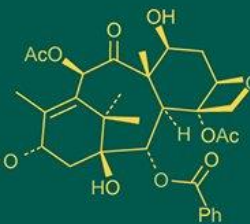
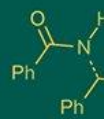


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Elucidating the effect of different methods of salicylic acid application on yield parameters of Oat (*Avena sativa* L.) varieties under saline condition

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Abstract

A field experiment was carried out during *rabi* season of 2024-25 and 2025-26 at Nawabganj Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The experiment was comprised of two variety viz., Kent (V_1) and NDO-1 (V_2) and seven salicylic acid applications method viz. Control (Untreated check) (T_1), Seed priming with salicylic acid @ 1.5 mM (T_2), Foliar application of salicylic acid @ 1.5 mM (T_3), Salicylic acid application @ 1.5 mM through drenching (T_4), Seed priming with salicylic acid @ 1.5 mM + Foliar application of salicylic acid @ 1.5 mM (T_5), Seed priming with salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching (T_6) and Foliar application of salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching (T_7). The experiment was laid out in factorial randomized block design with tree replication. The result revealed that the Kent (V_1) variety with seed priming along with foliar application of salicylic acid @ 1.5 mM (T_5) recorded significantly higher days to maturity, seed yield (kg ha^{-1}), 1000 grain yield (g), biological yield (kg ha^{-1}), harvest index (%) and protein content (%) as compared to control during both the years.

Keywords: HI, salicylic acid, Priming, Foliar, Drenching, Seed yield

1. Introduction

The oat (*Avena sativa* L.), a member of the Poaceae family, is a Mediterranean crop that was domesticated later than wheat and barley in antiquity. It is thought that *Avena sterilis* is where the cultivated oat originated. Of the oats collected worldwide, over 95% are hexaploid, and 45% are wild and weedy species. Oats are produced on about 27 million hectares and 40 metric tonnes of land worldwide. Russia, Canada, Poland, Finland, and Australia are the top five nations in the world for oat production (FAO, 2022). In India, fodder oats are cultivated over approximately 0.25 million hectares (M ha), with the maximum acreage in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%), and Madhya Pradesh (6%). Other states, like as Gujarat, Odissa, Maharashtra and Uttarakhand share the remaining portion of the oat cultivated area. The green and dry fodder productivity and seed yield range from 50 to 60, 12 to 15, and 2-3 t/ha, respectively (Chand *et al.*, 2025). Under favourable temperature, the crop is a brilliant source of hay, can be used for grazing and provides quality silage.

Salicylic acid (SA) is an important naturally occurring hormone in plant. SA involved in the regulation of plant development and growth, flowering and ripening and more recently, it was also reported to be involved in plant responses to abiotic stresses. Thus SA mediates the response to salinity, low temperature and drought.

Seed priming is one among the seed quality enhancement technique, in which seeds are partially hydrated until the germination process begins, but radicle emergence does not occur. This technique is used for improvement of germination speed, germination vigour, seedling establishment and yield.

Foliar spray is an efficient method of delivering SA directly to the photosynthetically active surfaces of plants. Through this method, SA is rapidly absorbed, influencing key physiological processes such as stomatal regulation, chlorophyll stability, and enzyme activity.

Foliar application under saline conditions enhances plant tolerance by improving water-use efficiency, reducing oxidative damage, and supporting better growth and yield attributes.

Application of SA through drenching allows for root-zone absorption, where SA interacts with the rhizosphere and is taken up by roots. This method may influence root growth, osmotic adjustment, and ion uptake regulation. In saline soils, SA through irrigation can help mitigate salt-induced damage by maintaining ion homeostasis, enhancing root vitality, and indirectly supporting above-ground growth and yield.

2. Materials and methods

A field experiment was carried out during *rabi* season of 2024-25 and 2025-26 at Nawabganj Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The experiment was comprised of two variety viz., Kent (V_1) and NDO-1 (V_2) and seven salicylic acid treatments application method viz. Control (Untreated check) (T_1), Seed priming with salicylic acid @ 1.5 mM (T_2), Foliar application of salicylic acid @ 1.5 mM (T_3), Salicylic acid application @ 1.5 mM through drenching (T_4), Seed priming with salicylic acid @ 1.5 mM + Foliar application of salicylic acid @ 1.5 mM (T_5), Seed priming with salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching (T_6) and Foliar application of salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching (T_7). The experiment was laid out in factorial randomized block design with tree replication. The oat varieties Kent and NDO-1 were used as a test crop which with a dose of 1000 kg/ha sown in line mark at 22.5 cm row to row and 10 cm of plant to plant distance. A common dose of 80 kg N and 40 kg P_2O_5 /ha was applied in the form of urea and DAP, respectively. All agronomic practices were applied equally to each experimental plot.

Days to maturity

Days to maturity is the duration from the date of sowing to the stage when 75% of the panicles in each treatment plot showed complete loss of green colour and reached physiological maturity.

Seed yield (kg ha⁻¹)

The net plot area was harvested manually; threshed, winnowed, and clean seeds were weighed. Moisture content was standardized, and the total seed weight per plot was converted and expressed in kilograms per hectare (kg ha⁻¹).

1000 grain weight

A representative sample of clean, healthy grains was counted from the harvested seed lot of each plot and weighed on an electronic precision balance to determine the test weight.

Biological yield (kg ha⁻¹)

Total above-ground biomass (including both grain and straw) was recorded by weighing the completely sun-dried bundled harvest from the net plot area prior to threshing, and the values were converted to kilograms per hectare (kg ha⁻¹).

Harvest index (%)

Calculated as the ratio of economic yield (seed yield) to the total biological yield, expressed as a percentage using the following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Seed Yield (kg ha}^{-2}\text{)}}{\text{Biological Yield (kg ha}^{-2}\text{)}} \times 100$$

Protein content (%)

Total nitrogen content in the oat grains was estimated using the standard micro-Kjeldahl method. The grain protein percentage was subsequently calculated by multiplying the total nitrogen value by the crop-specific factor (6.25).

$$\text{Protein content (\%)} = \text{Nitrogen content (\%)} \times 6.25$$

Results and discussion

Application of SA delayed senescence and extended the grain-filling window. (V_1T_5) took the longest to mature (114.00 days in 2024-25 and 116.28 days in 2025-26), compared to the earliest maturity observed in (V_2T_1) (106.00 and 108.12 days).

Grain test weight increased substantially with combined treatments. (V_1T_5) produced the heaviest grains (46.80 g and 47.74 g), closely followed by (V_1T_6) (44.20 g and 45.08 g), whereas the lowest test weight occurred in (V_2T_1) (34.50 g and 35.19 g).

Harvest Index (HI): Foliar application (T_3) alone or combined with other methods optimized carbohydrate partitioning. (V_1T_3) recorded the highest HI (36.05% and 36.09%), showing close statistical parity with (V_1T_7) and (V_2T_3).

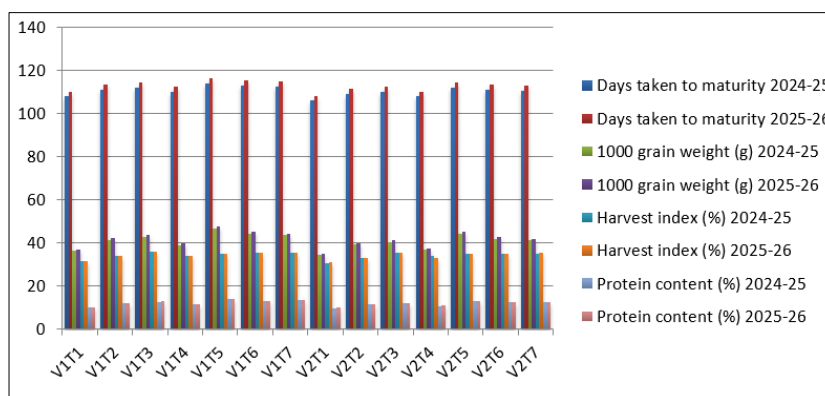
Protein Content: Synergistic application significantly enhanced nutritional quality. (V_1T_5) registered the maximum grain protein content (13.80% in 2024-25 and 13.97% in 2025-26), representing a sharp increase over the unprimed controls (V_1T_1), 10.20% and (V_2T_1), 9.80%.

The Kent variety significantly outperformed NDO-1 under saline stress conditions. The application method (T_5) (Seed priming + Foliar application) generated the maximum seed yield across both varieties. The interaction treatment (V_1T_5) recorded the peak seed yield of 2756.70 kg/ha in 2024-25 and 2814.59 kg/ha in 2025-26. For variety NDO-1, the maximum seed yield was also recorded under T_5 , 2510.00 and 2562.71 kg/ha, respectively both the years.

Biological Yield, Followed an identical positive trend. (V_1T_5) produced the highest total biological yield (7840.00 kg/ha and 7996.80 kg/ha), closely trailed by (V_1T_6). The lowest values occurred in the untreated control of NDO-1 (V_2T_1), 5450.00 and 5559.00 kg/ha, respectively both the years.

Table 1: Effect of different method of salicylic acid application on Days taken to maturity, 1000 grain weight (g), Harvest index (%) and Protein content (%) during both the years 2024-25 and 2025-26

Treatments	Days taken to maturity		1000 grain weight (g)		Harvest index (%)		Protein content (%)	
	2024-25	2025-26	2024-25	2025-26	2024-25	2025-26	2024-25	2025-26
V ₁ T ₁	108.00	110.16	36.20	36.92	31.62	31.66	10.20	10.32
V ₁ T ₂	111.00	113.22	41.50	42.33	33.77	33.81	12.10	12.24
V ₁ T ₃	112.00	114.24	42.80	43.66	36.05	36.09	12.80	12.95
V ₁ T ₄	110.00	112.20	38.90	39.68	33.95	33.99	11.50	11.64
V ₁ T ₅	114.00	116.28	46.80	47.74	35.16	35.20	13.80	13.97
V ₁ T ₆	113.00	115.26	44.20	45.08	35.29	35.32	13.10	13.26
V ₁ T ₇	112.50	114.75	43.50	44.37	35.53	35.57	13.40	13.56
V ₂ T ₁	106.00	108.12	34.50	35.19	30.83	30.86	9.80	9.92
V ₂ T ₂	109.00	111.18	39.20	39.98	33.15	33.18	11.40	11.54
V ₂ T ₃	110.00	112.20	40.50	41.31	35.41	35.45	12.10	12.24
V ₂ T ₄	108.00	110.16	36.80	37.54	34.14	33.18	10.80	10.93
V ₂ T ₅	112.00	114.24	44.10	44.98	34.96	34.99	12.90	13.05
V ₂ T ₆	111.00	113.22	41.90	42.74	34.97	35.01	12.40	12.55
V ₂ T ₇	110.50	112.71	41.20	42.02	35.21	35.24	12.60	12.75
SEm±	1.143	1.166	0.661	0.681	0.694	0.715	0.217	0.224
CD (P=0.05)	3.324	3.391	1.923	1.981	2.018	2.079	0.630	0.649
Interaction (V×T)								
SEm±	1.617	1.694	0.935	0.963	0.981	1.011	0.307	0.316
CD at 5%	4.700	4.794	2.720	2.802	2.854	2.940	0.891	0.918

**Fig 1:** Effect of different method of salicylic acid application on Days taken to maturity, 1000 grain weight (g), Harvest index (%) and Protein content (%) during both the years (2024-25 and 2025-26)**Table 2:** Effect of different method of salicylic acid application on Seed yield (kg ha⁻¹) and Biological yield (kg ha⁻¹) during both the years (2024-25 and 2025-26)

Treatments		Seed yield (kg ha ⁻¹)		Biological yield (kg ha ⁻¹)	
		2024-25	2025-26	2024-25	2025-26
Kent (V ₁)	Control (untreated check)	1850.00	1888.85	5850.0	5967.00
	Seed priming with salicylic acid @ 1.5 mM	2303.35	2351.72	6820.00	6956.40
	Foliar application of salicylic acid @ 1.5 mM	2394.02	2440.30	6640.00	6772.80
	Salicylic acid application @ 1.5 mM through drenching	2122.01	2166.57	6250.00	6375.00
	Seed priming with salicylic acid @ 1.5 mM + Foliar application of salicylic acid @ 1.5 mM	2756.70	2814.59	7840.00	7996.80
	Seed priming with salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching	2593.49	2647.96	7350.00	7996.80
	Foliar application of salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching	2530.02	2583.16	7120.00	7497.00
NDO-1 (V ₂)	Control (untreated check)	1680.00	1715.28	5450.00	5559.00
	Seed priming with salicylic acid @ 1.5 mM	2095.00	2139.00	6320.00	6446.40
	Foliar application of salicylic acid @ 1.5 mM	2178.00	2223.74	6150.00	6273.00
	Salicylic acid application @ 1.5 mM through drenching	1929.00	1969.51	5820.00	5936.40
	Seed priming with salicylic acid @ 1.5 mM + Foliar application of salicylic acid @ 1.5 mM	2510.00	2562.71	7180.00	7323.60
	Seed priming with salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching	2360.00	2410.17	6750.00	6885.00
	Foliar application of salicylic acid @ 1.5 mM + Salicylic acid application @ 1.5 mM through drenching	2302.50	2350.85	6540.00	6670.80
Treatment (T)					
SEm±		49.09	54.57	164.524	167.814
CD at 5%		142.74	158.68	478.374	487.941
Interaction (V×T)					
SEm±		69.43	77.17	232.672	237.325
CD at 5%		201.87	224.40	676.523	690.033

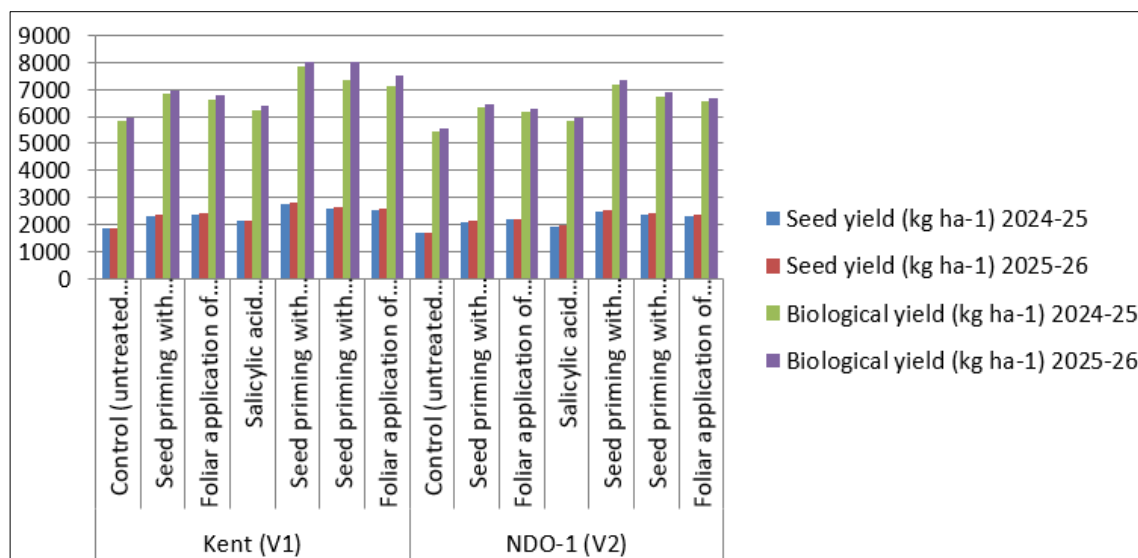


Fig 2: Effect of different method of salicylic acid application on Seed yield (kg ha⁻¹) and Biological yield (kg ha⁻¹) during both the years (2024-25 and 2025-26)

Conclusion

The results confirm that salicylic acid acts as an effective bio stimulant to mitigate salinity stress in oat crops. Combining Seed priming with salicylic acid @ 1.5 mM and Foliar application of salicylic acid @ 1.5 mM (T₅) proved to be the most efficient treatment protocol. Among varieties, Kent (V₁) paired with (T₅) (V₁T₅) is confidently recommended to farmers to secure superior crop stands, maximum grain protein (13.97%), enhanced seed yield (2814.59 kg/ha), and robust green fodder production under saline conditions.

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