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Research Communication

Productivity and thermal requirement of fodder oat varieties under different micro-environments in Bihar

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ABSTRACT

A field experiment was carried out at Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur during *Rabi* season, 2021–22**.** The experiment was conducted using a split plot design with three varieties of fodder oat (Kent, JHO-822 and Local) in main-plots and four different sowing dates (15th November, 25th November, 5th December and 15th December) in sub-plots with three replications. The results obtained from the experiment showed that 'JHO-822' recorded 9.4 and 29.5% higher green and dry fodder yield than local variety and accumulated the highest meteorological indices (GDD, HTU and PTU) and resulted in the highest HUE and PTUE. Among different micro-environments, seeding on 15th November recorded the highest green and dry fodder yield with substantially greater values of agro-meteorological indices which decreased with advancement of sowing date. Per day delay in sowing resulted in 0.7% decrease in green fodder yield and 1.2% decrease in dry fodder yield.

***Key words*:** Yield, GDD, Fodder oat, Date of sowing

Ample and nutritious feed has a direct impact on animal development and milk production. Oat (*Avena sativa* L.) is a prominent winter cereal fodder crop in northern India (Kauthale *et al.,* 2020; Paul *et al.*, 2022) and can help to bridge the deficiency of green fodder. High yielding fodder crop varieties are necessary to meet the nutritional needs of the animals. However, genotypes and environmental conditions have an impact on the fodder yield in a certain way (Zute *et al.*, 2010). Oat genotypes interact differentially with the current environmental conditions and show significant variation in the time needed to attain anthesis thereby affecting forage yield potential. The best non-monetary input and crucial element for good establishment of crop is timely sowing (Dhillon and Ram, 2022). Time of sowing, which is regulated by temperature and moisture, is a major yield contributing element (Dar *et al.*, 2022) for oat production. Temperature and day length control the development of oat. Accordingly, relative time of sowing determines the duration of phenophase of vegetative and reproductive growth (Sattar *et al.*, 2017). So, to boost fodder yield under the restricted growth circumstances (delayed sowing), high yielding oat genotypes should be identified for a particular area. Fodder oat in Bihar is typically sown in the month of November but delayed cessation of monsoon and heavy rainfall at *Hathia nakshatra* (fag end of monsoon on many occasions) delays sowing operation. Hence, the impact of early and delayed sowing on yield and quality of fodder oat need to be investigated in order to optimize the best sowing time for higher production. It is also necessary to find genotypes with greater yields under delayed sowing conditions. Planting best cultivars at appropriate sowing date for a specific location depending on the local climate may be helpful in improving green fodder production and close the supply-demand gap for green fodder. Therefore, taking all these facts into consideration, the current investigation was undertaken at Cattle Farm, RPCAU, Pusa, Samastipur, Bihar.

The field experiment was carried out at the Forage Research Block (Plot no. 12) of Cattle Farm, APRI, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur during *Rabi* season, 2021-22. The soil of the experimental plot had 7.96 pH, 0.25 dS m^{-1} EC, 0.49% organic carbon, low nitrogen (202.3 kg/ha), low potassium

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(104.0 kg/ha) availability and medium phosphorous (18.4 kg/ha) availability. The experiment was conducted using a split-plot design with three replications where oat cultivars such as JHO-822, Kent, and Local were taken in the main plot and date of sowing (15th November, 25th November, 5th December and 15th December) was taken in sub-plot. The seeds of the fodder oat varieties (JHO-822, Kent and Local) were manually seeded in lines opened at a distance of 25 cm using a seed rate of 100 kg/ha. The experimental crop received the recommended fertilizer dose for single-cut oats, which was 90:60:40 kg N, P_2O_5, K_2O/ha. When the crop reached at 50 per cent flowering stage, the crop stand in the net plot was manually harvested with a sickle from the ground level and green fodder yield (t/ha) was recorded. About one kilogram of fresh sample was collected from the harvested green fodder and preserved in marked brown paper to determine the dry fodder yield. The accumulated growing degree days (GDD, ºC day) at the time of harvesting (50% flowering) was worked out as per Sattar *et al.* (2017) using the base temperature for oat crop as 5ºC (Rajala and Peltonen-Sainio, 2011). Accumulated helio-thermal units (HTU, ºC day hour) and photo-thermal units at the time of harvesting were worked out by multiplying GDD and daily bright sunshine hours and multiplying GDD with length of the day, respectively. Heat use efficiency (HUE, kg/ °C day), Helio-thermal use efficiency (HTUE, kg/ °C day hour) and photo-thermal use efficiency (PTUE, kg/ °C day hour) were calculated by dividing the dry matter yield (kg ha^{-1}) by accumulated GDD (ºC day), accumulated HTU (ºC day hour) and accumulated PTU (ºC day hour), respectively. In order to determine whether there were any significant changes between the treatments, the experimental data was statistically analysed as per split plot design (Gomez and Gomez, 1984). Least significant difference at $p<0.05$ was calculated to compare treatment means.

Table 1. Effect of different varieties and date of sowing on yield of fodder oat

	Green fodder yield (t/ha)	Dry fodder yield (t/ ha)
Varieties		
'Kent'	36.8	7.7
'JHO-822'	38.3	9.2
'Local'	35.0	7.1
SEm±	0.3	0.2
CD (P=0.05)	1.2	0.6
Date of sowing		
15th November	41.4	10.0
25th November	37.8	8.5
5th December	35.4	7.4
15th December	32.2	6.2
SEm±	0.5	0.2
CD (P=0.05)	1.5	0.5

Green fodder yield (GFY) and dry fodder yield (DFY) of fodder oat was substantially impacted by varieties and dates of sowing (Table 1). JHO-822 showed the highest GFY (38.4 t/ ha) among all three varieties which was markedly higher than other two varieties. The per cent increase in GFY with JHO-822 over Kent and local variety was 4.3 and 9.6, respectively. Godara *et al.* (2016) and Sarkar *et al.* (2024) have also observed varietal differences in green fodder yield of fodder oat. Higher plant height and tiller number coupled with greater leaf number per tiller with JHO-822 led to higher GFY. In comparison to the other two kinds, JHO-822 recorded the highest DFY (9.2 t/ha). This was markedly superior over Kent and local variety. The per cent increase in DFY with JHO-822 over Kent and local variety was 19.4 and 29.57. It might be due to larger leaf area, increased photosynthetic activity, or high capacity to store assimilative photosynthesis products (Amanullah *et al*., 2004). Sowing on 15th November increased the green fodder yield by 28.57% than that of 15th December. Fourth date of sowing (15th December) recorded the lowest GFY (32.2 t ha^{-1}) among all dates of sowing. Per day delay in sowing resulted in 0.7% decrease in green fodder yield (Figure 1a). Higher GFY with 15th November seeded crop is ascribed to higher growth attributes such as plant height and tiller number per metre row and leaf number per tiller as a result of congenial macro- and micro-environment pre-dominating during crop growing season. Both Kalhapure and Shete (2013) and Lokesh *et al.* (2013) noted similar results. Sowing on 15th November increased the dry fodder yield by 61.29 % than that of 15th December. The fourth seeding date (15th December) had the lowest DFY (6.2 t ha^{-1}) among all the sowing dates. Favourable micro- and macro-climatic conditions promoted production of taller plants with more leaves and tiller, which increased the production of photosynthates and, ultimately, helped to increase the accumulation of dry matter, which might have favoured higher dry matter content in 15th November seeded crop. Higher GFY coupled with higher dry matter content resulted in higher DFY with 15th November seeded crop. Kumawat *et al.* (2017) also reported 15th November as the optimum date of sowing for fodder oats for enhancing dry fodder yield. Substantially lower DFY of fodder oats were found when sowing was delayed beyond 15th November. This could be because of reduced photosynthetic activity as a result of unfavourable weather conditions that prevailed during the various stages of crops and negatively impacted the growth performance of the fodder oats. Per day delay in sowing resulted in 1.2% decrease in dry fodder yield (Figure 1b).

Varieties and date of sowing had significant effect on agro-meteorological indices (Table 2). Variety 'JHO-222' recorded the greatest accumulated GDD, HTU and PTU

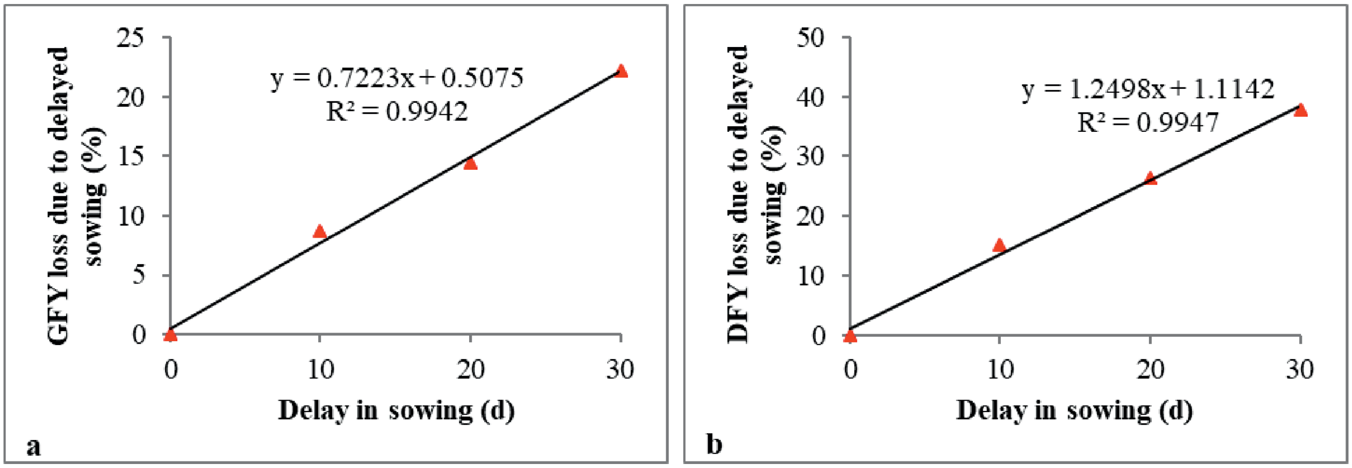

Fig. 1. Effect of delayed sowing on yield loss in terms of green (a) and dry (b) fodder yield

Table 2. Effect of different varieties and date of sowing on meteorological indices at harvest stage of fodder oat

	GDD (°C day)	HTU (°C day hour)	PTU (°C day hour)	HUE (kg/°C day)	HTUE (kg/°C day hour)	PTUE (kg/°C day hour)
Varieties						
'Kent'	957	4'408	10'419	8.0	1.73	0.73
'JHO-822'	1'088	5'412	11'936	8.4	1.69	0.77
'Local'	922	4'122	10'013	7.7	1.72	0.71
SEm±	8	66	88	0.1	0.02	0.01
CD (P=0.05)	30	260	346	0.5	NS	0.04
Date of sowing						
15th November	1145	5425	12434	1.85	0.80	1.85
25th November	1025	4748	11138	1.79	0.76	1.79
5th December	919	4349	10030	1.69	0.73	1.69
15th December	867	4066	9556	1.54	0.65	1.54
SEm±	6	48	66	0.04	0.02	0.04
CD (P=0.05)	17	141	196	0.11	0.05	0.11

followed by Kent and local variety. Accumulated GDD (1088ºC day), 'HTU (5412 ºC day hour) and PTU (11936 ºC day hour) value with JHO-822 were markedly higher compared to other two varieties. The increase in accumulated GDD, HTU and PTU with 'JHO-822' over local variety was 18.0, 31.29 and 19.20%, respectively. Variation in accumulated GDD was due to variation in days taken to 50% flowering which depends upon genetic constitution of varieties or in other words, different varieties have different thermal requirement and once it is achieved they reach 50% flowering. Pathania *et al.* (2019) noted variation in GDD, HTU and PTU among wheat varieties. Date of sowing had marked impact on agro-meteorological indices like GDD, HTU and PTU. Postponement of the sowing resulted in significant reduction in accumulated GDD, HTU and PTU. The first date of planting (15th November) had the greatest value of cumulative GDD (1145 ºC day), HTU (5425 ºC day hour) and PTU (12434 ºC day hour) at harvest, compared to subsequent sowing dates. Whereas, the lowest values of GDD, HTU and PTU were found in 4th date of sowing (15th December). Kala *et al.* (2018) observed that GDD and PTU decreased with advancement in date of sowing. The reduction in accumulated GDD and accumulated HTU due to postponement of seeding date in wheat were reported due to low temperature and bright sunshine hour (Pathania *et al.*, 2019). Increased accumulated HTU and PTU with 15th November in our study was due to higher days taken to attain 50% flowering.

Heat use efficiency (HUE), helio-thermal use efficiency (HTUE) and photo-thermal use efficiency (PTUE) are the indicators for the ability of crop for conversion of available energy to economic product (Pathania *et al.*, 2019). Varieties caused marked variation in HUE and PTUE of fodder oat. HUE (8.4 kg/°C day) and PTUE (0.77 kg/°C day hour) recorded the highest in JHO-822 that was comparable with Kent. Local variety registered the lowest HUE and PTUE. Significant variations in HUE, HTUE and PTUE were observed for wheat varieties by Pathania *et al.* (2019). Date of sowing had marked impact on HUE, HTUE and PTUE of fodder oat. HUE (8.7 kg/°C day), HTUE (1.85 kg/°C

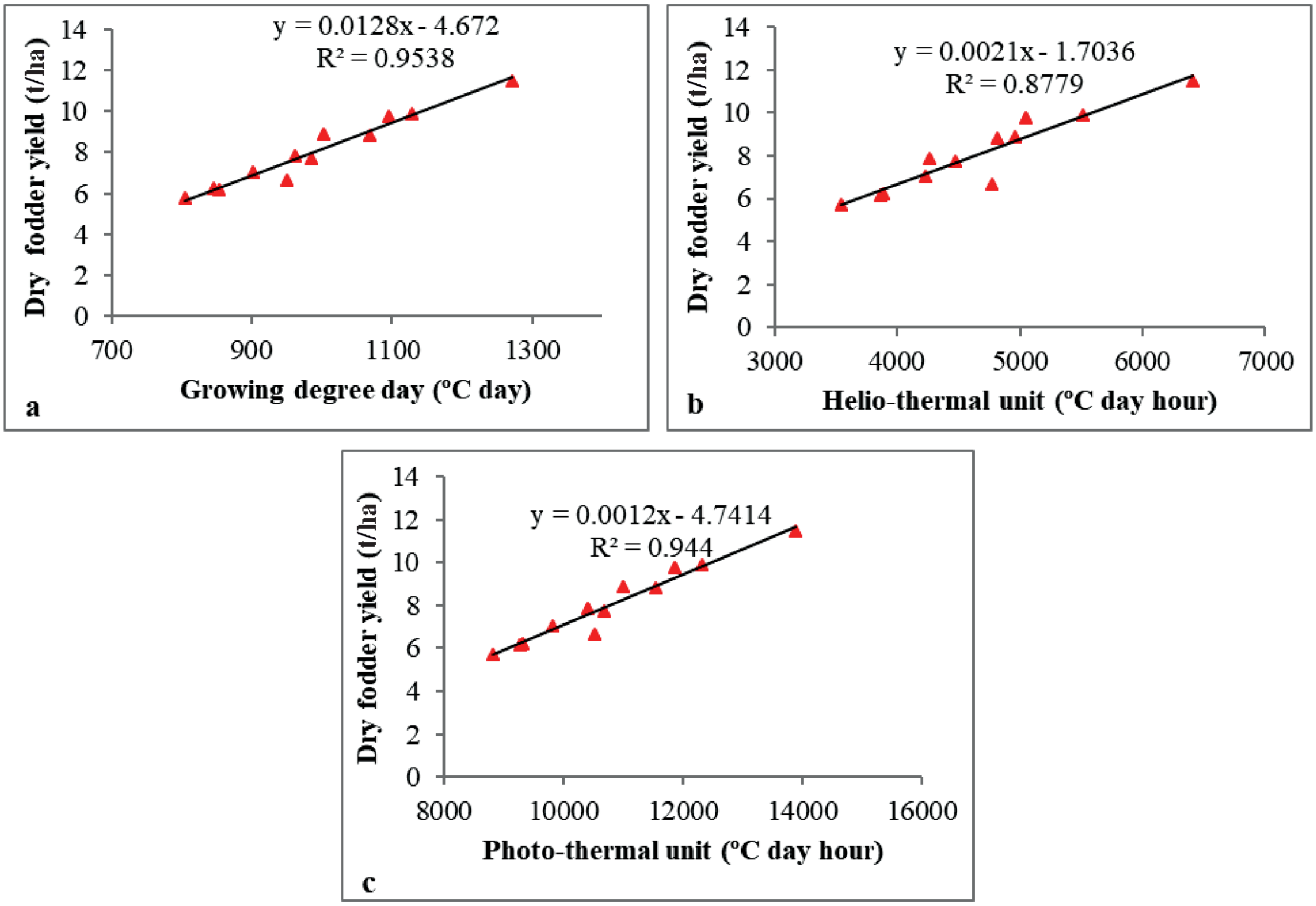

Fig. 2. Relationship between growing degree day (a), helio-thermal unit (b) and photo-thermal unit (c) and dry fodder yield of fodder oat

day hour) and PTUE (0.80 kg/°C day hour) was recorded to be the highest in 15th November seeded crop, which was statistically similar with crop seeded on 25th November. With delay in sowing, these values found to decrease subsequently. Lowest values of above observations were found with 15th December sown crop. Higher efficiencies with seeding on 15th November were due to higher dry fodder yield compared to delayed seeding dates. Higher efficiencies like HUE (Pathania *et al.*, 2019), HTUE (Girijesh *et al.*, 2011; Pathania *et al.*, 2019) and PTUE (Pathania *et al.*, 2019) in wheat with optimum sowing windows have been reported.

Significant linear regression between dry fodder yield and different agro-meteorological indices showed that dry fodder yield of fodder oat increased by 0.012 t/ha, 0.002 t/ha and 0.001 t/ha with 1 °C day increase in GDD, 1 °C day hour increase in HTU and 1 °C day hour increase in PTU, respectively (Figure 2a, b and c).

From the present study it may be concluded that JHO-822 variety and sowing on 15th November will be beneficial for enhancing green and dry fodder yield of fodder oat under North Bihar conditions and similar agro-ecologies.

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