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Sowing Time, Plant Growth Regulators and their Application Scheduling Affect Quality Traits of Wheat (*Triticum aestivum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during winter (*rabi*) seasons of 2020-21, 2021-22 at Research farm, seed technology research center, Department of Plant Physiology, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh to study the response of sowing time, plant growth regulators and their application scheduling on quality traits of wheat. The experiment consisting of 3 sowing

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dates (D1-15th November, D2-15th December, D3 - 15th January), 3 Spray scheduling at different stages (A1-Vegetative stage, A2-Anthesis stage, A3-Vegetative + Anthesis stage) and 7 Plant Growth Regulators (H1: Cycocel @1000 ppm, H2: Salicylic acid@400ppm, H3: Salicylic acid@800ppm, KCl@1%, H4: Ascorbic acid@10ppm, H5: Thiourea@400ppm, H6: Water spray and H7: Control) making 63 treatment combinations, replicated thrice in a split plot design. The crop sown at normal sowing time showed significantly positive affect on quality traits of wheat than the late sown crop. Spraying of plant growth regulators salicylic acid@400ppm and 800ppm along with other plant growth regulators at different growth stages have positive effect on seed quality and improve germination %, seedling length, seedling dry weight, seed vigour index I and II of wheat crop.

Keywords: High temperature PGRs; seed quality traits; sowing dates; wheat.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major cereal crop of the world and one third of the world's population uses it as a staple food. It is a thermo-sensitive long day crop and is excellent matched to temperate climates, but growing population pressure and increased demand for food has forced farmers to grow wheat in non-traditional and hotter environments, where heat stress is major factor limiting on wheat productivity. Wheat grains enclosed high starch 60-68% with protein 8-15%, fat 1.5-2.0%, cellulose 2.0-2.5% and minerals 1.5-2.0% [1]. In India, delayed sowing of wheat due to rice-wheat cropping system is one of the major factors responsible for reduced seed quality due to the sub-optimal temperature during germination, plant establishment and reproductive growth [2]. Late sown wheat faces terminal heat stress at the time of anthesis to grain filling which not only reduces grain yield but also affects the grain development processes and quality of wheat grain [3,4]. Quality seed increased crop yield by 20-25 % with the optimum agro-physilogical practices. The ability of the seed to germinate, emerge into a uniform and vigorous field stand is a direct function of its quality [5,6]. It is a general talk that the viability and the performance of the seed during its early stages of germination may be related to the conditions under which that seed had formed, developed, and matured. Terminal heat stress in wheat can be managed by applying Plant growth regulators (PGR's) which may be organic or inorganic in nature as they act as osmoregulent. PGR's play diverse roles in the regulation of different developmental processes and signaling networks as they are involved either directly or indirectly in a wide range of biotic and abiotic stress responses in plants. Exogenous application of PGR's enhanced proline contents, antioxidant activities, relative water contents and chlorophyll contents under stressed environment [7] and PGR's also have the potential to increase food production and quality much more quickly than plant breeding techniques. Pre-sowing seed treatment with PGR's is an easy, low cost and low risk technique and is also an alternative approach recently used to overcome the effect of heat stresses in wheat.

Although, the effect of heat stress on wheat yield and yield components and PGR's applications has diverse ability to improve seed yield under different a biotic stress condition by improving physiological and biochemical traits of plant is well documented, however, the effect of PGR's on seed quality and seed vigour is often ignored in these studies. Therefore, the objective of the present study was to examine the effect of sowing time, spray scheduling and plant growth regulators application on seed quality traits in wheat.

2. MATERIALS AND METHODS

The field experiment was conducted during Rabi 2020-21, 2021-22 at Research farm, seed technology research center, Department of Plant Physiology, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh. Experiment consisting of 3 sowing dates D1 - Normal sowing (15th November), D2- Late sowing (15th December), D3 - Very late sowing (15th January) were assigned in main plots,7 Plant Growth Regulators –H1: Cycocel @1000 ppm, H2: Salicylic acid@400ppm, H3: Salicylic acid@800ppm, KCl@1%, H4: Ascorbic acid@10ppm, H5: Thiourea@400ppm, H6: Water spray and H7: Control. 3 Spray scheduling at different stages A1-Vegetative stage, A2- Anthesis stage, A3-Vegetative + Anthesis stage making 63 treatment combinations, replicated thrice in a split plot design (SPD).

Seed germination was determined as per ISTA [8]. Seedling vigour was calculated following formula suggested by Abul-Baki and Anderson [9] as Vigour Index I = Germination% X Seedling length (Root + Shoot) (cm) Vigour Index II= Germination % X Seedling dry weight (g).The seedling length was measured from the tip of the primary leaf to base of hypocotyls with the help of a scale and mean seedling length was expressed in centimeters. Ten normal seedlings were selected randomly in each treatment from all the replications on eight day from germination test. The ten normal seedlings used for root and shoot length measurements were kept in hot air oven at 50±10C for 24 hour. The dry weight of the seedlings was recorded and expressed in grams. The data was statistically analyzed through three factors split-split plot experimental design with fisher t-test at 5% level.

3. RESULTS AND DISCUSSION

Seed germination is very important seed quality characteristics for wheat that affect crop establishment. Germination, root and shoot development progressively and significantly decreased with increase in temperature from 25 to 35°C due delay in sowing dates. It is obvious from the data given in Table 1 that germination % of wheat was affected by different sowing dates, spray scheduling and plant growth regulators. The data presented in Table 1 indicated that the D1 sown crop was having significantly higher germination % (95.71, 95.78 and 95.75) as compared to delayed sowing (D2 and D3) but it was statistically at par with D2 sowing during both the year (2020-21 and 2021-22). Seedling length (26.42, 26.31and 26.37) and Seedling Dry Weight (0.274, 0.279 and 0.277) on D1 sowing were also significantly higher than late sowing of wheat on D2 and D3. Our findings are accordance with the findings of Shaheb et al. [10] who reported that significant variations were observed due to different sowing time on the seed quality of wheat viz. germination %, seedling length and seedling dry weight.

Non-significant difference was observed with respect to spray scheduling with germination % during year 2020-21 and found to be significant on the year 2021-22.Foliar application of different PGRs at both stages Vegitative + anthesis record maximum germination % under normal, late and very late sowing. Growth regulators play an important role in increasing germination rate of seeds, employed for rooting, vegetative propagation and overall yield of several plants as well as they mostly used for improving seed germination and the productivity of a large number of agricultural crops [11]. By pooled analysis it was found that plant growth regulators had significant effect on germination %, seedling length and seedling dry weight. The maximum germination % (95.67, 95.93 and 95.80) was recorded in the plots receiving salicylic acid@800ppm but highest seedling length (25.80, 26.29 and 26.04 cm) and seedling dry weight (0.266, 0.264 and 0.265 g) was noted under application of salicylic acid@400ppm during both the year (2020-21 and 2021-22). The Salicylic acid @ 800ppm application exhibited maximum germination %, it might be due to seed germination was stimulates by salicylic acid application via bio-synthesis of gibberellic acid and acts as thermo gene inducers [12].

Data related to seed vigour index I and seed vigour index II (Table 2) also significantly influenced by different date of sowing during both the year (2020-21 and 2021-22). Seedling vigour is an important quality parameter which needs to be assessed to supplement germination and viability test to gain an insight in to the performance of a seed lot in the field or in storage. Sowing on D1 was having significantly maximum seed vigour index I (2528.55, 2520.50 and 2524.53) and seed vigour index II (26.24, 26.73 and 26.49) as compared to delayed sowing during both the year (2020−21 and 2021−22). The present study raveled that delay in sowing induce high temperature stress during grain filling period under very late sowing conditions significantly decrease the vigour index I at compare to normal sown crop. It might be due to disturbance in the source and sink relationship which reduces the quality of seed due to high temperature during seed maturation stage of wheat [13,14].

Non-significant difference was observed in seed vigour index I and seed vigour index II with respect to spray scheduling. But in case of plant growth regulators significant difference was observed in seed vigour index I and seed vigour index II. Highest seed vigour index I was noted under application of salicylic acid@800ppm and seed vigour index II was also affect by plant growth regulators. It is might be resulting because of exogenous application of this phyto hormone act as powerful tool in enhancing the growth, photosynthetic capacity, productivity and quality of seeds especially in areas where abiotic stresses are occurs [11].

Table 1. Effect of sowing time, spray scheduling and plant growth regulators application on Germination %, Seedling length and seedling dry weight in wheat

Treatment	Germination %			Seedling Length (cm)			Seedling Dry Weight (g)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Main Plot: 3 (Sowing time)									
Normal sowing (D1)	95.71	95.78	95.75	26.42	26.31	26.37	0.274	0.279	0.277
Late sowing (D2)	94.97	95.20	95.08	25.84	25.61	25.72	0.258	0.253	0.255
Very late sowing (D3)	94.25	94.24	94.25	23.99	24.55	24.27	0.252	0.233	0.242
SEM	0.255	0.276	0.253	0.433	0.317	0.371	0.004	0.005	0.002
CD	0.995	1.077	0.987	1.689	1.236	1.449	0.015	0.018	0.007
Sub Plot: 3 (Spray scheduling)									
Vegetative stage (A1)	94.56	94.86	94.71	25.75	25.46	25.61	0.259	0.252	0.255
Anthesis stage(A2)	94.87	95.02	94.95	25.23	25.70	25.47	0.266	0.259	0.263
Vege. + Anthesis (A3)	95.51	95.33	95.42	25.27	25.31	25.29	0.259	0.253	0.256
SEM	0.214	0.185	0.156	0.250	0.269	0.235	0.003	0.003	0.002
CD	0.600	N/A	0.436	N/A	N/A	N/A	N/A	N/A	0.005
Sub Plot: 7 (Plant Growth Regulators)									
CCC@1000 ppm (H1)	95.19	95.41	95.30	25.02	25.07	25.05	0.260	0.249	0.255
SA @400ppm (H2)	95.44	95.82	95.63	25.80	26.29	26.04	0.266	0.264	0.265
SA@800ppm (H3)	95.67	95.93	95.80	25.79	26.19	25.99	0.263	0.258	0.260
KCl@1% (H4)	95.22	94.93	95.07	25.20	25.68	25.44	0.267	0.256	0.261
AsA@10ppm(H5)	94.33	94.00	94.17	25.55	24.96	25.26	0.265	0.252	0.259
TU@400ppm (H6)	94.93	94.85	94.89	26.04	25.62	25.83	0.257	0.253	0.255
Water spray (H7)	94.07	94.57	94.33	24.54	24.63	24.58	0.252	0.252	0.252
SEM	0.328	0.282	0.238	0.381	0.412	0.359	0.005	0.004	0.003
CD	0.917	0.790	0.666	N/A	1.153	1.005	N/A	N/A	0.008

Table 2. Effect of sowing time, spray scheduling and plant growth regulators application on seed vigour index I and seed vigour index II in wheat

Treatment	Seed Vigour Index I			Seed Vigour Index II		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Main Plot: 3 (Showing time)						
Normal sowing (D1)	2528.55	2520.50	2524.53	26.24	26.73	26.49
Late sowing (D2)	2454.72	2438.51	2446.62	24.50	24.09	24.30
Very late sowing (D3)	2262.09	2314.08	2288.10	23.71	21.94	22.82
SEM	44.27	34.12	38.45	0.38	0.47	0.22
CD	172.83	133.23	150.11	1.49	1.85	0.87
Sub Plot: 3 (Spray scheduling)						
Vegetative stage (A1)	2437.28	2416.75	2427.02	24.47	23.92	24.20
Anthesis stage(A2)	2394.81	2442.83	2418.83	25.21	24.66	24.94
Vege. + Anthesis (A3)	2413.27	2413.51	2413.40	24.77	24.18	24.48
SEM	24.94	26.63	23.05	0.31	0.24	0.19
CD	N/A	N/A	N/A	N/A	N/A	0.53
Sub Plot: 7 (Plant Growth Regulators)						
CCC@1000 ppm (H1)	2381.82	2392.47	2387.14	24.84	23.80	24.33
SA @400ppm (H2)	2462.89	2519.04	2490.98	25.36	25.32	25.34
SA@800ppm (H3)	2467.17	2512.21	2489.69	25.07	24.77	24.92
KCl@1% (H4)	2400.76	2438.71	2419.73	25.43	24.27	24.86
AsA@10ppm(H5)	2411.70	2347.29	2379.49	25.00	23.72	24.36
TU@400ppm (H6)	2472.80	2430.80	2451.81	24.38	24.01	24.20
Water spray (H7)	2308.71	2330.03	2319.38	23.64	23.86	23.76
SEM	38.10	40.68	35.20	0.47	0.37	0.29
CD	106.68	113.92	98.58	N/A	1.04	0.81

4. CONCLUSION

The different sowing dates have directly impact on seed quality of wheat, delay in sowing cause high temperature during grain developing stage which have adverse effect on its germination %, seedling length, seedling dry weight, seed vigour index I and II. Sprayingof plant growth regulators salicylic acid@400ppm and 800ppm along with other plant growth regulators at different growth stages have positive effect on seed quality and improve germination %, seedling length, seedling dry weight, seed vigour index I and II of wheat crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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