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Effect of Gyttja and Nitrogen Applications on Growth and Flowering of Snapdragons (*Antirrhinum majus* L.) Plant in the Two Soils Depth

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Abstract: ***Plant morphological attribute has been reported to be increased through the application of organic material (Gyttja) to the soil. Snapdragons (Antirrhinum majus L.) was studied under plastic house conditions to determine the effect of two different soil depth-SH (0-20 cm and 20- 40 cm), four different gyttja doses-GD (0, 1, 2, and 3%), and three different nitrogen doses-ND (0, 140, and 280 mg kg^{-1}) on some of the plant's morphological characters; Plant Height (PH), Fresh Weight Per Plant (FWP), Number of Leaves Per Plant(NLP), Stem Diameter(SD), Number of Branches Per Plant (NBP), Number of Flower Per Spikes (NFPS) and Flower Spike Length (FSL). The results showed that gyttja application at doses of 3%, significantly increased PH, SD, NBP, NFPS, and FSL, while FWP increased only at 2% gyttja application dose and decreased at the 3% dose. The application of 280 mg kg^{-1} of nitrogen significantly increased (PH, FWP, NLP, NBP, NFPS and FSL). All parameters increased at (0-20 cm) soil depth, and the GD x SH x ND interaction had a significant effect on (SD, NLP, NFPS and FSL). These results suggest that adding of gyttja with nitrogen fertilizer to the calcareous and infertile soil will enhance the morphological attributes of plants.***

Keywords: Gyttja, Snapdragons plant, Nitrogen Fertilizer, Soil Depth.

1. INTRODUCTION

The agricultural soils in Bakrajo, Sulaimani, Kurdistan region/Iraq, contain low organic matters. This is because of cultivation system, high rate of soil erosion, land degradation and dry and hot microclimate. In order to address the agricultural, environmental and economic problems organic materials are essential to add to this agro-ecosystem [1].

There are higher and more active microbial population in the soils supported by organic inputs in compare to those managed with mineral fertilizers [2]. To improve soil properties and fertile its content, materials such as (leonardite, gyttja, poultry manure, sewage sludge, etc.) are commonly used [3], thus also address some of the soil-borne pathogens and plant diseases [4].

Gyttja is a semi-formed lignite coal cover layer that is black or brown mud with organic matter and not used for fuel due to low calorie [5, 6, and 7]. The (EC) was 0.68 mmhos/cm^{-1}, the acidity (pH) of gyttja was 7.75, total lime content was 32.5% and total organic carbon content was 25.5%. Total nitrogen content was 0.84% and total phosphor of gyttja was 17 mg kg^{-1}. The amounts of fulvic and humic acids were 27.49 and 40.78%, respectively [1, 8].

Snapdragons (*Antirrhinum majus* L.) is the most common flower growing in gardens and parks. The name comes from its character when pinch the flowers at the sides with the thumb and index finger, open and closes like the mouth of a dragon. Snapdragon cultivars growth and flowering based on their response to day length and temperature [9]. The bright and colored flowers and the ability of the plant to adapt in local growing conditions make it easy to produce and spread [10]. Snapdragon is desirable for cut flowers because of its wide range of petal colors and smell. The snapdragon cut flowers are sensitive to ethylene, and their vase lives are relatively short [11, 12, 13].

The aim of this study was to assess the gyttja effects, nitrogen applications and soil depth on some morphological characters of Snapdragons.

2. METHODS AND MATERIALS

The experiment was carried out during the years 2015-2016, and Snapdragons plants were used as test plants, under plastic house condition, in the Ornamental plants Department, Technical Institute of Bakrajo, Sulaimani Polytechnic University, Sulaimani - Iraq. Gyttja was gained from Lignite deposits at the Afsin - Elbistan (Kahramanmaraş, Eastern Turkey). The effect of gyttja on plant growth was tested by using four different gyttja doses (0, 1, 2, and 3 % plant (w/w), and three different nitrogen doses (0, 140, and 280 mg/ kg^{-1} -N). The nitrogen fertilizer was added as urea at three doses after 25 days of sowing.

2.1. Soil and Gyttja Analysis

The soil used for growing Snapdragons was taken at two different soil depths (0-20, 20-40) cm from Bakrajo, Sulaimani, Kurdistan region/Iraq. After collections the both of soil was dried by air and sieved (<2 mm) in the laboratory to determine physical and chemical properties (Table 1). Based on these values, both of soils have low organic matter and varied in macro and micronutrients contents, the soil pH was slightly alkaline and the amount of lime in the depth (0-20) lower than of (20-

40), and organic matter, P, Cu, Fe, Zn and EC contents in the soil depth (0-20) cm were very high compared with lower soil depth.

The (EC) and acidity (pH) of both soil depth and gyttja were measured in H_2O suspension by using a glass electrode - calomel electrode system [14]. The Walkley-Black method was used for determining Organic Matter (O.M) in gyttja and soil depth samples [15]. UV-VIS spectrophotometer was used to determine the concentration of phosphorus in soil by using a solution of 0.5 N sodium bicarbonate $NaHCO_3$ at pH 8.5 [16]. The DTPA-TEA extraction method that was developed by [17] for extracting metal micronutrients in neutral and calcareous soils was used for measuring plant available (Mn, Cu, Fe, and Zn) and the Ammonium acetate (1N NH_4OAc) at pH 7.0 solution was used for assayed macronutrient (Ca, Mg, K and Na) [18] by using Perkin Elmer 3110 Atomic Absorption Spectrophotometer (AAS). The Total lime ($CaCO_3$ %) in the soil was evaluated by using Scheibler Calcimeter method [19].

The gyttija used in the experiment was slightly alkaline, low EC, high calcium carbonate and organic matter content (Table 2).

Finally the gyttja was mixed manually at each application rate until the gyttja- 2kg soil mixture was homogenous for each pot.

Table l: The properties of the soil:

Parameters	Soil Depth (0 – 20) cm	Soil Depth (20 – 40) cm
pH	7.65	7.74
EC (mmhos/cm^{-1})	2.0	1.56
CaCO3 (%)	24.5	32.1
O.M. (%)	2.30	1.27
Ca (mgkg^{-1})	4521	5485
Mg (mgkg^{-1})	223.2	153.7
Na (mgkg^{-1})	48.1	44.2
K (mgkg^{-1})	203	255
P (mgkg^{-1})	4.07	2.37
Fe (mgkg^{-1})	9.22	7.8
Zn (mgkg^{-1})	1.43	0.85
Cu (mgkg^{-1})	2.60	1.06
Mn (mgkg^{-1})	27.2	35.16

Table 2: Properties of gyttja used in the study:

Parameters	Value
pH	7.70
EC (mmhos/cm^{-1})	0.86
$CaCO_3$ (%)	31.8
Organic Matter (%)	42.1

2.2. Plant Characteristic

Plants was harvested 90 days after planting and to record the following morphological attributes including, Plant Height (PH) cm, Fresh Weight Per Plant (FWP) g, Number of Leaves Per Plant (NLP), Stem Diameter (SD) cm, Number of Branches Per Plant (NBP), Number of Flower Per Spikes (NFPS) and Flower Spike Length (FSL) cm, the plants need to uprooted and washed with tap water.

2.3. Statistical Analysis

Experiment was performed by randomized complete block design (RCBD) with three replications was used in this study to test main and interaction effects. The data sets were analyzed with (IBM SPSS Advanced Statistics version 20.0.0). For direct comparison of treatments, Duncan's' Multiple Comparison tests were used. (ANOVA) analysis of variance was used for testing the main effect, the interaction of all variables; SH, GD and ND for all treatments at statistical significance level ($p \leq 0.05$). The figures were designed using Graph pad prism version 6.0 software.

3. RESULTS AND DISCUSSION

The results of (ANOVA) for the different soil depth, gyttja doses, nitrogen doses, and their interactions regarding the measured morphological characters of Snapdragons plant are shown in (Table 3). Nitrogen and gyttja doses had significant effects on all parameters. Soil depth showed significant variation in NBP, NFPS, and FSL. However, the effect of soil depth was non- significant on (PH, FWP, NLP and SD). Soil depth showed significant variation in NBP, NFPS, and FSL. However, the effect of soil depth was non-significant on (PH, FWP, NLP and SD). The interaction between the soil depth and gyttja doses has affected all the characters except FSL. The interaction of soil depth and nitrogen doses had a significant effect only on NLP and FSL. The interaction between gyttja doses and nitrogen doses significantly affected all morphological Snapdragons characters except PH. The interactions between SH x GD x ND were significant for all treatments except NFPS and PH.

Duncan's multiple comparison tests have indicated that the application of 140 and 280 mg kg^{-1} nitrogen doses significantly increased PH, FWP, and NLP. However, NBP, NFPS, and FSL were significantly higher than control when 280 mg kg^{-1} nitrogen was used (Table 4.). The stem diameter has shown linear increases when 140 mg kg^{-1} nitrogen was applied. Nitrogen was added as an experimental factor in this study because previous researches recommended that the application of N together with the gyttja positively affects the plant growth. This might be due to the decrease in nitrogen loss by leaching. Moreover, nutrient uptake by plants is controlled not only by nutrient supply but also by the demand of the plant. According to [21] peat and leaf compost as growing substrates with sufficient supply of N content are good for healthy plant growth.

Applying gyttja at 3% enhanced the morphological attributes; PH, SD, NBP, NFPS, NLP and FSL in the Snapdragons plant, but it does not increase FWP (Table 5). The Fresh Weight Per Plant increased at 2% gyttja application. The gyttja application presented maximum stem diameter which is also supported by [21] who observed thickest stem of dahlia in sand, silt, and Leaf mould medium. Results showed that plants gave a maximum increase in FWP in 2% gyttja doses containing media. In this respect, [22, 23] observed the fresh weight per plant increases in the media containing organic matter. The peak in a number of plants shoots presented the vital vegetative plant growth. Also it helped by nutrient rich and growing media. The maximum numbers of plant shoots were recorded in the result of treatment gyttja, N + topsoil that showed the enhanced vegetative growth in *Antirrhinum majus* L. These findings are similarly seen in both researches done by [24, 25] first was on *Sinmondsia chinensis* that the maximum number of shoots in organic material. The second was using coconut compost growing media in combination with silt + organic material increased side branches.

Table 3: The ANOVA results of the treatments and their interactions for the measured morphological attributes of Snapdragons plant.

Parameters		**Plant Height (cm)**		**Fresh Weight Per Plant (g)**		**No. of Leaves Per Plant**		**Stem Diameter (cm)**		**No. of Branches Per Plant**		**No. of Flowers Per Spike**		**Flower Spike Length (cm)**	
Source	***Df***	***F-Value***	***Sig.***	***F-Value***	***Sig.***	***F-Value***	***Sig.***	***F-Value***	***Sig.***	***F-Value***	***Sig.***	***F-Value***	***Sig.***	***F-Value***	***Sig.***
Soil Depth (SH)	1	7.004	0.770	7.281	0.206	61.661	0.145	10.509	0.162	1.730	0.001	57.845	0.000	37.902	0.000
Gyttja Dose (GD)	3	110.66	0.000	39.550	0.000	166.139	0.000	43.353	0.000	70.471	0.000	202.537	0.000	203.331	0.000
Nitrogen Dose (ND)	2	87.550	0.000	71.838	0.000	118.363	0.000	60.720	0.004	57.261	0.000	112.755	0.000	63.211	0.000
SH* GD	3	1.567	0.000	16.761	0.000	4.907	0.005	21.794	0.000	0.684	0.000	6.055	0.001	0.704	0.554
SH * ND	2	2.349	0.274	8.098	0.102	4.397	0.018	6.806	0.061	3.381	0.392	0.746	0.480	10.429	0.000
GD* ND	6	1.963	0.051	21.190	0.000	11.973	0.000	12.236	0.000	0.975	0.000	3.515	0.006	9.737	0.000
SH * GD * ND	6	1.668	0.072	11.301	0.017	5.300	0.000	10.123	0.000	1.420	0.004	2.158	0.064	7.471	0.000

Table 4: The effect of the nitrogen doses on some measured morphological attributes of Snapdragons plant.

Nitrogen Dose (mg/kg^{-1})	**Plant Height (cm)**	**Fresh Weight Per Plant (g)**	**No. of Leaves Per Plant**	**Stem Diameter (cm)**	**No. of Branches Per Plant**	**No. of Flowers Per Spike**	**Flower Spike Length (cm)**
0	89.375b	81.166b	334.38b	1.066b	10.50c	34.46c	25.92b
140	111.666a	120.792a	553.54a	1.370a	24.17b	46.79b	27.33b
280	105.292a	130.208a	540.92a	1.213ab	30.96a	53.83a	34.17a

***Means in the same column followed by the same symbol are not significantly different at $p \leq 0.05$ level based on Duncan test.**

Table 5: The effect of the gyttja doses on some measured morphological attributes of Snapdragons plant.

Gyttja Dose (%)	**Plant Height (cm)**	**Fresh Weight Per Plant (g)**	**No. of Leaves Per Plant**	**Stem Diameter (cm)**	**No. of Branches Per Plant**	**No. of Flowers Per Spike**	**Flower Spike Length (cm)**
0	75.28d	57.44c	261.06c	1.000b	9.28c	28.00d	17.28d
1	95.28c	74.28b	429.50d	1.128b	14.78b	38.17c	27.11c
2	107.17b	82.39a	574.22b	1.128b	30.61a	51.11b	33.94b
3	112.11a	73.06b	640.33a	1.611a	32.83a	62.83a	38.22a

***Means in the same column followed by the same symbol are not significantly different at $p \leq 0.05$ level based on Duncan test.**

Based on estimated marginal mean, both of soil depth effects on morphological attributes of Snapdragons plant were compared together are shown in (Table 6). Mostly, all parameters (FWP, NLP, NBP, NFPS and FSL) of the plants grown in the soils depth (0-20) cm were higher than those grown in soil depth (20 – 40) cm. This might be due to the higher amount of organic matter and some macro-micronutrients in the soil depth (0-20) cm than the second depth. The gyttja amended soils (0-20) cm had higher morphological attributes with nitrogen fertilizer compared with soil in (20-40) cm, due to that material contains high amounts of organic matter (42.21%) and having a stronger relationship between them.

Table 6: The effect of the soil depth on some measured morphologic attributes of Snapdragons plant.

Soil Depth (cm)	Plant Height (cm)	Fresh Weight Per Plant (g)	No. of Leaves Per Plant	Stem Diameter (cm)	No. of Branches Per Plant	No. of Flowers Per Spike	Flower Spike Length (cm)
0-20	101.67	114.390a	527.556a	1.27	23.333a	49.083a	31.111a
20-40	102.56	107.060b	425.000b	1.16	20.417b	40.972b	27.167b

***Values represent based on estimated marginal mean.**

Duncan's multiple comparison tests indicated that all the morphological attributes of snapdragons plants grown in the soils amended with gyttja in soil depth (0-20) cm better than soil (20-40) cm. The PH had statistically increased by increasing with gyttja doses with N-140 mg kg^{-1} and gets the high vale at 3% (115.04) cm followed at 2% (103.39) cm and 1% (92.43)cm over 0 % of gyttja doses, although maximum increases (94.66)cm in PH was obtained with N-Control and at 3% of gyttja doses (Fig1 A). The FWP (129.393) gm statistically increased in the fertilized with N-280 mg kg^{-1} at 2% of gyttja dose and (123.067) gm decline was observed with 3% doses, and in the non-fertilized treatments the FWP statistically was increased at 3% (119.197) gm followed by 2% (101.303)gm and 1% (80.720)gm over the 0% of gyttja (60.200) gm (Fig1 B). When the soil fertilized with N-140 mg kg^{-1}, the SD increased significantly at 3% doses (1.64) cm over the 0% doses (0.90) cm, and there were no statistical differences between 1, and 2% doses (1.09) cm, whereas in the non-fertilized treatment the SD expanded by increasing of gyttja doses, but statically a similar effect by 2 and 3% doses was observed (0.93), and (0.96) cm respectively (Fig1 C). In the fertilized treatment N-280 mg kg^{-1} maximum increases in NFPS (79.660) was observed at 3% application followed by 2% (61.660) and by 1% (46.660) over the 0% (40.000), although in the non-fertilized treatment the NFPS increased at 1,2,3% over the control (33.660, 42.330 and 59.660) respectively (Fig1 D). The NBP (49.000) statistically increased in the fertilized with N-280 mg kg^{-1} at 2% of gyttja dose and decline (42.700) was observed at 3% doses. In the non-fertilized treatments the NBP was increased statistically at 3% (15.660) followed by 2% (13.330) and at 1% (10.330) over the 0% of gyttja (5.330) (Fig1 E). In addition, NLP was significantly increased by gyttja application over the control. In the fertilized treatment N-140 mg kg^{-1} the NLP (883.000) initially increased till the 2% doses, however a steady decrease was observed with increasing at 3% (733.000), When the soil non-fertilized the NLP significantly increased at 3% doses (569.700) over the control (120.700), and statistically there were no differences between 1, and 2% doses (388.7), and (414.000) respectively (Fig 1F). Finally, in the fertilized treatment N-280 mg kg^{-1} maximum increases in FSL (48.33)cm was shown at 3% application followed at 2% (41.330)cm and at 1% (33.330)cm over the 0% (25.660)cm, although in the non-fertilized treatment the FSL increased at 1,2,3% over the control (29.000, 31.660, and 38.330)cm respectively (Fig 1G).

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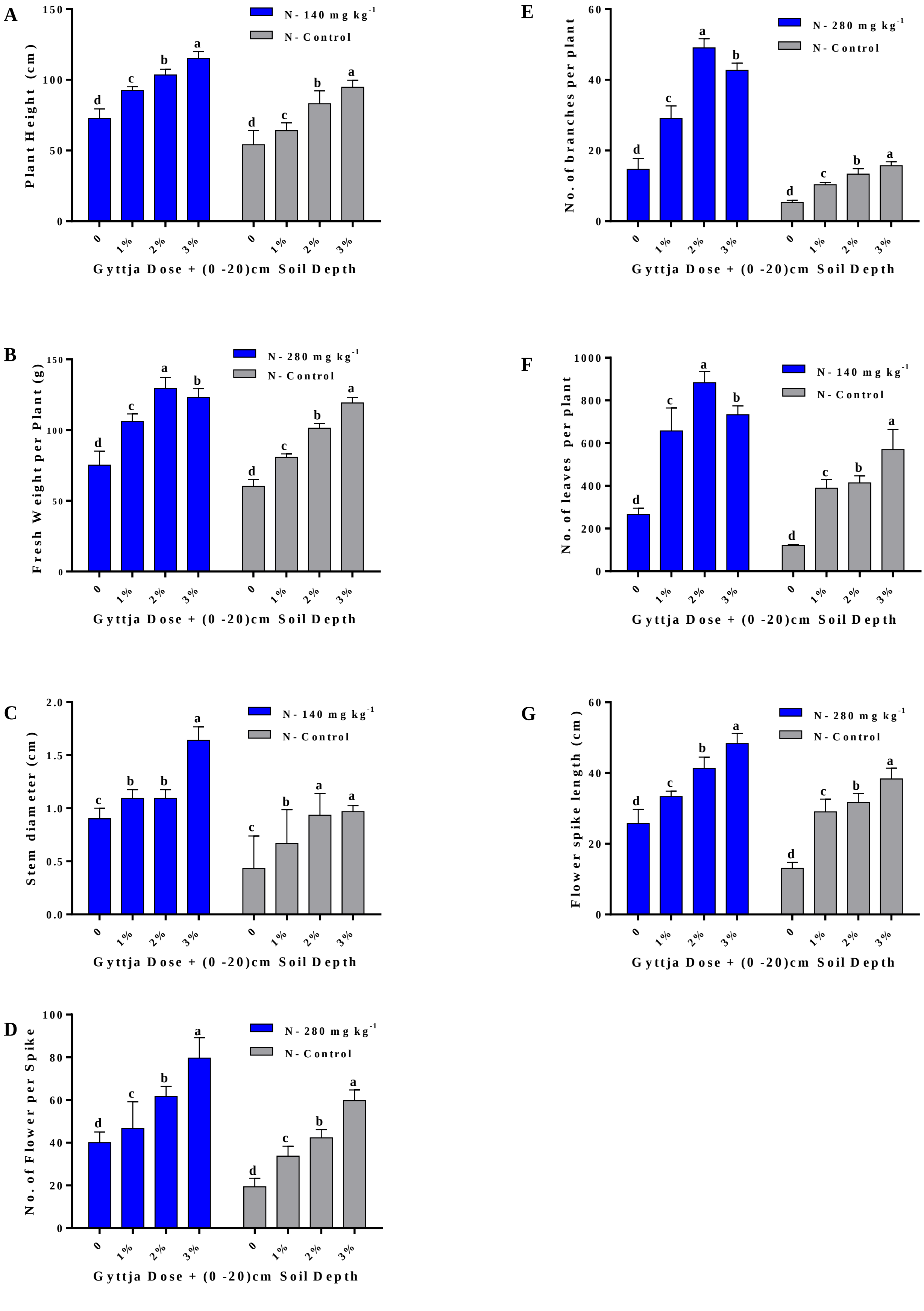

Figure 1: Plant growth measurements (Mean ± SE) of Antirrhinum. Measurements contain Plant Height (PH) cm, Fresh Weight Per Plant (FWP) g, Number of Leaves Per Plant(NLP), Stem Diameter(SD) cm , Number of Branches Per Plant(NBP), Number of Flower Per Spike (NFPS) and Flower Spike Length(FSL) cm. That figure illustrated the best interaction between four Gyttja doses (0, 1, 2, and 3%), tow soil depth (0-20) (20-40), and three Nitrogen doses (0, 140, and 280 mg kg^{-1}), compare with non-fertilized treatment (N- Control). The abbreviation (a) means the greatest effect on plant morphological attributed.

4. CONCLUSION

A number of experiments were conducted to test how gyttja application to the soil affects soil properties and plant growth. This study shows that the morphological attributed (PH, SD, NBP, NFP and FSL) had increased with gyttja application at 3%. Based on these results, it was observed that nitrogen dose 280 mg kg^{-1} had major effects and increases (PH, FWP, NLP, NBP, NFPS and FSL). The Snapdragons plants response was more in (0-20) cm than the (20-40) cm soil. This means that the top soil contains higher organic matter and macro-micronutrients than other soil depth. Based on the Fresh Weight per Plants, the combination of (soil (0-20) cm, 2% gyttja dose, and 280 mg kg^{-1} N application) had the greatest interaction.

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