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Design, Synthesis And Characterization Of Some Chalcone Pyrazole Analgues And Their Evaluation For Plant Growth Regulators

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Abstract:
Plant growth regulators have become a vital component of the agricultural and horticultural sectors. As a result, there is a high need for innovative and affordable items. However, a lack of innovation has limited the market. Chemical genomics should concentrate on this field in such a scenario. Plant growth regulators (PGRs) are an essential component of the horticultural and agricultural fields. As a result, there is a greater need for innovative and affordable products, yet the market is constrained by inadequate development. As a result, the chemical component has drawn attention on a particular path, namely PGR. Accordingly, a useful synthesis and discussion of some new chalcones and pyrazole pyridines were conducted. For maize and moong seeds, the majority of the synthesized compounds have demonstrated synergistic plant growth activities.
Keywords: *Chalcones, Pyrazole, PGR, Bischalcones, Conventional and Green synthesis.*

INTRODUCTION:

Two prominent families of heterocyclic compounds, chalcones and pyrazoles, have recently attracted considerable attention due to their varied biological activities [1]. Chalcones, distinguished by an α,β-unsaturated carbonyl system, serve as significant biosynthetic intermediates for flavonoids and exhibit diverse pharmacological properties, including antioxidant, antibacterial, anti-inflammatory, and anticancer activities [2, 3]. Pyrazoles, five-membered heterocycles containing two adjacent nitrogen atoms, exhibit considerable biological potential, demonstrating analgesic, antipyretic, antibacterial, and herbicidal activities [4, 5].

The combination of chalcone and pyrazole moieties in a single molecular framework has shown promising synergistic effects, leading to enhanced bioactivity [6]. This structural hybridization is particularly valuable in the design of novel agrochemical agents such as plant growth regulators (PGRs), which are essential in modern agriculture for improving crop yield, stress tolerance, and overall plant development [7, 8].

Plant growth regulators are organic compounds, whether synthetic or natural, that modify physiological processes in plants at minimal concentrations. Auxins, gibberellins, cytokinins, ethylene, and abscisic acid exemplify prevalent groups of plant growth regulators (PGRs). The development of synthetic plant growth regulators with enhanced target specificity, environmental safety, and efficacy is gaining momentum. Chalcone-pyrazole hybrids, with their structural versatility and potential bioactivity, represent an emerging class of candidates for this application [10, 11].

This study used both traditional and green chemical techniques to design and synthesis a number of novel chalcone-pyrazole analogues [12]. The synthesized compounds were characterized using standard spectroscopic techniques, and their potential as plant growth regulators was evaluated through biological assays. The objective is to establish structure-activity relationships (SAR) and assess their viability as eco-friendly agrochemical agents [13-18].

MATERIALAND METHODS:

Chemical, Reagents and Instruments: Melting points in capillaries composed of open glass were documented. The chemical structures of the synthesized substances were confirmed using spectrum analysis. To assess the compound's purity, thin layer chromatography employed pre-coated silica gel aluminum plates utilizing a 7:3 combination of diethyl ether and ethyl acetate. All compounds (4a to f and 5a to f) were produced utilizing the corresponding Succinic/ Glutaric Anhydride derivatives, which comprise ethanol, glacial acetic acid, hydrazine hydrate, commercially available aromatic aldehydes, and neutral Al2O3.

Material used for PGR:

Potassium Oxide, fulvic acid, and humic acid constitute 95% of VIM-95. Whatman Filter Paper No. 1 is classified as Standard Grade 1. Preservatives, stabilizers, aqueous diluents, and associated industrial derivatives: 78% weight/weight BioZYME Crop with Ascophyllum Nodosum Seaweed Standard 2 (22% w/w) comprises extracts of proteins, carbohydrates, inorganic salts, and other naturally occurring nutrients derived from vegetable and animal sources; DMSO constitutes Standard 3.

Evaluation of Plant Growth Regulator Activity:

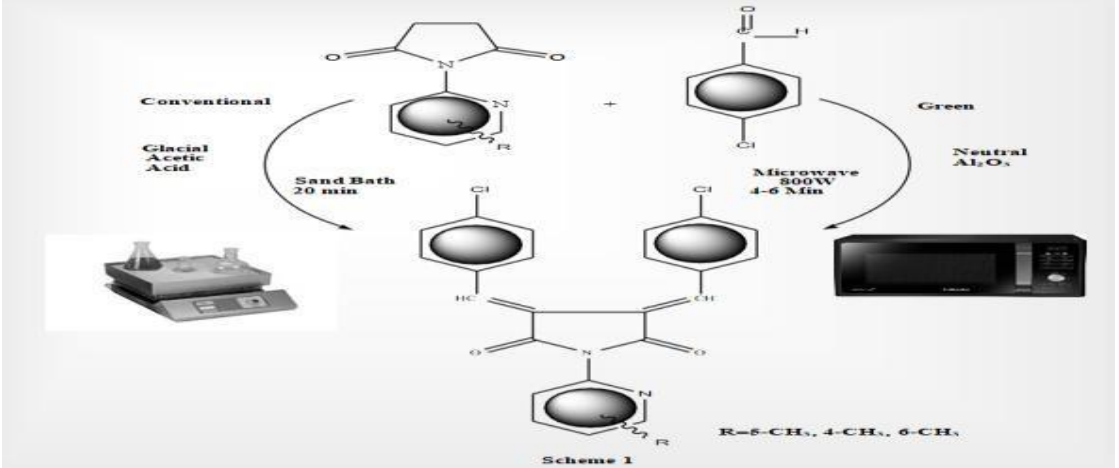
Selected were healthy, equally sized maize and moong seeds. The appropriate tags were utilized to designate the petri dishes. The initial Whatman filter paper was preserved in a Petri dish. Healthy seeds of uniform size (both maize and moong) were sown in Petri plates with Whatman Filter Paper No. 1. The researchers allocated three milliliters of the compound stock solution and Standard Solutions I, II, and III to the Petri dishes. The petri dishes were kept at 30°C in the incubator, with observations conducted every six hours daily. Measurements of the lengths of the roots and shoots were conducted three, six, and nine days later. Nine days later, the weights of the fruit and shoot were compared pre- and post-heating. The roots and shoots were subjected to heating for one hour at 500 degrees Celsius in an oven [19-22].

Conventional Method for Synthesis of bischalcones (4a-f) from N-phenyl Succinimide and N-phenyl Glutaramide dervatives:

15 ml of glacial acetic acid were utilized to combine N-phenyl Succinimide and N-phenyl Glutaramide derivatives and substituted aromatic aldehyde in a beaker. Following 15 minutes of heating in a sand bath, the reaction mixture was permitted to cool overnight. The bis chalcones were isolated as vibrant crystals. The crude product is isolated from ethanol using filtration, drying, and recrystallization, as seen in Schemes 1 and 2 [23, 24].

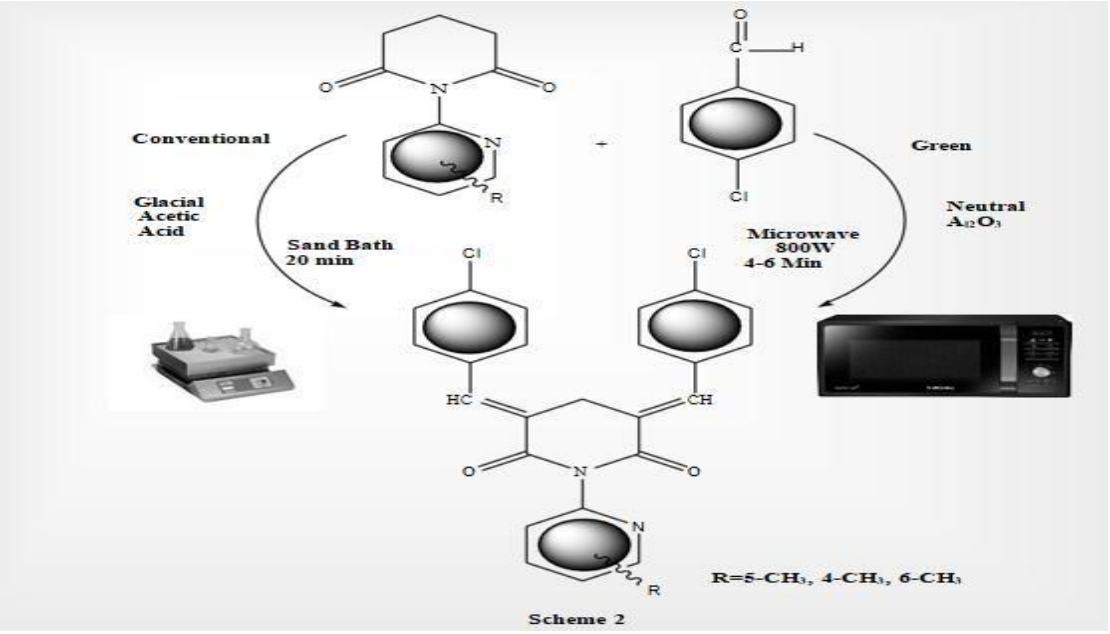
Green Method for Synthesis of bischalcones (4a-f) from N-phenyl Succinimide and N-phenyl Glutaramide dervatives:

A mixture of modified aromatic aldehyde and N-phenyl Succinimide and N-phenyl Glutaramide derivatives was condensed using microwave radiation in 1 gm of neutral Al_2O_3. This mixture is maintained solvent-free in an 800W microwave for four to six minutes. Diagrams 1 and 2 demonstrate the recrystallization of the freshly synthesized compounds from ethanol [25, 26].



Scheme 1

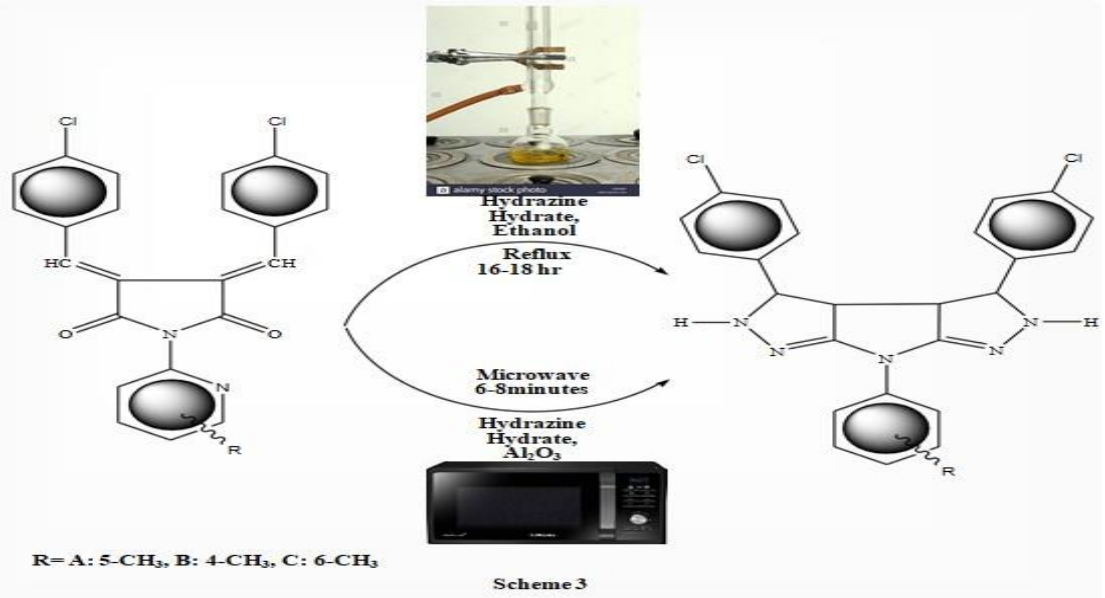
Scheme 1: Preparation of bischalcones (4a-c) from N-phenyl Succinimide by using Conventional and Green Method



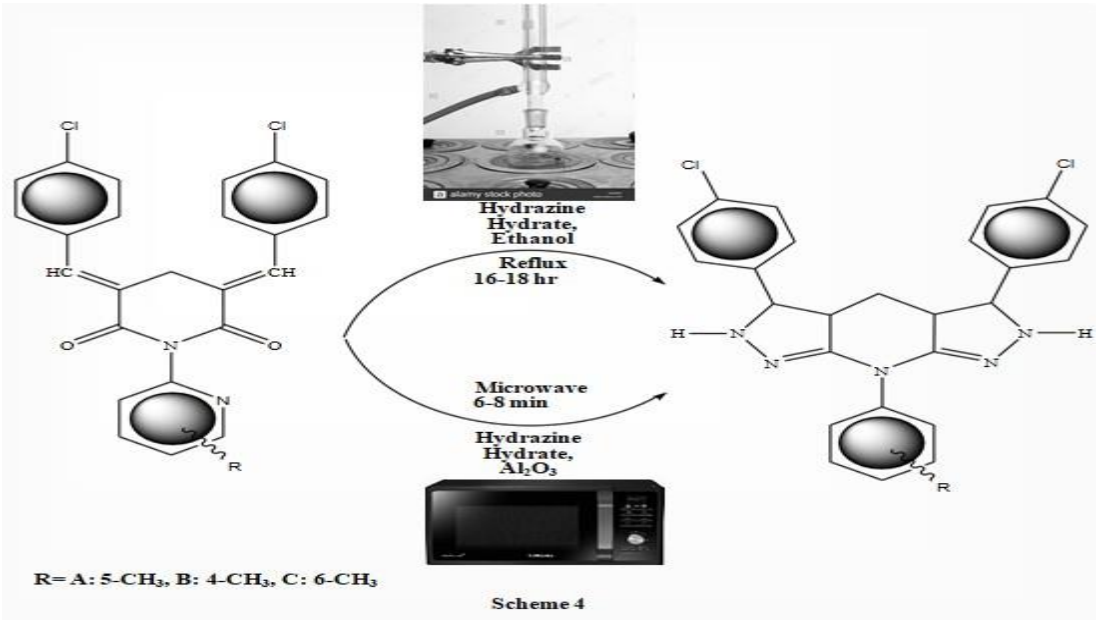
Scheme 2: Preparation of bischalcones (4d to f) from N-phenyl Glutarimide by using Conventional and Green Method

Conventional Method for synthesis of pyrazoles (5a to f) from bischalcones (4a to f):
For 16–18 hours, a solution of hydrazine hydrate and bischalcone 4a–f in 50 milliliters of ethanol was refluxed over a water bath. It was then cooled and exposed to ice water. The final product was filtered, cleaned with water, dried, and recrystallized from ethanol, as shown in Schemes 3 and 4 [27, 28].

Green Method for synthesis of pyrazoles (5a to f) from bischalcones (4a to f):
Microwave irradiation was employed to condense a mixture of bis-chalcone 4a to f and 1 gm hydrazine hydrate of neutral Al_2O_3. This mixture remains solvent-free for 6 to 8 minutes at 800 watts in a microwave. Diagrams 3 and 4 demonstrate the recrystallization of the newly synthesized compounds from ethanol [29, 30-33].



Scheme 3: Preparation of pyrazoles (5a to c) from bischalcones (4a to c) by using Conventional and Green Method



Scheme 4: Preparation of pyrazoles (5d to f) from bischalcones (4d to f) by using Conventional and Green Method

RESULTS AND DISCUSSION:

N-phenyl Succinimide and N-phenyl Glutaramide derivatives, along with substituted aromatic aldehydes, were reacted by both conventional and eco-friendly methods to produce a sequence of bischalcones (4a to f). Eco-friendly technologies have exhibited a notable performance relative to conventional methods. FTIR, 1H NMR, and elemental analysis were utilized to verify the synthesis of bischalcones. The appropriate bis-chalcones and substituted hydrazine hydrate were reacted using both traditional and environmentally friendly methods to synthesize a sequence of pyrazoles (5a to f). Both synthesis approaches yield commendable results. Nonetheless, the more eco-friendly approach yields a somewhat higher output. FTIR, 1H NMR, and elemental analysis were utilized to confirm the pyrazole structures.

Physicochemical chatacterization of Compound 4a to f and 5a to f:

Table 1: Physicochemical characterization of Compound 4a to f and 5a to f:

CID	Nature/ Color	% Yield		MP	MF	MW	Composition
		Conventional	Green				
4a	Traffic Yellow solid	63.37	85.13	258-60 ºC	$C_{24}H_{16}O_2N_2Cl_2$	435.30	C (66.95%) H (3.21%) N (6.99%)
4b	Dahlia Yellow Solid	73.55	86.15	278-80 ºC	$C_{24}H_{16}O_2N_2Cl_2$	435.30	C (66.73%) H (3.03%) N (6.08%)
4c	Broom Yellow Solid	61.64	84.79	290-92 ºC	$C_{24}H_{16}O_2N_2Cl_2$	435.30	C (65.98%) H (3.03%) N (6.08%)
4d	Ivory Solid	64.73	84.74	264-66 ºC	$C_{25}H_{18}O_2N_2Cl_2$	449.32	C (66.57%) H (4.21% N (6.93%)
4e	Olive Brown Solid	70.48	82.59	308-10 ºC	$C_{25}H_{18}O_2N_2Cl_2$	449.32	C (66.17%) H (4.34%) N (6.87%)

4f	Broom Yellow Solid	60.46	82.26	292-94 ºC	$C_{25}H_{18}O_2N_2Cl_2$	449.32	C (66.19%) H (4.39%) N (6.81%)
5a	Traffic Yellow Solid	52.45	81.22	296-98 ºC	$C_{24}H_{20}N_6Cl_2$	463.36	C (63.04%) H (3.97%) N (18.74%)
5b	Melon Yellow Solid	59.74	70.38	208-10 ºC	$C_{24}H_{20}N_6Cl_2$	463.36	C (62.78%) H (4.46%) N (18.82%)
5c	Sulfur Yellow Solid	50.16	83.68	304-06 ºC	$C_{24}H_{20}N_6Cl_2$	463.36	C (62.85%) H (4.68%) N (18.92%)
5d	Cream Solid	57.47	71.59	240-42 ºC	$C_{25}H_{22}N_6Cl_2$	477.38	C (63.01%) H (4.97%) N (17.01%)
5e	Pastel Orange Solid	57.47	71.59	238-40 ºC	$C_{25}H_{22}N_6Cl_2$	477.38	C (62.11%) H (4.07%) N (17.09%)
5f	Zinc Yellow Solid	49.61	72.59	318-20 ºC	$C_{25}H_{22}N_6Cl_2$	477.38	C (62.19%) H (4.08%) N (17.22%)

*CID: Compound ID

Plant Growth Regulator Activities of 4a to f and 5a to f:

The plant growth activity of the freshly synthesized bischalcones, pyrazoles, and standard compounds 1, 2, and 3 was assessed using DMSO solvent on maize and moong seeds. The root weight and shoot length of each compound were measured before and after heating at 500°C. Tables 2 to 6 and Figures 1 to 5 illustrate that certain compounds displayed moderate to substantial activity.

Table 2: Root and Shoot Length in mm after 3 days for 4a to f and 5a to f

ID	**Root Length (mm)**		**Shoot Length (mm)**	
	Maize	**Moong**	**Maize**	**Moong**
4a	08	03	12	09
4b	09	02	10	07
4c	07	03	23	12
4d	08	00	06	02
4e	07	00	16	03
4f	10	02	18	05
5a	03	03	14	08
5b	09	05	13	13
5c	10	00	15	15
5d	08	04	11	08
5e	05	02	17	11
5f	04	02	09	06
Standard 1	10	03	14	11
Standard 2	11	02	15	16
Standard 3	09	04	12	10

*CID: Compound ID

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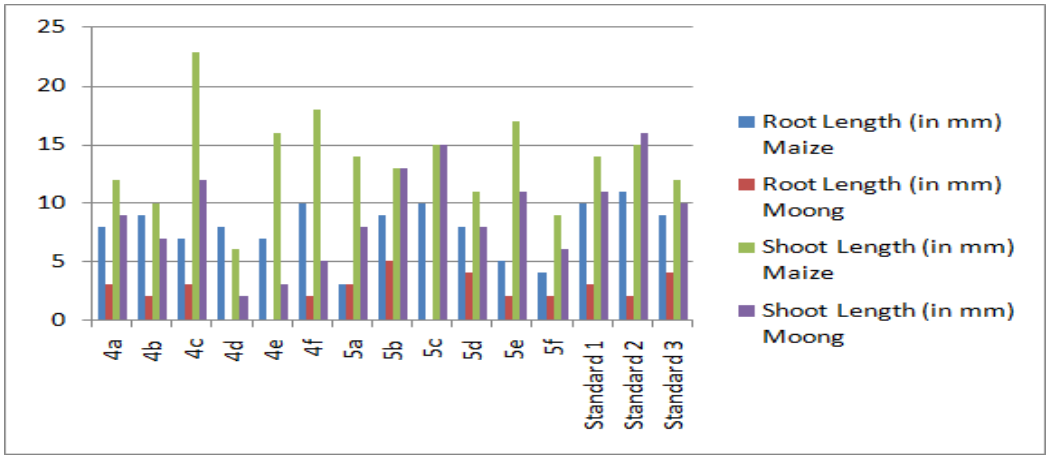

Figure 1: Root and Shoot Length in mm after 3 days for 4a to f and 5a to f

Table 3: Root and Shoot Length in mm after 6 days for 4a to f and 5a to f

Sample	Root Length (mm)		Shoot Length (mm)	
	Maize	Moong	Maize	Moong
4a	16	07	27	19
4b	17	04	28	18
4c	18	07	38	32
4d	14	02	19	06
4e	18	02	31	08
4f	22	05	33	11
5a	08	06	26	22
5b	11	10	29	33
5c	22	03	25	27
5d	15	06	21	15
5e	10	04	30	19
5f	09	03	24	14
Standard 1	12	06	34	20
Standard 2	15	08	39	29
Standard 3	11	12	30	22

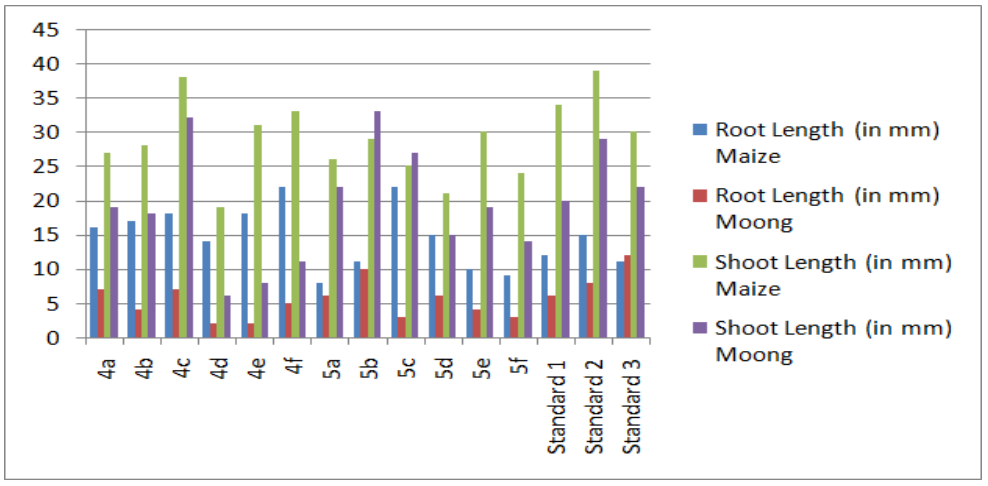

Figure 2: Root and Shoot Length in mm after 6 days for 4a to f and 5a to f

Table 4: Root and Shoot Length in mm after 9 days for 5a to f and 5a-f

Sample	Root Length (mm)		Shoot Length (mm)	
	Maize	Moong	Maize	Moong

4a	25	12	35	27
4b	34	08	36	24
4c	33	11	60	57
4d	22	05	26	10
4e	31	06	48	18
4f	43	08	54	22
5a	16	09	36	34
5b	37	18	41	53
5c	44	07	47	43
5d	32	10	40	27
5e	23	08	58	29
5f	18	07	44	24
Standard 1	34	10	58	31
Standard 2	36	11	57	45
Standard 3	30	19	46	40

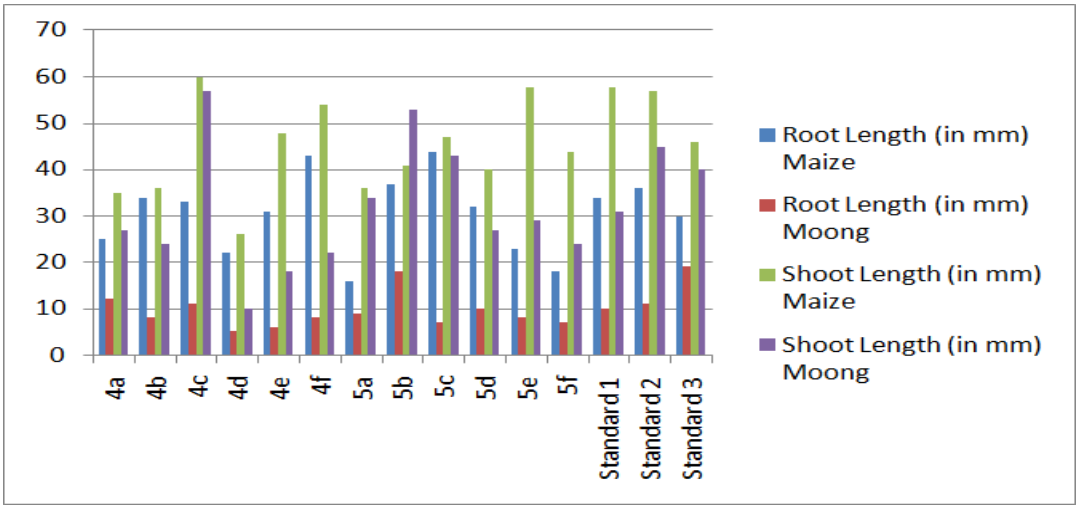

Figure 3: Root and Shoot Length in mm after 9 days for 4a to f and 5a to f

Table 5: Weight of Root in gm before and after heating after 9 days for 4a to f and 5a to f

Sample	**Before Heating**		**After Heating**	
	Maize	**Moong**	**Maize**	**Moong**
4a	0.028	0.079	0.020	0.054
4b	0.031	0.081	0.024	0.052
4c	0.026	0.069	0.020	0.048
4d	0.024	0.037	0.018	0.026
4e	0.025	0.041	0.019	0.028
5f	0.021	0.053	0.016	0.037
5a	0.017	0.081	0.012	0.053
5b	0.025	0.077	0.019	0.052
5c	0.029	0.061	0.022	0.042
5d	0.019	0.091	0.014	0.058
5e	0.059	0.081	0.043	0.053
5f	0.047	0.068	0.036	0.048
Standard 1	0.03	0.089	0.023	0.057
Standard 2	0.028	0.087	0.021	0.056
Standard 3	0.025	0.068	0.019	0.048
#Observations are made after 6hrs during 24hrs for 9 days				

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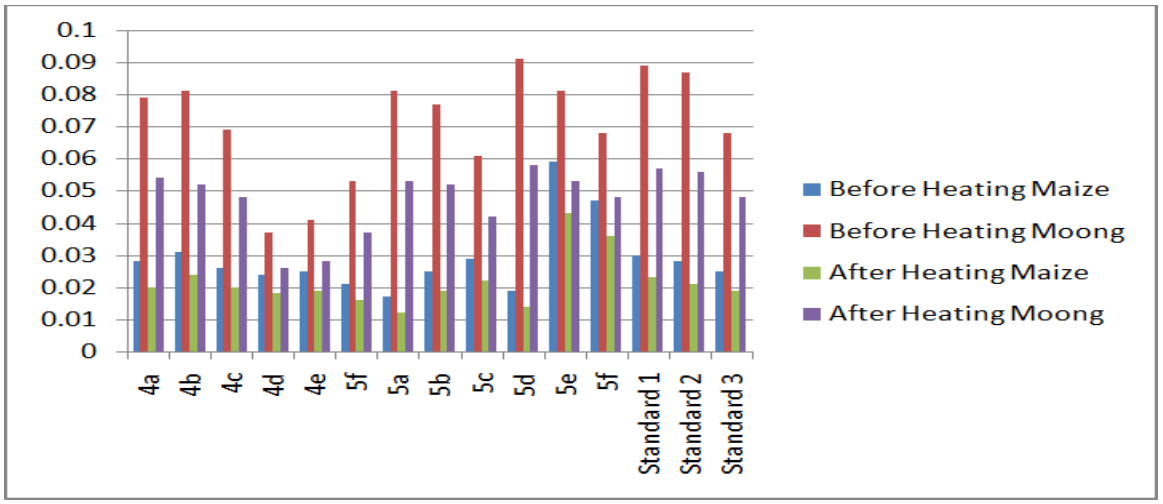

Figure 4: Weight of Root in gm before and after heating after 9 days for 4a to f and 5a to f

Table 6: Weight of Shoot in gm before and after heating after 9 days for 4a to f and 5a to f

Sample	**Before Heating**		**After Heating**	
	Maize	**Moong**	**Maize**	**Moong**
4a	0.324	0.183	0.249	0.074
4b	0.525	0.295	0.368	0.102
4c	0.572	0.257	0.395	0.094
4d	0.453	0.189	0.331	0.077
4e	0.387	0.197	0.298	0.079
4f	0.543	0.231	0.380	0.088
5a	0.357	0.356	0.275	0.108
5b	0.544	0.343	0.381	0.105
5c	0.553	0.28	0.382	0.097
5d	0.374	0.459	0.288	0.11
5e	0.382	0.253	0.294	0.093
5f	0.49	0.32	0.343	0.103
Standard 01	0.49	0.281	0.358	0.097
Standard 02	0.552	0.269	0.381	0.095
Standard 03	0.44	0.215	0.326	0.084
# Observations are made after 6hrs during 24 hrs for 9 days				

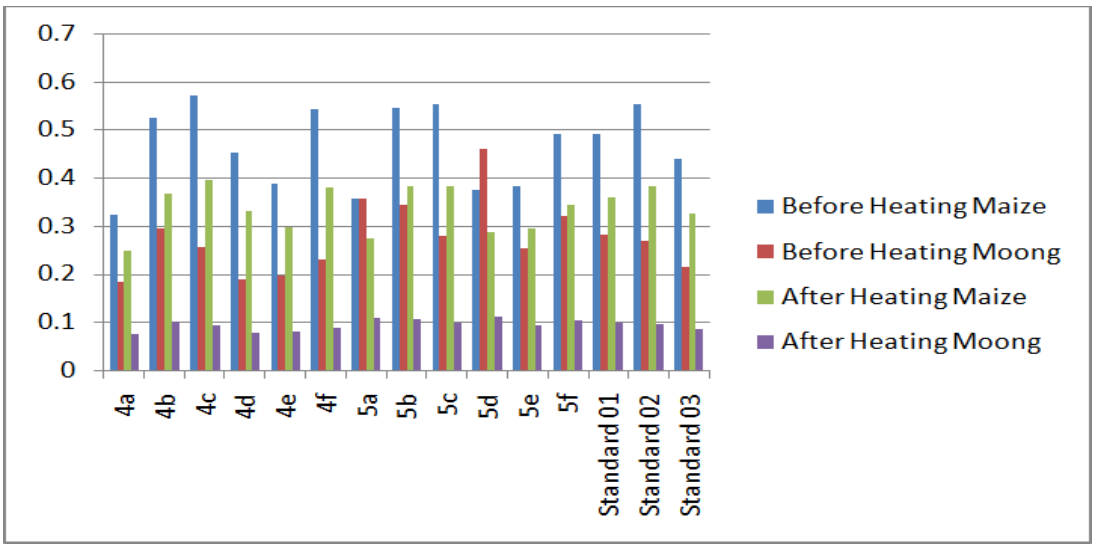

Figure 5: Weight of Shoot in gm before and after heating after 9 days for 4a to f and 5a t of

DISCUSSION:

N-phenyl succinimide and N-phenyl glutaramide derivatives and substituted aromatic aldehydes were reacted by conventional and eco-friendly procedures to synthesize a series of bis-chalcones (4a to f). Eco-friendly technologies have demonstrated a commendable yield in comparison to traditional techniques. Furthermore, the respective bis-chalcones and substituted hydrazine hydrates were reacted in both conventional and environmentally friendly ways to synthesize the series of pyrazoles (5a– f). Both syntheses have shown commendable yields. Nevertheless, the environmentally friendly process produces a slightly higher yield. FTIR, ^{1}H NMR, and elemental analysis were employed to confirm the synthesis of bis-chalcones and pyrazoles. All freshly synthesized bis-chalcones (9a-f), pyrazoles (12a-f), and standard compounds 1, 2, and 3 were evaluated for their efficacy in promoting plant growth in maize and moong seeds using DMSO as the solvent. A segment of the compound demonstrated excellent to moderate efficacy. Plant growth regulators (PGRs) are now an essential element in the agricultural and horticultural industries. Consequently, there exists a significant demand for creative and cost-effective products. Nevertheless, an absence of innovation has constrained the market. Chemical genomics ought to focus on this domain in such a context.

CONCLUSION:

In summary, we have created a new class of chalcones (4a to f) by combining p-chlorobenzaldehyde with N-phenyl succinimides/glutarimides. Additionally, chalcones with hydrazine hydrate were used in both traditional and environmentally friendly methods to understand the unique class of pyrazoles (5a to f). There is a noticeable difference between traditional and greener approach yields. The green method yields the maximum yield for pyrazole (5c) and bis-chalcone (4b). For moong and maize seeds, all of the novel classes of synthesized compounds have demonstrated improved activity as plant growth regulators. Compared to Standards 1, 2, and 3, 5b and 5c are entitled to superior progress regulators for maize roots. Additionally, compound 5b is discovered to be a remarkable agent for moong-related shoot growth.

DECLARATIONS:

Consent for publication: All the authors approved the manuscript for publication.
Competing interests:: All authors declare no competing interests.
Funding:: Not applicable.

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