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Correlation of Germination, Seedling Vigour Indices and Enzyme Activities in Response to Liquid Organic *Kunapajala* to Predict Field Emergence in Late Sown Wheat

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ABSTRACT

A laboratory experiment was conducted to correlate the germination test with seed vigour parameters and enzyme activities to predict seedling vigour and planting value on late sown wheat variety UP-2526. The experiment was conducted at GBPUA and T, Pantnagar during *rabi* season of 2020-2. The experiment consisted of five treatments viz; no priming (control), hydropriming, 10%, 25% and 50% *Kunapajala* priming for 16 hrs. Results revealed that germination percentage was positively and significantly correlated with speed of germination (0.914*), seedling vigour index-II (0.890*), α-amylase activity at 12 and 16 hrs of priming (0.942* and 0.947*, respectively), seed reserve mobilization efficiency on 4th day (0.954*) after incubation and imbibition rate after 16 and 24 hrs of soaking duration (0.933* and 0.894*, respectively). Heat stress both low and high temperature are major reason of declining yield in wheat when sown delayed. Prediction of seedling vigour and field emergence of seed before sowing is prime important for assured yield in late sown condition.

Keywords Seed germination, Seedling vigour, Seed priming, Wheat.

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INTRODUCTION

Wheat is the main staple food crop of the world and north Indian populace. It constitutes a significant amount in food security worldwide. In India, wheat production was 98.5 Mt from 30.8 Mha areas with average productivity of 3.2 t ha^{-1}(Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, 2016–17). Globally, India is the second largest producer of wheat contributing 14.0% in terms of area and 13.6% in production (Anonymous 2018). Despite the fact that India's significant share in global wheat area and the total production, the productivity is marginally higher, when compared between India and World with 3.17

t ha^{-1} and 3.12 t ha^{-1}, respectively. With increase in population, there is shrinkage on cultivable land. Therefore, the main focus would be on increasing the productivity by adopting improved cultivation practices. Crop establishment is an important factor depends upon optimum plant population and uniform emergence. Proper crop establishment depends upon quality of the seed in terms of its germination and seedling vigour (Devi *et al.* 2022). Planting time, seed quality material and supply of optimum nutrients during crop growth are some of the important parameters that limit productivity. These elements decide crop establishment, growth and development, which thus decide yielding capability of the harvest. Wheat is predominantly grown during *rabi* season and has more wider planting window. In the north western plain zone of India, it is planted in second fortnight of October as early planting, first to third week of November as optimum sowing time and upto fourth week of November to end of December. Always it is a challenge to achieve desirable yield potential and grain quality under both normal as well as late sowing condition. In normal sowing condition, poor quality seed material and inadequate soil moisture and nutrients may cause reduction in yield potential and seed quality. On the other hand, heat stress both low and high temperature are major reason of declining yield in wheat when sown delayed. Prediction of seedling vigour and field emergence of seed before sowing is prime important for assured yield in late sown condition.

Seed priming is a process of regulating the germination process by managing the temperature and seed moisture content and is the most widely used seed invigoration technique to improve field emergence and crop establishment under adverse environmental condition. Hydropriming is one of the oldest practices used for seed invigoration. This practice has been used widely to stimulate the speed, uniformity of emergence and improve the final plant stand (Devi *et al.* 2022). Seed priming with either 10% or 25% herbal based *kunapajala* is an eco-friendly seed invigoration technique to improve emergence, seedling development and biochemical activity of wheat over hydropriming and no priming (Devi *et al.* 2022). For preparing herbal *kunapajala*, the ingredients (10 kg cow dung, 10 L cow urine, 2 L sour butter milk, 2 kg jaggery, 2 kg sprouted urd, 2 kg mustard cakes, 3 L rice bran water, 1 L fresh milk, 3-4 pieces of dry cow dung, 10 kg nettle grass and 10 kg leaves of other grasses) were mixed into a plastic drum of 200 L capacity and the volume of solution was made up to 200 L with water. Then it was shaken properly with a stick and the lid was closed. The contents of the drum were mixed properly with stick twice a day (morning and evening). The day when the bubbles stopped appearing in the drum, the process was completed and herbal *kunapajala* was ready. Then it was sieved properly with cloth for further use.

The standard germination test is considered as the common test for evaluating seed quality particular seed performance under ideal environmental conditions, but this test does not always show field emergence potential performance. Seed lots do not vary in viability and may also differ in field emergence potential; in that way, a seed vigour test is considered powerful when ranking the seed lots based on vigour level groups. Therefore, correlation analysis results can bring more precise solution to field emergence. According to Indian Minimum Seed Certification Standards (IMSCS 2013), final count of wheat seedling evaluation is 8th day for its germination per cent. With this key points, the present study was carried out to correlate germination per cent with seed vigor parameters and enzyme activity to assess the seed vigour and planting value of late sown wheat var 2526.

MATERIALS AND METHODS

The laboratory study was conducted at seed physiology laboratory, Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar (29°1' N latitude, 79°29'E longitude and elevation of 231 m above MSL) during rabi season of 2020-21. The experiment was laid out in Completely Randomized Design with five treatments (no priming, hydropriming, 10%, 25% and 50% *kunapajala* priming) and six replications. Wheat seeds of variety UP-2526 were soaked in herbal *kunapajala* at 10%, 25% and 50% concentrations and tap water (hydropriming) for 16 hrs in 1: 2: seed: priming media ratio and seeds were shade dried up to original moisture content (11.8%). For determination of water imbibitions rate and α-amylase activity, seeds are soaked in different priming media for 8, 12, 16 and 24 h and 12, 16 and 24 h, respectively. Physiological parameters i.e., Germination % (Kala and Eswari 2019) at 8^{th} day, speed of germination (Maguire 1962), mean germination time (Ellis and Robert 1981), days to 50% germination (Farooq *et al.* 2019), root length, shoot length and dry weight of seedling, seedling vigour index^{-1} (SVI-I) and seedling vigour index-II (SVI-II) (Abdul-Baki and Anderson 1973), seed mobilization efficiency (Sikder *et al.* 2009) at 4^{th} and 8^{th} days after incubation and biochemical parameter like the α-amylase activity of wheat seeds (Mazumdar and Majumder 2017), were evaluated. The rate of water imbibitions was calculated by method given by Tian *et al.* (2014) with modification. The collected experimental data from laboratory experiment was analyzed by OPSTAT software for Completely Randomized Design (CRD). The critical difference was calculated at 5% level of significance.

RESULTS AND DISCUSSION

A correlation study was carried calculated among germination, seedling vigour and enzymes activities

Table 1. Correlation coefficient (r) among germination, seedling vigour parameters, seed reserve mobilization efficiency, α-amylase activity and water imbibition rate of wheat.

	G %	SG	MGT	T50	SL	SDW	SVI-I	SVI-II
G %								
SG	0.914*							
MGT	-0.913*	-0.999**						
T50	-0.915*	-1.000**	0.999**					
SL	0.740	0.671	-0.644	-0.663				
SDW	0.870	0.672	-0.657	-0.674	0.859			
SVI-I	0.788	0.718	-0.693	-0.710	0.997**	0.879*		
SVI-II	0.890*	0.697	-0.683	-0.699	0.853	0.999**	0.875	
α-amylase 12 hrs	0.942*	0.745	-0.743	-0.745	0.758	0.898*	0.799	0.910*
α-amylase 16 hrs	0.947*	0.764	-0.763	-0.771	0.671	0.929*	0.716	0.942*
α-amylase 24 hrs	0.761	0.584	-0.594	-0.578	0.500	0.583	0.547	0.604
ME 4^{th}	0.954*	0.910*	-0.898*	-0.909*	0.887*	0.906*	0.917*	0.917*
ME 8^{th}	0.748	0.820	-0.796	-0.811	0.935*	0.735	0.939*	0.737
IR 8 hrs	0.701	0.377	-0.377	-0.387	0.470	0.845	0.502	0.847
IR 12 hrs	0.810	0.516	-0.513	-0.523	0.618	0.923*	0.651	0.926*
IR 16 hrs	0.933*	0.743	-0.746	-0.751	0.604	0.897*	0.653	0.912*
IR 24 hrs	0.894*	0.639	-0.639	-0.645	0.645	0.923*	0.686	0.932*

Table 1. Continued.

	α-amylase 12 hrs	α-amylase 16 hrs	α-amylase 24 hrs	ME 4^{th}	ME 8^{th}	IR 8 hrs	IR 12 hrs	IR 16 hrs	IR 24 hrs
G%									
SG									
MGT									
T50									
SL									
SDW									
SVI-I									
SVI-II									
α-amylase 12 hrs									
α-amylase 16 hrs	0.928*								
α-amylase 24 hrs	0.877	0.681							
ME 4^{th}	0.882*	0.883*	0.623						
ME 8^{th}	0.655	0.602	0.406	0.903*					
IR 8 hrs	0.792	0.886*	0.554	0.608	0.266				
IR 12 hrs	0.891*	0.943*	0.653	0.742	0.436	0.980**			
IR 16 hrs	0.913*	0.996**	0.683	0.845	0.536	0.896*	0.941*		
IR 24 hrs	0.947*	0.976**	0.746	0.810	0.506	0.940*	0.984**	0.975**	

G%: Germination percentage, SG: Speed of germination; SL, Seedling length, MGT: Mean germination time, SDW: Seedling dry weight, SVI-I: Seedling vigour index I, SVI-II: Seedling vigour index II, ME: Mobilization efficiency, IR: Imbibition rate .

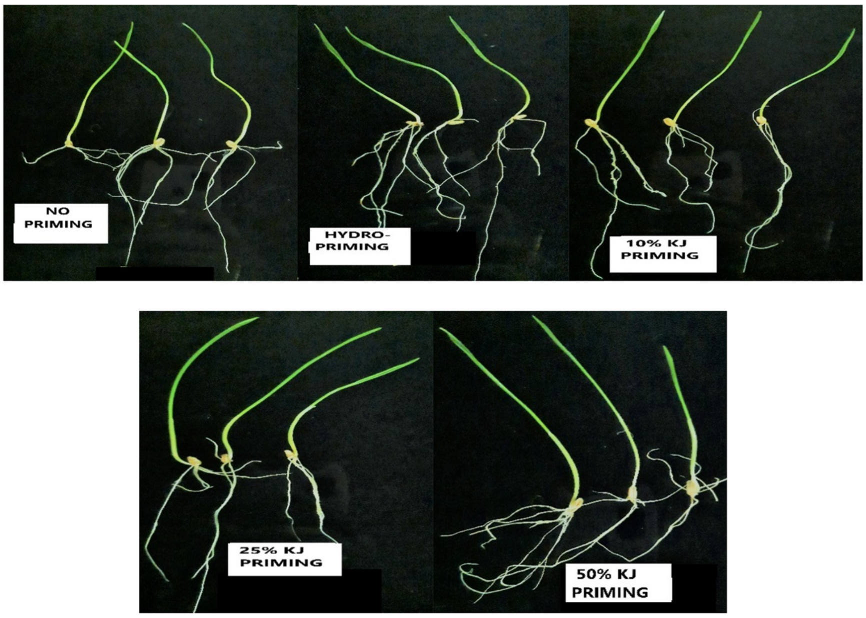

Fig. 1. Effect of seed invigoration treatments on seedling growth of wheat after 1st day (I), 2nd day (II), 4th day (III) and 8th day after incubation (IV).

of wheat are given in Table 1.

Perusal of Table 1 clearly showed that germination percentage was positively and significantly correlated with speed of germination, seedling vigour index-II, α-amylase activity at 12 and 16 hrs of priming, seed reserve mobilization efficiency on 4th day after incubation and imbibitions rate after 16 and 24 hrs of soaking duration. Germination percentage was negatively and significantly correlated with mean germination time and days taken to 50% germination. Speed of germination was positively and significantly correlated with seed reserve mobilization efficiency on 4th day after incubation and negatively and significantly correlated with mean germination time and days taken to 50% germination. Mean germination time and days taken to 50% germination were negatively and significantly correlated with seed reserve mobilization efficiency on 4th day after incubation while mean germination time positively and significantly correlated with days taken to 50% germination. Seedling length for as shown in Fig. 1 was positively and significantly correlated with seedling vigour index-I and seed reserve mobilization efficiency on 4th and 8th day after incubation. Seedling dry weight was positively and significantly correlated with seedling vigour index-I, seedling vigour index-II, α-amylase activity of 12 and 16 hrs of soaking, seed reserve mobilization efficiency on 4th day after incubation and water imbibitions rate after 12, 16 and 24 hrs of soaking. Seedling vigour index-I was positively and significantly correlated with seedling length and mobilization efficiency on 4th and 8th day of incubation. Seedling vigour index-II was positively and significantly correlated with germination, seedling dry weight, α-amylase activity of 16 and 24 hrs of soaking, seed reserve mobilization efficiency on 4th day after incubation and water imbibitions rate after 12, 16 and 24 hrs of soaking.

The α-amylase activity of 12 and 16 hrs of soaking were found be to positively and significantly correlated with germination percentage, seedling dry weight, SVI-II, α-amylase activity of 24 hrs of soaking, seed reserve mobilization efficiency on 4th day after incubation and water imbibitions rate after 12, 16 and 24 hrs of soaking. The α-amylase activity of 24 hrs of soaking could not attain positive and significant correlation with any other parameters.

Seed reserve mobilization efficiency on 4th day after incubation was positively and significantly correlated with all the seedling vigour parameters except α-amylase activity of 24 hrs of soaking and imbibitions rate after 12, 16 and 24 hrs of soaking while mobilization efficiency on 8th day after incubation was positively and significantly correlated with seedling vigour index-I.

CONCLUSION

The present study concluded that germination percentage was positively and significantly correlated with speed of germination (0.914*), seedling vigour index-II (0.890*), α-amylase activity at 12 and 16 hrs of priming (0.942* and 0.947*, respectively), seed reserve mobilization efficiency on 4th day (0.954*) after incubation and imbibitions rate after 16 and 24 hrs of soaking duration (0.933* and 0.894*, respectively). Speed of germination was positively and significantly correlated with seed reserve mobilization efficiency on 4th day after incubation (0.910*). The α-amylase activity of 12 and 16 hrs of soaking were found be to positively and significantly correlated with seedling dry weight (0.898*), SVI-II (0.910*), seed reserve mobilization efficiency on 4th day (0.882*) after incubation and water imbibitions rate after 12, 16 and 24 hrs of soaking (0.891*, 0.913* and 0.947*, respectively). Finally, the study concluded that the germination per cent along with other parameters discussed above could be used as a quick indicator of seedling vigour in terms of field emergence when treated with liquid organic *kunapajala.*

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