as 10 t/ha. However, it is a very delicate crop, especially to the moisture stress i.e. during the reproductive phase and extremely sensitive to excess moisture during the seedling stage. Its seasonal water requirement goes around 550–600 mm. Any kind of shortage of nutrients and moisture adversely affects the performance as well as the quality of the produce during the spring season. Therefore, sustaining the availability of inputs mainly that of moisture in the root zone is of utmost importance to harvest good yields from non-rainy season maize. Further, it is a tall-statured crop making it susceptible to lodging in the events of high winds and rainfall. Since, it is a widely spaced crop, it offers opportunities to make certain adjustments in the crop establishment and intercultural operations to improve upon the efficiency of applied nutrients and soil moisture. Among various options tried to improve upon the nutrient and moisture use efficiency of non-rainy season maize crop, sowing in furrows followed by ridge-furrow reversal (RIFUR) is adjudged as one of the most viable options.

Production practices for RIFUR sown maize

***Seed sowing*:** Laser land leveling ensures higher and uniform germination. The land should be prepared well up to 15–20 cm depth having well-pulverized soil. Change the land surface into a ridge and furrow with the help of a tractor-drawn ridge maker at 60 cm apart and place the seed at a 20 cm plant-to-plant distance. Ensuring proper plant stand is a pre-requisite for realizing higher productivity of maize crop. Therefore, pre-sowing irrigation is a must in case sufficient moisture is not present at the time of land preparation. To sustain good moisture in the field, have minimum time gap between start of land preparation and seed bed readiness. The objective here is to have enough moisture to support germination. Sow the seeds in furrows, gently cover the seeds with soil and press it well to have firm contact between seed and soil. This helps to achieve higher germination of the maize crop. Preferably maize crops should be sown in east-west direction to reduce the impact of high winds to prevent lodging. For higher productivity, use the recommended hybrid variety of maize for the region. The optimum time of sowing for spring season maize is second fortnight of February.

***Fertilizer application*:** Maize is a highly nutrient-requiring crop therefore timely application and the right dose of fertilizer is a must. Use $N:P_2O_5:K_2O$ @150:60:40 kg/ha. Use of zinc sulfate @15 kg/ha (33%) has been found beneficial. Apply

50 kg N along with entire dose of P and K as basal in furrows and mix gently before placing the seeds. Apply nitrogen @50 kg/ha at the knee-height stage and 50 kg N/ha at the tasseling stage. Need-based foliar sprays of growth promoters like KNO_3 @1% have been found advantageous.

***Ridge–furrow reversal (RIFUR)*:** When the crop is 30–35 days old (knee-height stage), go for top dressing of nitrogen (as urea) in the furrows. Urea application should be done after the second irrigation. Following that dismantle the ridges with the help of a spade as a result urea gets covered with the soil thereby cutting down the volatilization loss. In this process, the ridges are replaced by furrows, and furrows are converted into ridges. One added advantage during this process is the destruction of weeds surely. Thus, it can be a very viable proposition for the cultivation of maize under organic farming.

***Weed management*:** The application of pre-emergence (Atrazine) or early post-emergence (Tembotrione/ Topramezone) herbicide is good enough to control the weeds, as leftover weeds are uprooted or destroyed during the process of RIFUR.

***Irrigation management*:** First irrigation should be applied when the crop is 10–15 cm tall. In case the soil moisture is not sufficient to support germination, then go for early post-sowing irrigation, followed by one more irrigation (after 3–4 days) to prevent crusting. However, it is advisable to ensure good moisture at sowing and avoid early post-sowing irrigation. Subsequently, irrigation depth amounting to 50 mm (RIFUR technique), should be applied at IW: CPE ratio of 1.2. On average, on loam soils, 6–8 irrigations are required at an interval of 10–12 days during the vegetative phase and 6–8 days interval during the reproductive phase.

Furrow sown maize with ridge-furrow reversal (RIFUR)

***Pest management*:** Pest management is done following the recommended practices and as per the appearance of the pest in a particular region.

Productivity and economics of maize

As compared to flat sowing, an increase in grain yield to the tune of 1.81 t/ha (25.7% higher) is observed during the demonstration. There is also a saving of irrigation water amounting to 16 cm (28.6%) as irrigation is applied in furrows only. When recorded before the application of irrigation, the soil moisture content in the root zone is also higher in the case of furrow sowing.

The cost of cultivation is higher by ₹ 4300/ha under RIFUR than flat sowing, owing to additional process of ridge-furrow formation and dismantling of ridges. The net returns and benefit: cost ratio are higher by 34.1% and 23.6% as compared to flat sowing, respectively.

Table 1. Herbicide formulation, dose, and application in the process of RIFUR maize

Herbicide	Formulation	Dose (g a.i./ha)	Time of application (DAS)
Atrazine	50% WP	1000	0–2
Topramezone	33.6% SC	25	20–30
Tembotrione	42% SC	120	20–30

WP, Wettable powder; SC, Soluble concentrates.

Table 2. Comparative performance of spring season maize under different sowing methods

Sowing method	Grain yield (t/ha)	Stover yield (t/ha)	Irrigation depth (cm)	*Soil moisture (%)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
Flat	7.04	15.03	56	7.14	51632	94008	1.82
RIFUR	8.85	16.62	40	8.09	55932	126015	2.25

*Before irrigation at the reproductive stage.

Maize sown in flat beds

Benefits of RIFUR technique

***Water conservation*:** Furrow sowing can save a significant amount of irrigation water compared to flat sowing amounting to 25–30%.

***Weed control*:** Weeds are less problematic in furrow sowing method due to ridge-furrow reversal process.

***Nutrient use efficiency*:** The technique enhances the efficiency of applied nutrients as the fertilizers are placed in furrows, which concentrate in the root zone. Further, during the first top dressing of urea, it is covered by soil, hence, curtailing the loss of nitrogen likely to occur through the volatilization process.

***Lodging prevention*:** Crop lodging which can occur due to high winds and excess moisture can be prevented up to some extent with this technique, as the crop stems are covered by soil up to a height of 10–15 cm during the process of RIFUR.

SUMMARY

The ridge-furrow reversal technique enhances non-rainy season maize yield by enhancing the availability of moisture and nutrients in the root zone. Maize being sensitive to both moisture excess and shortage, high productivity potential necessitates focused care. RIFUR involves precision sowing, targeted fertilization, and reversing ridges to conserve moisture, control weeds, improve nutrient utilization, and prevent lodging. Comparative analysis confirms RIFUR's superiority in yield and water use efficiency. This technique presents a holistic solution for maximizing maize productivity of non-rainy season maize.

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