β-Methyl Crotonitrile in Synthesis of Some New Compounds and Evaluation of Their Herbicidal Efficiency

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Abstract: In an effort to establish new candidates with improved antiherbal activities we report here the synthesis and herbicidal evaluation of various series of β-methyl crotonitrile benzoxazoles, α-(benzoxazole-2-yl)- β-cycloalkylidene crotonitrile (**3**) and 3-(benzoxazole-2-yl)-2-mercapto-4- methyl-6-pyridinethione (**10**) together with the synthesis of some substituted benzoxazolyl anilines(**5,7,9**).The herbicidal evaluation of these compounds was carried out on wheat as pattern for monocotyledonous plants under laboratory conditions. Three plant parameters, seed germination, root and shoot growth of wheat seeds were taken as indicators for the herbicidal efficiency of the newly synthesized compounds. The most active compounds that showed an observable inhibition effect on the process of germination, root and shoot growth or one of them were (**3**),(**5b**),(**5c**),(**9a**) and (**9c**) so that, they were rescreened by a serial of concentrations to stand on the most potent derivative. Their EC_{50} values were calculated and showed that compound (**9a**) was the most potent and greatly inhibited shoot growth (EC_{50}, 1.4mg/ml).
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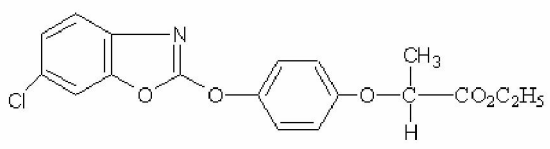
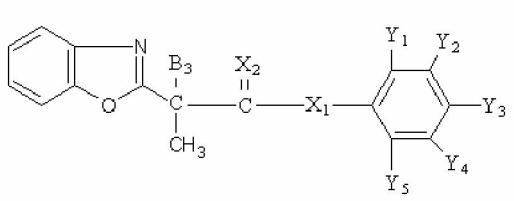
Introduction.

In the last few years various 2-substituted benzoxazole derivatives were studied extensively for their antiviral [1-7], antimicrobial [8-15], antibacterial [16], antifungal [17-26], and antiherbal activity[27-30].In addition to the previously mentioned applications. It was reported that the presence of this heterocycle in any compound supports the ability to expect that the whole compound is biologically active, for example ethyl (R)–2–[4–(6-chloro–2–benzoxazolyl) oxy] phenoxy propanoate, which contain benzoxazole moiety as shown from its structure, is one of the most commonly used selective herbicides (I, fig. 1). Furthermore the cyano function is included in the structure of some pesticides like cymoxanil (II. Fig.1),chlorothalonil(III,fig.1),dichiobenil(IV,fig.1) and bromoxynil(V,fig.1)[31].



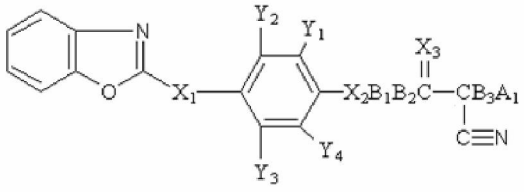
I

Moreover, it was also reported that many benzoxazole derivatives like (VI,VII,fig.2) control wide spectrum of weeds in rice paddies for long time [32] and benzoxazole (VIII,fig.2) that completely controls barnyard grass [33].



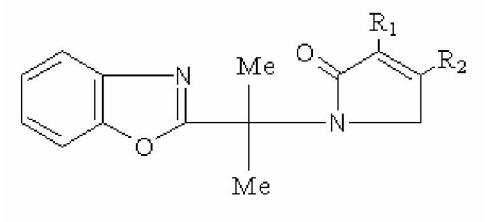
VI

Y1-Y5= H,halo,(un)substituted alkyl,alkoxy,alkylthio,cyano,SH.
X1,X2=O,S
B3= H,Alkyl,CN



VII

Y1-Y4= H,halo, alkyl
X1,X2,X3=O,S
B1,B2,B3=Alkyl,alkenyl,alkynyl.



VIII
R1=Ph.
R2=Me.
Fig.2

In view of the above mentioned findings and as continuation of our effort to identify new candidates, that may be of value in designing new, potent, selective antiherbal agents, we report in the present work the synthesis of some related new 2-substited benzoxazoles that comprise both benzoxazoles and cyano groups in their framework in order to investigate their herbicidal efficiency.

The synthesized compounds include phenyl or substituted phenyl, aniline carbonitrile, aniline carboxylic ester, (thio) amide aniline and pyridinethione groups linked to benzoxazole moiety through one or two atom spacer (compounds 2,3,5,7,9 and 10). These compounds are considered as related structures to the previously reported (I)as they contain the same heterocycle, so it was found that the synthesis and study of the herbicidal activity of some new 2-cyanomethyl benzoxazole derivatives is a subject of great interest hoping that these new compounds could be applied as new herbicidal agents in the field of pest control.

Results and discussion

1-Chemistry part

The target compounds were synthesized as outlined in Schemes 1 and 2. Condensation of crotonitrile (**1**) with aldehydes in alkaline medium afforded an isolable product identified as α-(Benzoxazole-2`-yl)-β-styrenylcrotonitrile (**2a-d**). The products that were found to be directed to the opposite positions (trans) to the benzoxazole ring while, the other expected isomer due to the attack from the cis position to the benzoxazole ring was excluded due to the expected steric factors with the heterocyclic ring system. Both elemental and spectral data of the obtained compounds are consistent with the assigned structure (c.f. Experimental). In analogy α-(Benzoxazole-2`-yl)-β-ycloalkylidene crotonitrile (**3**) was prepared by reacting (**1**) with cyclo hexanone in ethanol and piperidine as a basic catalyst.

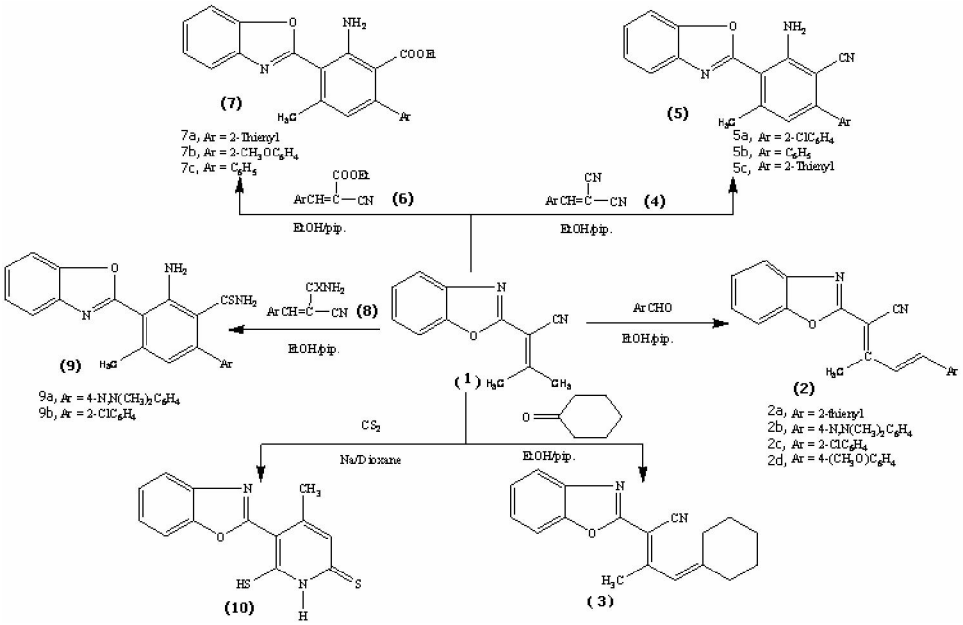
β-Methyl Crotonitrile (**1**) on treatment with α,β-unsaturated nitriles (4)in ethanol and ppiperidine under reflux resulted in the formation of aniline derivatives which were formulated as 5-Aryl-6-cyano-3-methyl-2-(benzoxazole-2`-yl)aniline (**5a-c**).Structural elucidation of derivatives (**5a-d**) was carried out by different ways as elemental analysis, spectroscopic analysis as well as chemical ways. Whereas IR spectra of all obtained compounds revealed a new absorption bands at 3350 and 3217cm^{-1} region due to the formation of NH_2 functional group. Moreover ^{1}H-NMR (DMSO-d6) of compound (**5a**) showed signals at 2.50 (s,3H,CH3), 5.37 (s,2H,NH_2) and 6.90-7.91 (m,9H,Ar-H). Furthermore the structures of anilines (**5a-c**) was confirmed chemically through the reaction of compound (**2d**)with malononitrile in the presence of catalytic amount of piperidine under reflux to afford aniline derivative (**5d**), which was confirmed by m.p, mixed m.p, IR spectra that revealed the new absorption bands at 33730,3437cm^{-1} region due to the formation of NH2 functional group. Moreover, mass spectrum of the compound showed the expected molecular ion peak at m/z=355 with relative abundance of 3.2 corresponding to the correct molecular formula.

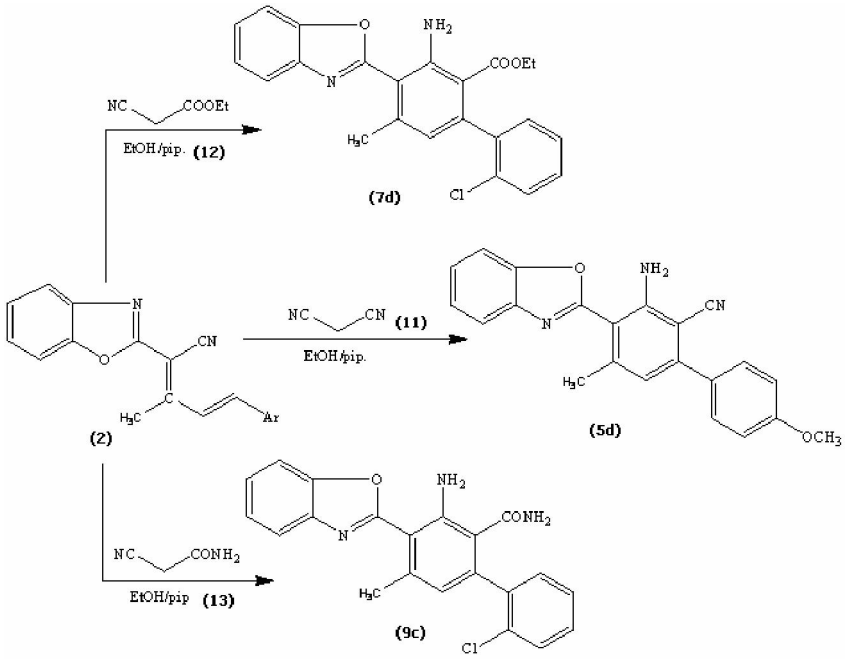
Similarly β-Methyl Crotonitrile (**1**) was reacted with arylidene ethyl α-cyanocinnamate (**6**) in ethanol in the presence of piperidine as a basic catalyst under reflux to afford aniline derivatives (**7a-c**). The structures of compounds (**7a-c**) were confirmed by elemental analysis, spectroscopic analysis as well as chemical ways. Whereas IR spectra of all obtained compounds revealed a new absorption bands at 3425cm^{-1} region due to the formation of NH_2 group and at 1741cm$_{-1}$ due to the presence of C=O group. Also ^{1}H-NMR (DMSO-d6) of derivative (**7a**) showed signals at 1.30(s, 3H,CH_3ester), 3.1(s,3H,CH_3), 4.3(q,2H,CH_2 ester), 7.3 (s,3H,thiophene-H), 8.04-8.19 (m,5H,Ar-H) and 8.57(s,2H,NH_2) In addition to that , the structure of anilines (**7a-c**) was confirmed chemically by reacting crotonitrile derivative (**2c**) with ethyl cyano acetate in ethanol and piperidine to afford aniline derivative (7d). The structure of compound (**7d**) was confirmed upon the compatible elemental analyses and spectral data (c.f. Experimental).

In analogy β-Methyl Crotonitrile (**1**) on treatment with α,β-unsaturated nitriles (**8**) in ethanol in the presence of piperidine as a basic catalyst afforded aniline derivatives (**9a,b**) Structural elucidation of derivatives (**9a,b**) was carried out by different ways as elemental analysis, spectroscopic data as well chemical ways. Whereas, IR spectra of all obtained compounds revealed a new absorption band at 3186cm^{-1} region due to the formation of NH_2 functional group. Also structure (**9**) was confirmed by the presence characteristic signal at 6.1-6.7(br.s, 4H, 2NH_2) due to the presence of two NH_2 groups, mass spectrum of compound (**9a**) showed the expected molecular ion peak at m/z=402 with relative abundance 33.0

corresponding to the correct molecular formula. Refluxing crotonitrile derivative (**2c**) with cyano thio acetamide in ethanol and piperidine gave aniline derivative (**9c**) which was confirmed by elemental analysis and spectroscopic data (c.f. Experimental).

In addition, β-Methyl Crotonitrile (**1**) was reacted with carbon disulfide in alkaline medium to yield 3-(Benzoxazole-2`-yl)-2-mercapto-4-methyl-6-pyridinethione (**10**), the product that was obtained by addition of the active methylene of crotonitrile (**1**) to C=S to form a non isolable acyclic intermediate which, in turn, undergoes cyclization to form pyridinethione (**10**). Both elemental and spectral data of compound (**10**) provided satisfying evidences for the proposed structure.





EXPERMENTAL

All melting points are uncorrected and were determined on an electric melting point (Gallenkamp) 9200 A apparatus. IR spectra were recorded (KBr) on pye Unicam SP-1000 Spectrophotometer. 1H–NMR spectra were obtained from Varian Gemini 200 MHz spectrometer and chemical shifts are expressed in δ (ppm) using TMS as internal reference. Mass spectra were recorded on a GCMS–QP 1000 mass spectrometer opening at 70 eV. Microanalytical data were obtained from the micro analytical data center at Cairo University.

α-(Benzoxazole-2`-yl)-β-styrenylcrotonitrile (2a-d).

To a solution of compound (**1a**) (1.98 g, 0.01 mole), in ethanol (40 ml) containing catalytic amount of piperidine (0.5 ml, 0.02 mole), aromatic or heterocyclic aldhyde (0.01 mole) was added. The reaction mixture was heated under reflux for 5 hrs. The solid product precipitated was collected by filtration, washed with ethanol, dried and crystallized from a suitable solvent to give styrenyl crotonitrile derivatives (**2a-d**).

(**2a**) yield (2.63 g, 85%); (DMF); mp 172-74ºC. IR (cm^{-1}): 3098 (CH-arom.), 2924 (CH-aliph.), 2195 (CN), 1650, 1606 (C=C), 1531 (C=N), 1115 (C-O-C); 1H-NMR (DMSO–d6): 2.50 (s, 2H, CH3), 6.09-7.02 (m, 3H, thiophene -H), 7.02-7.96 (m, 6H, Ar-H). MS m/z (%): 294 (M+ + 2, 20.0), 292 (M+ , not detected), 251 (28.0), 91 (32), 65 (100). Ana. Calcd. for C17H12N2OS (292.35): C 69.84, H 4.14, N 9.58, S 10.97. Found: C 69.62, H 4.08, N 9.44, S 10.63%.

(**2b**) yield (3.12 g, 90%); (EtOH/H2O); mp 178-80ºC. IR (cm^{-1}): 3060 (CH-arom), 2931 (CH-aliph..), 2203 (CN), 1590 (C=C), 1517 (C=N), 1037 (C-O-C). Ana. Calcd. for C21H19N3O (329.4): C 76.57, H 5.81, N 12.76. Found: C 76.34, H 5.59, N 12.63%.

(**17c**) yield (3.19 g, 94%); (EtOH/H2O); mp 155-57ºC. IR (cm^{-1}): 3061 (CH-arom), 2968 (CH-aliph.), 2201 (CN), 1519 (C=N), 1590 (C=C), 1040 (C-O-C). Ana. Calcd. for C19H13ClN2O (320.77): C 71.14, H 4.08, Cl 11.05, N 8.73. Found: C 71.06, H 3.99, Cl 10.97, N 8.65%.

(**2d**) yield (2.73 g, 82%); (EtOH/ H2O); mp 192-94C. IR (cm^{-1}): 3065 (CH-arom), 2930 (CH–aliph.), 2198 (CN), 1600 (C=C), 1510 (C=N), 1029 (C-O-C). Ana. Calcd. for C20H16N2O2 (316.35): C 75.93, H 5.10, N 8.86. Found: C 75.65, H 5.12, N 8.64%.

α-(Benzoxazole-2`-yl)-β-ycloalkylidene crotonitrile (3).

To a solution of compound (**1a**) (1.98 g, 0.01 mole), in ethanol (40 ml) catalytic amount of piperidine (0.5 ml, 0.02 mole), cyclohexanone (1.96 g, 0.01 mole) was added. The reaction mixture was refluxed for 5 hrs, cooled, poured into ice/ cold water mixture and neutralized with dilute HCl. The solid product which precipitate was collected by filtration, washed was water, dried and crystallized from acetonitrile to afford alkylidene derivative (**3**).

(**3**) yield (2.75 g, 93%); (Acetonitrile); mp 168-70ºC. IR (cm^{-1}): 2934 (CH-aliph.), 2200 (CN), 1617 (C=C), 1590 (C=N), 1034 (C-O-C). MS m/z (%): 281 (M+ + 3, 0.1), 280 (M+ + 2, 3.0), 279 (M+ + 1, 10.0), 278 (M+, not detected), 250 (2.0), 167 (28.5), 149 (100.0), 132 (7.0), 104 (11.0), 57 (28.5). Ana. Calcd. for C18H18N2O (278.35): C 77.67, H 6.52, N 10.06. Found: C 77.52, H 6.43, N 9.79%.

5-Aryl-6-cyano-3-methyl-2-(benzoxazole-2`-yl)aniline (5a-d).

Method A

To a solution of compound (1a) (1.98 g, 0.01 mole), in ethanol (40 ml) containing catalytic amount of piperidine (0.5 ml, 0.02 mole), arylidene malononitrile (**4)** (0.01 mole) was added. The reaction mixture was heated under reflux for 10 hrs, cooled, then the solid product precipitated was collected by filtration, washed by ethanol, dried and crystallized from proper solvent to give aniline derivatives (**5a-c**).

Method B

β-Stytenyl crotonitrile (**2d)** (3.16 g, 0.01 mole), malono-nitrile (**11**) (0.66 g, 0.01 mole) and catalytic amount of piperidine (0.5 ml, 0.02 mole) was heated under reflux for 10 hrs. The reaction mixture was left to cool at room temperature, poured into an acidified crushed ice, filtered off and the finally obtained solid product was crystallized from ethanol to afford aniline derivative (**5d**).

(**5a**) yield (3.47 g, 90%); (EtOH/H2O); mp 163-65ºC. IR (cm^{-1}): 3350, 3217 (NH2), 2937 (CH–aliph.), 2206 (CN), 1617 (C=C), 1517 (C=N), 1042 (C-O-C). 1H-NMR (DMSO–d6): 2.50 (s, 3H, CH3), 5.37 (s, 2H, NH2), 6.90–7.91 (m, 9H, Ar-H). MS m/z (%): 359 (M+, not detected), 356 (M+ -3, 39.1), 315 (43.5), 199 (56.5), 129 (13.5), 121 (34.8), 95 (60.9), 53 (100). Ana. Calcd. for C21H14ClN3O (359.81): C 70.10, H 3.92, Cl 9.85, N 11.68. Found: C 69.87, H 3.84, Cl 9.77, N 11.62%.

(**5b**) yield (3.02 g, 86%); (EtOH/H2O); mp 192-94ºC. IR (cm^{-1}): 3435, 3335 (NH2), 2208 (CN), 1618 (C=C), 1030 (C-O-C). Ana. Calcd. for C21H15N3O (325.36):

C 77.52, H 4.56, N 12.91. Found: C 77.47, H 4.53, N 12.84%.

(**5c**) yield (2.79 g, 78%); (DMF); mp 144-46ºC. IR (cm^{-1}): 3420, 3328 (NH2), 3094 (CH-arom.), 2932 (CH-aliph.), 2207 (CN), 1585 (C=C), 1038 (C-O-C). Ana. Calcd. for C19H13N3OS (331.39): C 68.86, H 3.95, N 12.68, S 9.68. Found: C 68.53, H 3.84, N 12.72, S 9.75%.

(**5d**) yield (2.67 g, 70%); (EtOH/H2O); mp 152-54ºC. IR (cm^{-1}): 3730, 3437 (NH2), 2932 (CH-aliph.), 2208 (CN), 1609 (C=C), 1029 (C-O-C). 1H-NMR (DMSO-d6): 2.50 (s, 3H, CH3), 3.46 (s, 3H, OCH3), 5.36 (s, 2H, NH2), 6.81-6.91 (m, 9H, Ar-H). MS m/z (%): 355 (M+, 3.2), 354 (M+ -1, 32.3), 317 (19.4), 245 (35.5), 183 (40.3), 158 (24.2), 123 (59.7), 91 (85.5). Ana. Calcd. for C22H17N3O2 (355.39): C 74.35, H 4.82, N 11.82. Found: C 74.21, H 4.68, N 11.72%.

5-Aryl-6-ethoxycarbonyl-3-methyl-2-(benzoxazole-2`-yl) aniline (7a-d).

Method A

A mixture of β-methyl crotonitrile (**1a**) (1.98 g, 0.01 mole), arylidene ethyl α-cyanocinnamate (**6**) (0.01 mole), catalytic amount of piperidine (0.5 ml, 0.02 mole), in ethanol (40 ml) was heated under reflux for 10 hrs. The reaction mixture was left a side at room temperature to cool, poured into an acidified crushed ice and filtered off. The obtained solid product was crystallized from suitable solvent to afford aniline derivatives (**7a-c**).

Method B

To a solution of β–styrenyl crotonitrile (**2c**) (3.2 g, 0.01 mole), in ethanol (40 ml) containing catalytic amount of piperidine (0.5 ml, 0.02 mole), ethyl cyanoacetate (**12**) (1.13 g, 0.01 mole) was added. The reaction mixture was heated under reflux for 10 hrs, left to cool at room temperature, poured into an acidified crushed ice. The solid formed product was filtered off and crystallized from a proper solvent to afford the corresponding aniline derivative (**7d**).

(**7a**) yield (3.24 g, 80%); (EtOH/H2O); mp 125 -27ºC. IR (cm^{-1}): 3425 (NH_2), 2928 (CH-aliph.), 1741 (C=O), 1514 (C=N), 1095 (C-O-C). ^{1}H-NMR (DMSO-d_6): 1.30 (s, 3H, CH_3 ester), 3.1 (s, 3H, CH_3), 4.3 (q, 2H, CH_2 ester), 7.3 (s, 3H, thiophene-H), 8.04 (m, 5H, Ar-H) and 8.57 (s, 2H, NH_2). MS m/z (%): 381 (M^+ + 3, 13.3), 380 (M^+ + 2, 16.7), 379 (M^+ + 1, 18.3), 378 (M^+, not detected), 343 (10.0), 294 (18.3), 241 (81.7), 176 (43.3), 135 (100.0), and 114 (11.7). Ana. Calcd. for $C_{21}H_{18}N_2O_3S$ (378.44): C 66.65, H 4.79, N 7.40, S 8.47. Found: C 66.51, H 4.68, N 7.21, S 8.32%.

(**7b**) yield (3.5 g, 82%); (EtOH/H2O); mp 121-23ºC. IR (cm^{-1}): 3425 (NH_2), 2933 (CH-aliph.), 1740 (C=O), 1069 (C=C), 1513 (C=N), 1030 (C-O-C). Ana. Calcd. for C24H22N2O4 (402.44): C 71.63, H 5.51, N 6.96. Found: C 71.49, H 5.32, N 6.78%.

(**7c**) yield (3.7 g, 94%); (EtOH/H2O); mp 147-49ºC. IR (cm^{-1}): 3364 (NH2), 3063(CH-arom.), 2933 (CH-aliph.), 1740 (C=O), 1616 (C=C), 1517 (C=N), 1026 (C-O-C). Ana. Calcd. for C23H20N2O3 (372.42): C 74.18, H 5.41, N 7.52. Found: C 74.04, H 5.32, N 7.41%.

(**7d**) yield (3.4 g, 80%); (EtOH/H2O); mp 123-25ºC. IR (cm^{-1}): 3392 (NH2), 2934 (CH-aliph.), 1742 (C=O), 1611 (C=C), 1514 (C=N), 1035 (C-O-C). MS m/z (%): 407 (M+, 4.9), 325 (20.6), 280 (14.7), 245 (43.1), 209 (33.3), 172 (73.5), 127 (48.0), 63 (100). Ana. Calcd. for C23H19ClN2O3 (406.86): C 67.90, H 4.71, Cl 8.71, N 6.89. Found: C 67.58, H 4.62, Cl 8.63, N 6.73%.

5-Aryl-3-methyl-6-(thio)amide-2-(benzoxazole-2`-yl)aniline (9a-c).

Method A

To a solution of β-methyl crotonitrile (**1a**) (1.98g, 0.01 mole), in ethanol (40 ml) containing catalytic amount of piperidine (0.5 ml, 0.02 mole), α,β-unsaturated nitrile (**8**) (0.01 mole) was added and the reaction was heated under reflux for 10 hrs. The reaction mixture was left a side at room temperature to cool, poured into an acidified crushed ice and the precipitated solid product was filtered off and crystallized from a suitable solvent to afford aniline derivatives (**9a,b**).

Method B

B-Styrenyl crotonitrile (**1c**) (3.2 g, 0.01 mole), cyano actamide (**13**) (1.0g, 0.01 mole) , catalytic amount of piperidine (0.5 ml, 0.02 mole) was heated under reflux for 10 hrs. The reaction mixture was left to cool at room temperature, poured into an acidified crushed ice and the formed solid product was filtered off and crystallized from isopropyl alcohol to give aniline derivative (**9c**).

(**9a**) yield (3.4 g, 80%); (EtOH); mp 197-99ºC. IR (cm^{-1}): 3186 (NH_2), 2965 (CH-aliph.), 1617 (C=C), 1514 (C=N), 1241 (C=S), 1037 (C-O-C). 1H-NMR (DMSO-d6): 2.39, 2.50 (2s, 2CH3, N (CH3)2), 3.2 (s, 3H, CH3), 6.1-6.7 (br.s, 4H, 2NH2), and 7.4-7.8 (m, 9H, Ar-H). MS m/z (%): 404 (M+ + 2, 2.0), 403 (M+ + 1, 8.0), 402 (M+, 33.0), 387 (6.0), 373 (100.0), 356 (80.0), 345 (20.0), 318 (18.0), 283 (22.0), 254 (75.0),

226 (50.0). Ana. Calcd. for C23H22N4OS (402.51): C 68.63, H 5.51, N 13.92, S 7.96. Found: C 68.42, H 5.31, N 13.83, S 7.78%.

(**9b**) yield (3.6 g, 88%); (EtOH); mp 210-12ºC. IR (cm^{-1}): 3328, 3198 (NH2), 3063 (CH-arom.), 2935 (CH-aliph.), 1614 (C=C), 1520 (C=N), 1241 (C=S), 1039 (C-O-C). Ana. Calcd. for C21H16ClN3OS (393.89): C 64.03, H 4.09, Cl 9.00, N 10.67, S 8.14. Found: C 63.95, H 3.92, Cl 8.92, N 10.52, S 8.04%.

(**9c**) yield (3.4 g 90%); (isopropyl alcohol); mp 188-90ºC. IR (cm^{-1}): 3401 (NH2), 3022 (CH-arom.), 2916 (CH-aliph.), 1666 (C=O), 1606 (C=C), 1569 (C=N), 1035 (C-O-C). MS m/z (%): 380 (M+ + 1, 0.3), 379 (M+, 0.4), 367 (2.0), 352 (5.0), 279 (10.0), 245 (100), 216 (9.0), 190 (7.0), 158 (6.0), 78 (10.0), 63 (20.0). Ana. Calcd. for C21H16ClN3O2 (377.82): C 66.76, H 4.27, Cl 9.37, N 11.12. Found: C 66.62, H4.11, C l9.12, N 11.06%.

3-(Benzoxazole-2`-yl)-2-mercapto-4-methyl-6-pyridinethione (10)

To a mixture of compound (**1a**) (1.98 g, 0.01 mole) in sodium/dioxane [prepared from sodium metal (0.23 g, 0.01 mole) dissolved in day dioxane], carbon disulfide (1.5 ml, 0.01 mole) was added gradually. The reaction mixture was heated under reflux for 8 hrs and cooled. The reaction mixture was evaporated under reduced pressure and the residue was triturated with crushed ice and neutralized with dilute HCl. The separated solid products were filtered off and crystallized from dioxane to afford pyridine thione (**10**).

(**10**) yield (3.2 g, 92%); mp 137-39ºC. IR (cm^{-1}): 3416 (NH), 3056 (CH-arom.), 2915 (CH-aliph.), 1601 (C=C), 1548 (C=N), 1242 (C=S), 1038 (C-O-C). 1H-NMR (DMSO-d6); 3.3, (s, 3H, CH3), 6.85 (s, 1H, 5H), 7.8-8.06 (m, 5H, Ar-H) and 9.95 (s, 1H, pyridine-NH). MS m/z (%): 277 (M+ + 3, 0.2), 276 (M+ + 2, 0.4), 275 (M+ + 1, 7.5), 274 (M+, 0.2), 260 (9.0), 223 (40.0), 198 (60.0), 158 (80.0), 133 (100.0), 78 (30.0), 63 (96.0). Ana. Calcd for. $C_{13}H_{10}N_2OS_2$ (274.36): C 65.91, H 3.67, N 10.21, S 23.37. Found: C 65.78, H 3.54, N 10.11, S 23.26%.

2- Biological study

The herbicidal evaluation of the newly synthesized compounds on wheat as pattern for monocotyledonous plants.

Preliminary test :-

The preliminary study of the herbicidal efficiency of the newly synthesized compounds was carried out on wheat as pattern for monocotyledonous plants with concentration of 2000 ppm for each compound under laboratory conditions (table 1). Three plant parameters, seed germination, root and shoot growth were taken as indicators for the herbicidal efficiency of the tested compounds. According to the obtained data all tested compounds caused changes to growth parameters of wheat. These changes were as activation or inhibition of growth parameters. Activation was recorded in compounds (**2a**), (**2d**), (**5a**) and (**10**). These compounds activated all or some growth parameters of wheat. On contrast the other tested compounds inhibited all growth parameters of wheat. So the later compounds were considered as effective compounds On the other hand most of these compounds recorded high inhibition effect on shoot growth followed by root then germination.

From another point of view compounds that recorded inhibition percentages greater than 22, 39, and 41 on germination, root and shoot growth respectively were considered as candidate compounds. The descending order of the promising compounds on germination was (9a), (**3**), (**5b**) and (**9c**), while it was (**9a**), (**9c**), (**7d**), (**3**) and (**7c**) in case of root growth. On the other hand compound (**9a**) showed the highest inhibition effect on shoot growth followed by (**9c**), (**5c**), (**7d**) and (**3**) respectively.

The variation in effect between the different derivatives of the same compound could be attributed to substitution in each case, for example compounds (**2a**), (**2c**) and (**2d**) inhibited germination as a result to the presence of thienyl, chloro phenyl and methoxy groups but this effect was changed to activation in compound (**2b**) due to the presence of amino phenyl group.

Preliminary evaluation of synthesized compounds on wheat as pattern for monocotyledonous plants with concentration of 2000 ppm.

Compound	germination	root growth	Shoot growth
2a	15.2	18.7	24.5
2b	12.3	-29.0	26.7
2c	2.6	8.7	32.1
2d	0	-2.5	-.97
3	30.3	41.9	42.9
5a	-4.88	-21.7	-13.2
5b	0	27	28
5c	26.7	33.8	47.3
5d	15.2	24.3	21.5
7a	15.8	15.5	31.9
7b	15.2	9.3	0
7c	18.6	40.96	36.7
7d	18.6	49.4	44.97
9a	34.8	51.0	59.9
9b	15.2	8.3	14.7
9c	23.3	50.4	53.3
10	-0.69	-37.9	5.99

Compounds (**3**), (**5b**), (**9a**) and (**9c**) that were considered as herbicidal active ingredients were re-evaluated with a serial of concentrations to determine their EC50 values (table 2). Generally all tested compounds showed a regration relation between the tested concentration and shoot growth, in contrast the above result was not observed with germination and root growth except compound (3) that showed an inhibition for root growth.

Table (2): Effect of candidate compounds (5b, 9a, 9c, 3) on shoot growth of wheat.

Concentration (ppm)	**% of Inhibition of shoot growth of compounds**			
	5b	**9a**	**9c**	**3**
250	5.7	-	-	-
500	10.6	-	-	-
1000	18.5	10.6	14.7	-
1250	20.9	-	-	-
1500	24.3	15.2	17.2	30.4
2000	-	-	-	-
2500	31.6	-	-	-
4000	-	28.8	22.7	-
5000	44.1	-	-	-
8000	-	39.8	27.5	52.8
10000	57.2	-	-	-
16000	-	52.7	32.7	56.4
2000	-	-	-	57.4
32000	-	65.7	38.3	59.9
64000	-	-	44.1	-
128000	-	-	54.0	-
EC50	6.2mg/ml	1.4mg/ml	125mg/ml	5.01mg/ml
Slope	1.1	1.1	.5	.3
Toxicity index	22.5	100	1.1	27

* EC_{50} is the effective concentration that inhibits 50% of the sample under study.

Data in table **(2)** showed that there is a positive relation ship between the tested concentration and their percentage of inhibition, depending on EC_{50} values, compound **(9a)** was found to be the most effective against the shoot growth of wheat followed by **(3), (5b)** and **(9c)** by EC_{50} values 1.4, 5.01, 6.2 and 125 mg/ml, respectively, according to slope values, compounds **(5b)** and **(9a)** possess the same slope value 1.1, this result may be due to the ability of both compounds to act with the same mode of action. Also the slope of both compounds was sharper than compounds **(9c)** and **(3)** that recorded a flattest slope with small values 0.5 and 0.3.

Depending on toxicity index compound **(9a)** was found to be the most effective followed by **(3)**, **(5b)** and **(9c)** with toxicity index values 100, 27, 22.5 and 1.1, respectively.

Conclusion

1- All tested compounds showed change in growth of wheat (germination, root and shoot growth).
2- These changes were activation effect in compounds (**2a**), (**2d**), (**5a**) and (**10**) or inhibition effect in the other compounds.
3- The highest inhibition effect was recorded against shoot followed by root growth then germination.
4- The variation in effect between the different derivatives of the same compound could be attributed to substitution in each case.
5- Depending on the percentages of inhibition compounds (**3**), (**5b**), (**5c**) and (**9a**) were considered as promising compounds and were re-evaluated with a serial of concentrations to determine their EC_{50} values.
6- Rgration relation was recorded with all promising compounds against shoot growth, whereas this relation was not found with other growth parameters except compound (**3**) with root growth.
7- The descending order of inhibition of the promising compounds depending on their EC50 values were (**9a**), (**3**), (**5b**) and (**9c**).

Experimental

Evaluation of Herbicidal Efficiency of the newly synthesized compounds.

Under laboratory conditions.

- Seed germination, root and shoot growth inhibition were carried out according to the procedure described by Powel and Spencer [34], some modifications were made for this work as described below.
- Serial concentrations from each compound were prepared by dissolving it in dimethyl sulfoxide and dilution with water. The calculated amount from each concentration was pipetted on thirty seeds of wheat or cucumber as a test plant and agitated to coat the seed surface. Each ten seeds were transferred to Petri dish (90 mm diameter), lined with a dry filter paper and left at 25°C without led to grant solvent evaporation. After that, 6 ml distilled water was pipetted on the filter paper, Petri dish was sealed with (PVC) electrical insulting tape. After complete germination of control (Petri dishes containing untreated seeds), the number of germinated and non germinated seeds and radical length were recorded. Three replicates were done for each treatment [35,36].

Under green house conditions:

Compounds that showed an observable inhibition effect on germination, root and shoot growth were considered as candidate compounds and tested under green house conditions to ensure the obtained results from treating seeds in Petri dishes under laboratory conditions. Three plastic pots for each compound were filled till their lower surface by sand, teen wheat seeds were planted in each pot and filled with water, left untill wheat seeds grown up then the three pots were spayed by the calculated concentration for each compound, left for about ten days, irrigated with water daily according to need, then compared with untreated pots [37].

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