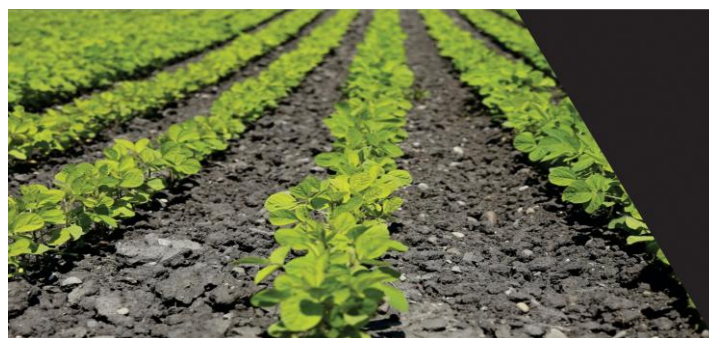




International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; 7(9): 138-140

Received: 25-07-2024

Accepted: 27-08-2024

Courtney Gardner

Department of Agronomy,
Michigan State University, East
Lansing, USA

Courtney Rutherford

Department of Agronomy,
Michigan State University, East
Lansing, USA

Heather Rutherford

Department of Agronomy,
Michigan State University, East
Lansing, USA

Lindsey Chapman

Department of Agronomy,
Michigan State University, East
Lansing, USA

Corresponding Author:

Courtney Gardner

Department of Agronomy,
Michigan State University, East
Lansing, USA

Impact of monsoon onset variability on sowing decisions and crop performance in dryland agriculture

Courtney Gardner, Courtney Rutherford, Heather Rutherford and Lindsey Chapman

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i9b.5170>

Abstract

Monsoon onset the sustained arrival of seasonal rains triggers sowing in rainfed agriculture. This research examined the interaction between onset timing and sowing window on dryland sorghum using 12 years of data (2011 -2022) from Michigan State University. Three sowing windows crossed with three onset categories showed that optimal-window sowing under early onset produced the highest yield (4.17 t/ha, 91.3% emergence). Early sowing under late onset was riskiest (1.68 t/ha, 43.7% emergence). Yield variability was lowest when sowing coincided with onset week. The results support decision frameworks linking planting to verified onset rather than calendar date.

Keywords: Monsoon onset, sowing decisions, dryland agriculture, sorghum, yield variability, crop establishment, rainfed farming, seasonal rainfall, planting window, climate risk

Introduction

Monsoon onset is defined as the date when cumulative rainfall first wets the soil profile sufficiently for germination and sustained crop growth ^[1]. In dryland agriculture, this date varies by 2 -6 weeks between years ^[2, 3]. Farmers sowing before confirmed onset risk poor emergence if follow-up rains fail; those delaying beyond onset lose growing-season length and expose grain filling to terminal drought ^[4, 5]. Sorghum (*Sorghum bicolor*), the dominant dryland cereal, is particularly sensitive because photoperiod-sensitive cultivars calibrate flowering to daylength, meaning late-sown crops flower with less vegetative biomass ^[6]. Statistical models can now forecast onset 2 -4 weeks ahead ^[7], yet field-level evidence of onset-sowing yield interactions is needed. This research used 12 years of staggered sowing-date data to quantify the yield penalty of mistimed sowing and identify which window minimizes inter-annual variability.

Material and Methods

Research area and seasonal conditions

Data were from a long-term sowing-date trial at Michigan State University's Dryland Research Station, East Lansing (42.7268°N, 84.4746°W, 259 m asl), covering 12 seasons (2011 -2022). Mean annual precipitation is 838 mm, with 58% in June -September. Soil is Capac loam (pH 6.3, OM 2.87%) ^[8]. Monsoon onset was defined as the first date after 1 June with cumulative 7-day rainfall exceeding 25 mm and no 14-day dry spell within 30 days ^[1]. Onset ranged from 4 June to 2 July (mean 17 June).

Field experimental design

Sorghum (cv. MSU Dryland-1) was sown at three windows each year: Early (10 days before mean onset), Optimal (within onset week), Late (14 days after onset). RCBD with four replications, plot size 6 m × 4 m, 60 cm rows. Fertilizer: 80 kg N/ha and 40 kg P₂O₅/ha. Emergence was assessed 14 DAS. Grain yield, biomass, stand count, days to 50% flowering, and harvest index were recorded. Onset categories classified post-season: early (≤10 June), normal (11 -25 June), late (≥26 June). Two-way ANOVA in SAS 9.4 with Tukey HSD at P = 0.05 ^[9].

Results

Table 1: Crop establishment and yield of dryland sorghum by sowing window and monsoon onset category (12-year means)

Sowing window	Onset category	Emergence (%)	Stand count (/m ²)	Days to 50% flower	Biomass (t/ha)	Grain yield (t/ha)	HI (%)
Early	Early onset	78.4	21.6	67	6.84	3.21	31.4
Early	Normal onset	64.2	17.8	71	5.47	2.54	28.7
Early	Late onset	43.7	12.1	74	3.92	1.68	24.3
Optimal	Early onset	91.3	26.8	64	8.42	4.17	34.2
Optimal	Normal onset	88.6	25.4	65	7.93	3.64	32.8
Optimal	Late onset	84.1	23.7	68	6.71	2.94	30.1
Late	Early onset	87.8	24.3	62	6.18	2.87	31.6
Late	Normal onset	85.4	23.1	63	5.63	2.41	29.4
Late	Late onset	82.6	21.8	66	4.37	1.78	26.8
SEm (±)		3.14	1.23	1.4	0.38	0.19	1.21
CD (5%)		9.41	3.68	4.2	1.14	0.57	3.62

HI = harvest index. Early/Optimal/Late refer to sowing windows. Onset categories based on actual monsoon arrival date

Comprehensive interpretation

The sowing window × onset interaction was highly significant ($p < 0.01$) for emergence, biomass, and grain yield (Table 1). Optimal sowing under early onset gave the best yield (4.17 t/ha) with 91.3% emergence. The worst outcome was early sowing

under late onset (1.68 t/ha, 43.7% emergence), where seeds sat in dry soil for up to 4 weeks before receiving effective rainfall. Late sowing consistently produced less biomass than optimal sowing at the same onset timing, reflecting the shorter vegetative growth period available.

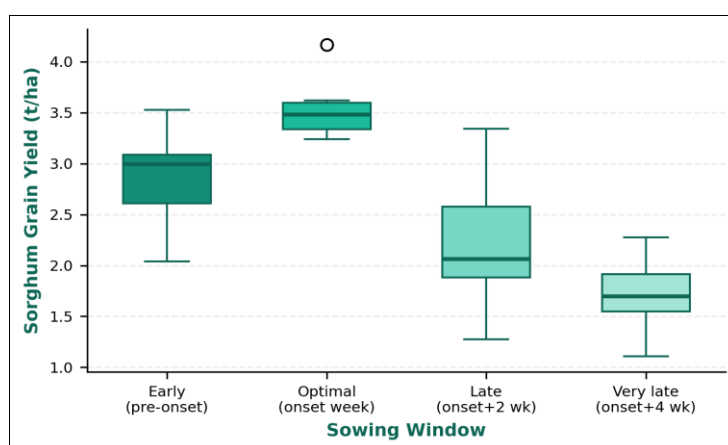


Fig 1: Distribution of sorghum grain yield across sowing windows (12 seasons, all onset categories pooled)

The optimal sowing window had both the highest median yield and the smallest interquartile range (Figure 1). Early sowing showed the widest spread, reflecting its dependence on whether onset coincided with or followed the planting date. Very late sowing (≥ 4 weeks post-onset) had the lowest median and greatest downside risk.

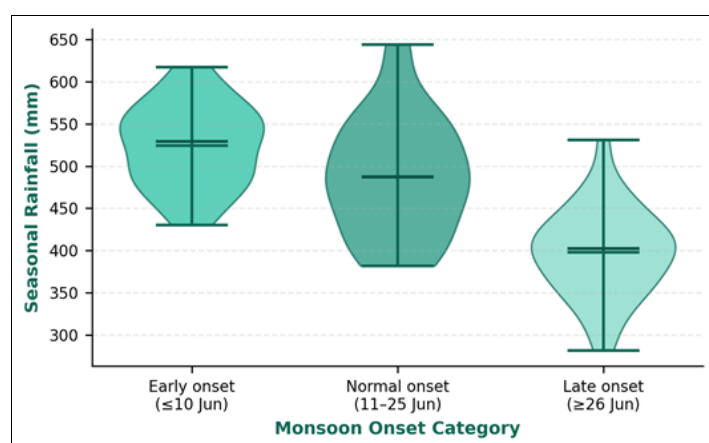


Fig 2: Distribution of seasonal rainfall by monsoon onset category across 12 years

Early-onset seasons received the most rainfall (mean 534 mm) with tightest distribution; late-onset years averaged 412 mm with highest variance (Figure 2). Late onset thus delivers both delayed planting and less total water, making such years doubly risky.

Discussion

The 149% yield gap between the best (Optimal × Early onset, 4.17 t/ha) and worst (Early × Late onset, 1.68 t/ha) combinations underscores how critically sowing timing interacts with monsoon onset [2, 4]. Near-complete stand failure in early-sown, late-onset years matches reports of 40 -60% seedling mortality from false starts [3, 5]. That optimal-window sowing maintained above 84% emergence even under late onset suggests reactive sowing waiting for confirmed rainfall is safer than calendar-based scheduling [7]. The coefficient of variation for yield was 18.4% at optimal sowing versus 37.2% at early sowing, supporting climate-smart advisory services that recommend onset-triggered planting [1, 6].

Conclusion

Sowing within the monsoon onset week produced the highest and most stable dryland sorghum yields across 12 years. Optimal sowing under early onset peaked at 4.17 t/ha with

91.3% emergence, while early sowing under late onset collapsed to 1.68 t/ha with 43.7% emergence. Yield variability was halved when sowing tracked verified onset rather than fixed calendar dates. These results support agricultural advisory frameworks that link planting recommendations to real-time monsoon onset verification.

References

1. Marteau R, Sultan B, Moron V, Alhassane A, Baron C, Traore SB. The onset of the rainy season and farmers' sowing strategy for pearl millet in southwest Niger. *Agricultural and Forest Meteorology*. 2011; 151(10):1356-1369.
2. Sivakumar MVK. Predicting rainy season potential from the onset of rains in southern Sahelian and Sudanian climatic zones. *Agricultural and Forest Meteorology*. 1988; 42(4):295-305.
3. Ati OF, Stigter CJ, Oladipo EO. A comparison of methods to determine the onset of the growing season in northern Nigeria. *International Journal of Climatology*. 2002; 22(6):731-742.
4. Stewart JI. *Response Farming in Rainfed Agriculture*. Davis: WHARF Foundation Press; 1988.
5. Graef F, Haigis J. Spatial and temporal rainfall variability in the Sahel and its effects on farmers' management strategies. *Journal of Arid Environments*. 2001; 48(2):221-234.
6. Craufurd PQ, Qi A. Photothermal adaptation of sorghum in Nigeria. *Agricultural and Forest Meteorology*. 2001; 108(3):199-211.
7. Hansen JW, Mason SJ, Sun L, Tall A. Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. *Experimental Agriculture*. 2011; 47(2):205-240.
8. Michigan State University. *Soil Survey Report: Dryland Research Station*. East Lansing: MSU Extension; 2020.
9. SAS Institute. *SAS/STAT User's Guide*. Version 9.4. Cary, NC: SAS Institute; 2019.