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Effect of organic and inorganic pre-sowing treatments on phenotypic characteristics in pea (*Pisum sativum* L.)

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Abstract

The present investigation, entitled "Effect of Organic and Inorganic Pre-sowing Treatments on Phenotypic Characteristics in Pea (*Pisum sativum* L.)", was undertaken to examine the impact of various organic and inorganic seed priming agents on morphological characteristics and yield-associated traits of pea. The experimental design consisted of twelve treatments, comprising four base varieties—Kali Naina, AP-3, K-6, and Swami Aparna—each in combination with organic (Tulsi leaf extract @ 6%) and inorganic agents (Carbendazim WP @ 5%, polyethylene glycol [PEG_{6000}] @ 5%, and gibberellic acid [GA_3] @ 10 ppm).The principal aim was to evaluate the influence of these treatments on critical growth and productivity parameters, including plant height, branch number, flowering period, pod and seed attributes, seed yield (per plant and per plot), biological yield, and harvest index. Statistically significant variation was observed for all measured traits. Among the treatments, Kali Naina + Carbendazim WP @ 5% achieved the greatest plant height at 90 days after sowing (121.47 cm), followed by Kali Naina + PEG_{6000} @ 5% (114.10 cm). The earliest attainment of 50% flowering (70.33 days) was recorded in AP-3 + PEG_{6000} @ 5%, indicating accelerated phenological development attributable to osmotic priming. The maximum branch number per plant (6.60) and the highest seeds per pod (6.50) were noted in Kali Naina + Carbendazim WP @ 5% and Kali Naina + PEG_{6000} @ 5%, respectively, reflecting substantial enhancement of reproductive performance. Yield-related parameters demonstrated considerable improvement with pre-sowing treatments. The highest seed yield per plant (34.10 g) and per plot (4.27 kg) were obtained under Kali Naina + PEG_{6000} @ 5%, establishing PEG_{6000} as the most efficacious priming agent under the experimental conditions. This treatment also registered the maximum harvest index (64.52%), signifying superior assimilate partitioning towards economic yield. Biological yield was likewise elevated in PEG_{6000}- and Carbendazim-based treatments, with K-6 + GA_3 @ 10 ppm and Kali Naina + Carbendazim WP @ 5% exhibiting promising results. Although organic priming with Tulsi leaf extract produced measurable improvements over the untreated control, its overall efficacy was comparatively lower than that of inorganic agents. Nonetheless, its environmentally sustainable nature and moderate enhancement of traits such as seed weight and pod number highlight its potential for integration into eco-friendly and sustainable crop production systems.

Keywords: Pea, GA_3, PEG_{6000}, growth, yield, carbendazim, tulsi leaf extract

Introduction

Field pea (*Pisum sativum* L.) belongs to leguminous family Fabaceae. It is cultivated in temperate regions at high elevations or during cool season in warm regions throughout the world. Pea is diploid with chromosome number 2n=14. India ranks third in area after China and USSR under pea (vegetable and pulses pea) cultivation (Singh *et al.* 2017) [3]. In India, the total area covered by pea is 0.442 million hectares with the production of 4.239 million tonnes whereas, productivity is 9.5 tonne per hectare. Uttar Pradesh is the highest producing state in India. In Uttar Pradesh, area under this crop is 0.178 million hectares with the production of 1.953 million tonnes and productivity 10.97 tonne per hectare (Anonymous, 2015). India is the largest producer of pulses (about 18.5 million tons) and processor of pulses in the world and also imports around 3.5 million tonnes. According to Indian Institute of Pulses research, Indian population is expected to touch 1.68 billion by 2030 and pulse requirement for the year 2030 is projected 32 million tonnes with required annual growth rate of 4.2 percent. The major pulse producing states in India are M.P. (23%), U.P. (18%), Maharashtra (14%), Rajasthan (9%), and Karnataka (6%) and rest (30%) Pulses are produced in other states of India. The major problem which limits field pea productivity is the crop establishment under rainfed environment. Other factors such as water logging and drought are the major stressors that limit the crop productivity. Use of quality seed alone has been reported to improve productivity in field pea. The most cost-effective method available for better stand establishment is to sow the seed with high germination which shows quick early growth. The major constraints of good establishment are due to low quality seed in addition to lack of soil moisture (Gurumu and Naylor, 1991) [2]. The crop is cultivated for its tender immature pods for use as vegetables and mature dry pods for use as a pulse. They are major source of protein for vegetarian human diet and improve the soil fertility through fixation of atmospheric nitrogen. Grain legume is the cheapest source of protein for both urban and rural population in tropics as well as in temperate region. (Rachie and Roberts, 1974) [18] These conditions result in poor emergence that may subsequently cause sparse plant stands (Saxena *et al.* 1997) [4]. Improving the productivity of field pea under rainfed environment is possible through seed priming treatment. Pre-sowing seed treatment including chemical, polymer coating, botanical and priming treatments plays an important role in improve seed performance. Usually, priming leads to improve plant performance through enhancement in vigour, germination and drought tolerance (Kumar *et al.*, 2015) [7]. The seed priming process involves soaking the seed overnight (for about 8 hrs), surface drying them up to initial seed moisture content (Musa *et al.* 2001) to hasten germination, enhances crop establishment and promotes seedling vigor (Harris *et al.*, 1999) [5]. Seed coating with biological fungicides protects the seed and young seedlings from fungal invasions. The seed treatment with hormones such as gibberellic acid, polyethylene glycol plays an important role in enhancing germination through increased cell division activity. Seed priming with organic substance it is enhancing yield and its important role in sustainable agriculture. To compete with weed species and better seed performance quick and synchronized germination is desirable to set crop successfully. This was achieved by priming, which involves controlled hydration that restricts germination but permit pre germinative physiological and biochemical changes to occur (Bradford *et al.* 1990; Khan, 1992) [1, 6]. Keeping in view the above facts, the present research work was carried out to investigate the effect of different seed priming treatments on the enhancement of seed yield and seed quality attributes in field pea.

2. Materials and Method

The present study, entitled "Effect of Organic and Inorganic Pre-sowing Treatments on Phenotypic Characteristics in Pea (*Pisum sativum* L.)", was undertaken during the Rabi season of 2024-25 at Prof. Rajendra Singh (Rajju Bhaiya) University, Prayagraj, Uttar Pradesh. The experiment was arranged in a Randomized Block Design (RBD) with three replications, employing a plot size of 4m². The experimental material comprised twelve treatments, including organic priming with tulsi (Ocimum sanctum) leaf extract, inorganic priming agents such as gibberellic acid (GA_3), polyethylene glycol (PEG6000), and a fungicide (Carbendazim WP @ 5%), along with an untreated control. These treatments were applied across four pea (*Pisum sativum* L.) varieties—Kali Naina, AP-3, K-6, and Swami Aparna. The field will be organized in 3 replications total 36 plot Each plot will feature three rows, each 2 meters long, with a 10 cm plant-to-plant spacing and row to row 30cm row spacing. The experiment comprised of 12 different pre-sowing seed treatment *viz.*, T_1 (KALI NAINA+ control), T_2 (AP-3+ control), T_3 (K-6 + control), T4 (SWAMI APRNA + control), T_5 (KALI NAINA + Carbendazim WP @5%), T_6 (AP-3+ Carbendazim WP @5%), T_7 (K-6 + Tulsi leaf extract @6%) T8 (SWAMI APRNA + Tulsi leaf extract @6%), T_9 (KALI NAINA + PEG6000 @ 5%), T_{10} (AP-3 + PEG6000 @ 5%), T_{11} (K-6 + GA_3 @ 10 ppm), T_{12} (SWAMI APRNA + GA_3 @ 10 ppm).Observations were recorded from five randomly selected representative plants per plot for eighteen morphological and yield-related traits, namely: plant height at 30, 60, and 90 days after sowing (DAS); number of pods per plant; days to 50% flowering; number of branches per plant; number of seeds per pod; total pods per plant; days to maturity; seed yield per plant (g); 1000-seed weight (g); biological yield (kg); and harvest index (%).The recorded data for each trait were subjected to analysis of variance (ANOVA) in accordance with the experimental design to assess the statistical significance of differences among treatments.

Fig 1: 50% Flowering

Fig 2: Harvesting

3. Result and Discussion

Table 1: Mean performance

Treatment	DAS to 50% Flowering	Plant height 30 DAS	Plant height 60 DAS	Plant height 90 DAS	No. of pod / plant
Kali naina	55.33	44.83	81.30	118.40	15.60
AP-3	39.33	29.07	37.10	39.87	12.90
K-6	34.33	29.87	43.97	47.37	11.90
Swami Aprna	57.67	21.13	48.60	53.30	11.13
Kali Naina + Carbendazim WP @5%	56.33	43.20	85.17	121.47	15.63
AP-3 + Carbendazim WP @5%	37.67	29.47	38.43	48.53	13.60
K-6 +Tulsi Leaf Extract @6%	33.67	28.47	45.37	60.00	12.50
Swami Aprna+ Tulsi Leaf Extract @6%	56.67	20.93	49.27	98.20	13.47
Kali Naina +PEG @5%	56.00	41.33	81.57	114.10	14.70
AP-3 +PEG @5%	36.00	25.07	43.23	52.60	11.43
K-6+GA_3 @10 ppm	32.67	45.00	93.10	73.57	21.17
Swami Aprna +GA_3 @10 ppm	56.33	34.60	58.37	61.93	20.03
Mean	46.00	34.69	58.79	84.29	14.51
SEm (±)	0.97	1.38	1.59	5.02	0.98
CD(5%)	2.02	2.86	3.31	10.42	2.04
CV	2.60	4.87	3.32	7.30	8.32
Max	57.67	45	93.10	121.47	21.17
Min	32.67	20.93	37.1	39.87	11.13

Table 2: Effect of treatments on yield

Treatment	DAS to maturity	No. of seed / pod	Seed yield / plant (g)	Seed yield / plot (kg)	Biological yield (kg)	100 Seed weight (g)	Harvest index (%)
Kali naina	100.67	6.27	29.92	3.23	6.34	31.67	50.95
AP-3	74.33	6.00	24.03	2.46	6.25	25.00	39.30
K-6	76.33	6.27	23.00	2.47	6.12	26.67	40.37
Swami Aprna	93.00	6.20	21.27	2.63	6.39	22.67	41.19
Kali Naina + Carbendazim WP @5%	103.00	6.47	30.20	3.65	6.61	29.67	55.22
AP-3 + Carbendazim WP @5%	73.67	6.50	25.47	3.07	6.53	20.00	47.05
K-6 +Tulsi Leaf Extract	75.00	6.30	24.13	2.77	6.39	26.00	43.30

@6%							
Swami Aprna+ Tulsi Leaf Extract @6%	94.00	6.27	23.43	2.67	5.12	25.33	52.05
Kali Naina +PEG @5%	102.33	6.50	34.10	3.94	6.85	29.33	57.52
AP-3 +PEG @5%	73.67	6.10	22.47	2.67	4.24	26.33	63.03
K-6+GA$_3$ @10 ppm	74.67	6.40	29.20	3.65	7.08	23.00	51.59
Swami Aprna +GA$_3$ @10 ppm	92.67	6.33	24.50	3.47	5.92	24.67	58.63
Mean	86.11	6.30	31.32	3.10	7.32	25.86	73.16
SEm (±)	1.54	0.20	1.23	0.40	1.38	1.04	1.95
CD(5%)	**3.20**	**0.41**	**2.55**	**0.84**	**2.87**	**2.17**	4.05
CV	2.19	3.89	5.80	16.05	4.76	4.96	3.27
Max	103	6.5	33.70	3.94	7.40	31.67	64.52
Min	73.67	6	21.27	2.46	5.11	20	39.77

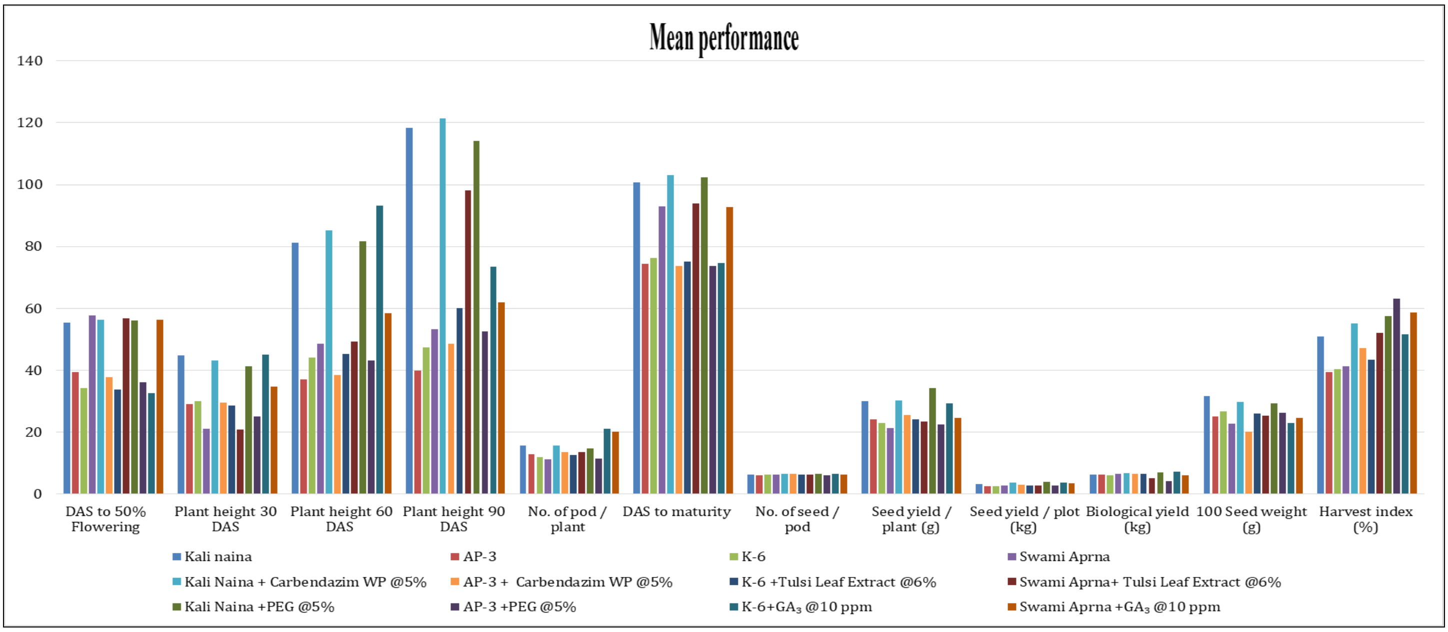

Fig 3: Effect of Different Pre- sowing treatment on all parameters

At 30 days after sowing (DAS), the maximum plant height (45.00 cm) was recorded in K-6 + GA$_3$ 10 ppm (T$_{11}$), whereas the minimum height (21.13 cm) was observed in Swami Aprna (T$_4$). At 60 DAS, the tallest plants (85.17 cm) were produced by Kali Naina + Carbendazim WP 5% (T$_5$), while the shortest (37.10 cm) occurred in AP-3 + control (T$_2$). By 90 DAS, Kali Naina + Carbendazim WP 5% (T$_5$) again attained the greatest stature (121.47 cm), with AP-3 + control (T$_2$) maintaining the lowest height (39.87 cm). Earliness in flowering was achieved by AP-3 + PEG 5% (T$_{10}$), reaching 50% flowering in 70.33 days, whereas delayed flowering was recorded in Swami Aprna + GA$_3$ 10 ppm (T$_{12}$; 95.20 days). The highest number of branches per plant (6.13) was produced by Kali Naina + PEG 5% (T$_9$), while the lowest (2.00) was in Swami Aprna + GA$_3$ 10 ppm T$_{12}$. The maximum seeds per pod (6.50) were recorded in both AP-3 + Carbendazim WP 5% (T$_6$) and Kali Naina + PEG 5% (T$_9$), whereas the minimum (6.00) was in AP-3 + control (T$_2$). Regarding maturity, the earliest crop completion (73.67 days) was noted in T$_6$ and T$_{10}$, while the longest duration to maturity (103.00 days) occurred in (T$_5$). The highest 100-seed weight (31.67 g) was recorded in Kali Naina (T$_1$), followed by by Kali Naina + Carbendazim WP 5% (T$_5$) (29.67 g), whereas the lowest (20.00 g) was in T$_6$. The greatest number of pods per plant (21.17) was obtained in K-6 + GA$_3$ 10 ppm (T$_{11}$), while the fewest (11.13) occurred in (T$_4$). The maximum seed yield per plant (34.10 g) was achieved by T$_9$, whereas the lowest (21.27 g) was in (T$_4$) Similarly, the highest seed yield per plot (3.94 kg) was produced by T$_9$, followed by by Kali Naina + Carbendazim WP 5% (T$_5$) and T$_{11}$ (3.65 kg each), while the minimum (2.46 kg) was recorded in AP-3 + control (T$_2$). The maximum biological yield (7.08 kg) was registered in T$_{11}$, with the lowest (4.24 kg) in AP-3 + PEG 5% T$_{10}$. The highest harvest index (63.03%) was observed in AP-3 + PEG 5% T$_{10}$, followed by Swami Aprna + GA$_3$ 10 ppm (T$_{12}$; 58.63%), whereas the lowest (39.30%) was noted in AP-3 + control (T$_2$). These results are in line with the findings of Singh *et al.* (2018) [9[], Gurmani *et al.* (2022), JAVED *et al.* (2021), Kumar *et al.* (2022), Siddiqui *et al.* (2008), Rathod *et al.* (2015), Saxena *et al.* (1997) and Abenavoli *et al.* (2015) [17, 12, 10, 11, 13, 14, 18].

4. Conclusion

The present study, entitled "Effect of Organic and Inorganic Pre-sowing Treatments on Phenotypic Characteristics in Pea (*Pisum sativum* L.)", was conducted to evaluate the impact of selected pre-sowing interventions on the growth and yield performance of pea. The experimental framework encompassed organic priming with Tulsi (Ocimum sanctum) leaf extract; inorganic treatments involving gibberellic acid (GA$_3$), polyethylene glycol (PEG6000), and a fungicidal application of Carbendazim WP @ 5%; in addition to untreated control plots. These treatments were tested across four pea variety—Kali Naina, AP-3, K-6, and Swami Aparna. The highest performance was recorded in Kali Naina primed with PEG6000 @ 10 ppm, which markedly improved yield-contributing traits. Conversely, variety such as

AP-3 consistently produced lower yields under minimal or no intervention, reflecting limited genetic potential and the detrimental influence of inadequate agronomic management.

5. Acknowledgement
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6. Conflicts of Interest Statement
We have no conflicts of interest to disclose. Authors declare that they have no conflicts of interest. The research was fully done in independently not any financial support involved.
Author contribution Contributed to the conception and design of the analysis paper Contributed to the data collection Data and analysis tools wrote the analysed paper. Also evaluated the paper and then suggested to publish in this journal.

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