Role of Pruning and Foliar Application of Humic Acid on Growth and Yield of Soybean (*Glycine max* L.)

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Abstract

This research studied to determine the impact of pruning and foliar applied humic acid on growth and yield of soybean. The experiment conducted in Grdarasha Field, College of Agricultural Sciences, Salahaddin University-Erbil, and Factorial Randomized Complete Block Design is used in which pruning was done for soybean (P0= No pruning and P1= with pruning) was done when flowering started. As well as, humic acid used H0 as control with three levels (H1, H2 and H3) at the rates (0.5, 1 and 1.5) g/1 L water as foliar application after pruning was applied twice with the interval of 15 days. Thus, the results showed that highest and lowest plant height was (58.4 and 45.7) cm recorded by (P0H1 and P1H2), respectively. In addition, pruning with no humic acid increased (number of branches plant^{-1}, number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1}, 100 seed weight and seed yield) which was (4.7, 131.9, 63.3 g, 313.7, 12.3 g and 9500 kg ha^{-1}), respectively in comparison to other treatments. In the interaction of factors P1H2 and P1H3 have the same value of number of seeds pod^{-1} was 28.3. In the context of results pruning and humic acid should also be used at different times or doses to determine its impact on soybean for determining best agronomic practices and results and increasing growth and yield.

Keywords: Pruning, Humic acid, Foliar application, Seed yield and Soybean.

Introduction

Soybean (*Glycine max* L.) which belongs to the Fabaceae family is a major source of edible oil and protein. According to chemical analysis, seeds of soybean have about 40 % protein, 20 % oil, 30 % carbohydrates, 10 % total sugar, and 5 % ash [8]. [25,4] reported that East Asia uses soybeans for human consumption, but the US, Argentina, and Brazil mostly crush them into meal and oil, which are subsequently used for human use (as cooking oil, margarine, etc.) or animal feed. Thus, by enhancing the genetic potential of plants and implementing integrated land, fertilizer, water, and pest management, soybean productivity can be raised. Applying plant cultivation technologies that can provide increased productivity of soybean plant [1].

Pruning or Nipping is a well-known important agronomic manipulation in pulses to arrest the apical growth and increase the lateral branches for maximizes the yield [2]. There more, According to [6,13] in order to balance the creation of new branches and increase crop

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productivity, pruning will inhibit the growth of apical shoots and maximize the growth of lateral shoots. Shoot deaths have comparable effects as shoot tip pruning. [24] described pruning as an energizing procedure that removes the apex, eliminates apical dominance (the growing point at the tip of the main stem), and promotes the development of lateral buds into shoots.

As well as, plant development is impacted by humic acid, a bio-stimulant made of organic molecules that passes through a humification process. Humic acid has a direct impact on plant metabolism or an indirect effect on soil fertility. There are nutritional, chemical, and biological advantages to humic acid [5]. According to [9] humic acid chemically absorbs and binds plant nutrients, enhances root growth, and biologically influences the activity of microbes. It also offers nitrogen, phosphorus, and sulfur for both plants and microorganisms. Humic acid (HA) is predominantly produced from plant and animal wastes and microbial synthesis, accounting for 65-70% of soil organic matter. There more, for achieving sustainable production, it is necessary to modernize conventional agricultural production techniques and increase crop productivity. The agricultural advancements that increase crop yield can lessen environmental consequences and improve overall sustainability. Using bio-stimulants can enhance the efficiency of traditional mineral fertilizers. Humic acid might be a potential solution [20].
Therefore, the aim of this study is to investigate the impact of pruning and foliar applied humic acid on soybean growth and yield.

Materials and Methods

The study was conducted in Grdarasha Field in the College of Agricultural Engineering Sciences, Salahaddin University-Erbil, the study location for this present research (Latitude 36. 10116 N and Longitude 44.00925 E). In this study Factorial Randomized Complete Block Design (RCBD) was used as an experimental design with three replications. Plot size was (1 × 2 m) with a space of (1 m) between replicates and plots. Five rows per plot, the distance between rows (50 cm) while the distance between plants in a row was (20 cm).
One variety of soybean was used with pruning (P0 no pruning and P1 with pruning), pruning was done once the plant started flowering by cutting top of the plant. As well as, foliar applied humic acid with 4 levels H0 as control (H1, H2 and H3) at the rates of (0.5, 1 and 1.5 g/ 1 L of water) respectively, produced by (Plants Choice) company. Humic acid after mixing it with water dishwashing liquid soap (Zehy) was used for insuring the stickiness of Humic acid, and its applied twice after pruning with the interval of 15 days between first and second application.

Soil Analysis

Table 1 displays the physical and chemical properties of the soil from the studied site. The samples were taken randomly at the depth of 0 to 30 cm from several places on the farm, which was before divided into plots. Later, the soil was air dried and sieved through a (2 mm) pore size sieve in the laboratory.

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Table 1. Physicochemical properties of the soil samples from the study site.

Physicochemical Properties			
Physical properties	Sand	100.25	
	Silt	515	($g\ kg^{-1}$)
	Clay	384.75	
	Texture	Silty Clay Loma	
	pH	7.53	
	ECe	300	($\mu S\ cm^{-1}$)
Chemical properties	O.M.	9.6	
	$CaCO_3$	306	($g\ kg^{-1}$)
	N (total)	89.17	($g\ kg^{-1}$)
	P	4.67	(ppm)
	(available)	312	($mg.\ kg^{-1}$)
	K		(ppm)
	(available)		

Data Collection

At full maturity stage from each experimental treatment five plants were nominated as a sample for measuring the following traits:

Growth Parameters:

Plant Height (cm)

The height of each of the five chosen plants was measured from the base of the plant at the soil's surface to the top of the main stem, and the average height of the plants was then recorded and represented in cm [17].

Lowest Pod Height (cm)

It is measured by the height of first pod appeared on branches of the plant and expressed in cm [8].

Number of Branches Plant^{-1}

Numbers of branches were measured for each plant and the averages were taken [18].

Number of Pods Plant^{-1}

Numbers of pods were measured for each sample and the averages were taken [18].

Weight of Pods Plant^{-1} (g)

Weights of pods were taken for each sample and the average expressed in gram [17].

Yield Parameters:

Number of Seeds Pod^{-1}

The pods were collected from each experimental unit of the selected plants, which were then manually rubbed and cleaned. The average number of seeds per pod was recorded [18].

Weight of Seeds Pod^{-1} (g)

After threshing the pods and separating the seeds from pods, seeds were weighted for each sample and average was taken in gram [17].

Number of Seeds Plant^{-1}

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Numbers of seeds were measured for each sample of the soybean plant and the averages were taken [18].

Weight of Seeds Plant^{-1} (g)

Seeds were weighted for each sample and average was taken in gram [8].

100 Seed Weight (g)

From each treatment 100 seeds were counted and weighted to be expressed in grams [8].

Seed Yield (kg ha^{-1})

After cleaning and drying seeds of soybean, seed yield determined by weighting the seeds of all plants from each experimental unit in Kg ha^{-1} [19].

Data Analysis

Growth and yield parameters were all taken at maturity stage and statistically analyzed according to the technique of analysis of variance (ANOVA) for randomized complete block design, (RCBD) using IBM SPSS Statistics program (20) the mean comparison was fulfilled according to Duncan multiple range test at the level of significant 0.05.

Results and Discussions

The analysis of variance in Table 2 shows that some growth parameters for example plant height and number of branches plant^{-1} significantly affected by pruning. On the other hand, lowest pod height, number of branches plant^{-1} and weight of pod plant^{-1} significantly affected by the interaction of humic acid and pruning. Table 3 the results revealed that only weight of seeds plant^{-1} and seed yield of yield parameter significantly affected by the interaction of factors, and other parameters not affected either by single effect of pruning or humic acid and their interactions.

Table 2: Analysis of variance (ANOVA) for the influence of pruning, humic acid and their interaction on growth parameters of soybean.

Growth Parameters																
		PH			LPH			NB			NP			WP		
S.O.V	DF	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V
P	1	187.04	187.04	6.37^{*}	0.84	0.84	0.74^{ns}	1.98	1.98	8.49^{*}	14.72	14.72	0.03^{ns}	41.60	41.60	1.19^{ns}
H	3	68.85	22.95	0.78^{ns}	2.74	0.91	0.80^{ns}	0.87	0.29	1.25^{ns}	1264.4	421.47	0.95^{ns}	360.0	120.0	3.43^{*}
P-H	3	214.32	71.44	2.43^{ns}	14.91	4.97	4.38^{*}	2.91	0.97	4.15^{*}	539.12	179.70	0.40^{ns}	909.6	303.2	8.66^{*}

* Significant at 5%, when p-value less than 0.05 (typically ≤ 0.05). ns= none significance.

S.O.V= Source of variance, DF= Degrees of freedom, SS= Sum of square, MS= Mean square, F.V= F value, P= Pruning, H= Humic acid, P-H= Interaction of factors, PH= Plant height, LPH= Lowest pod height, N= Number of branches plant^{-1}, NP= Number of pods plant^{-1} and WP= Weight of pods plant^{-1}.

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Table 3: Analysis of variance (ANOVA) for the influence of pruning, humic acid and their interaction on yield parameters of soybean.

		Yield Parameters																	
		NS/pod			WS/pod(g)			NSP			WSP(g)			100 SW(g)			SY(kg/ha)		
S.O.V	DF	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V	SS	MS	F.V
P	1	0.13	0.13	0.08^{ns}	0.22	0.22	0.97^{ns}	5.04	5.04	0.01^{ns}	15.04	15.04	0.7^{ns}	4.68	4.7	2.04^{ns}	960000	960000	0.74^{ns}
H	3	6.28	2.09	1.35^{ns}	0.52	0.17	0.77^{ns}	9824.6	3274.8	0.63^{ns}	136.94	45.64	2.12^{ns}	12.9	4.3	1.88^{ns}	8363333.3	2787777.7	2.15^{ns}
P-H	3	1.31	0.43	0.28^{ns}	0.31	0.10	0.46^{ns}	12955.3	2640	0.51^{ns}	417.65	139.2	6.5*	7.03	2.3	1.03^{ns}	26583333	8861111.1	6.83*

* Significant at 5%, when p-value less than 0.05 (typically ≤ 0.05). ns= none significance.
S.O.V= Source of variance, DF= Degrees of freedom, SS= Sum of square, MS= Mean square, F.V= F value, P= Pruning, H= Humic acid, P-H= Interaction of factors, NS/pod= Number of seeds pod^{-1}, WS/pod= Weight of pods plant^{-1}, NSP= Number of seeds plant^{-1}, WS= Weight of seeds plant^{-1}, 100 SW= 100 seed weight and SY= Seed yield.

Plant Height (cm)

Figure 1 display that single factors for plant height was not significant in which maximum plant height was (53.9 and 51.7) cm respectively for no pruning and when 1.5 g/ 1 L of water was applied as compared with pruned and control treatment. While, in the interaction of factors highest and lowest plant height was (58.4 and 45.7) cm recorded by P0H1 and P1H2, respectively. This means that in the interaction of factors application of humic acid alone with no pruning increased plant height as compared to control treatment. These results supported by [13] who institute that pruning reduced plant height. As with terminal clipping, the apical bud is removed, therefore the crop's consumption of photosynthesis for lateral branches may be higher, which might explain the lower plant height. The removal of the apical bud inhibits plant vertical development, causing photosynthate to translocate to leaf axils and therefore stimulating auxiliary branches [23]. [15] investigated that humic acid maximized plant height. There more, [17] discovered that plant height increased due to foliar application of humic acid with no pruning, while pruning decreased plant height in sesame plant.

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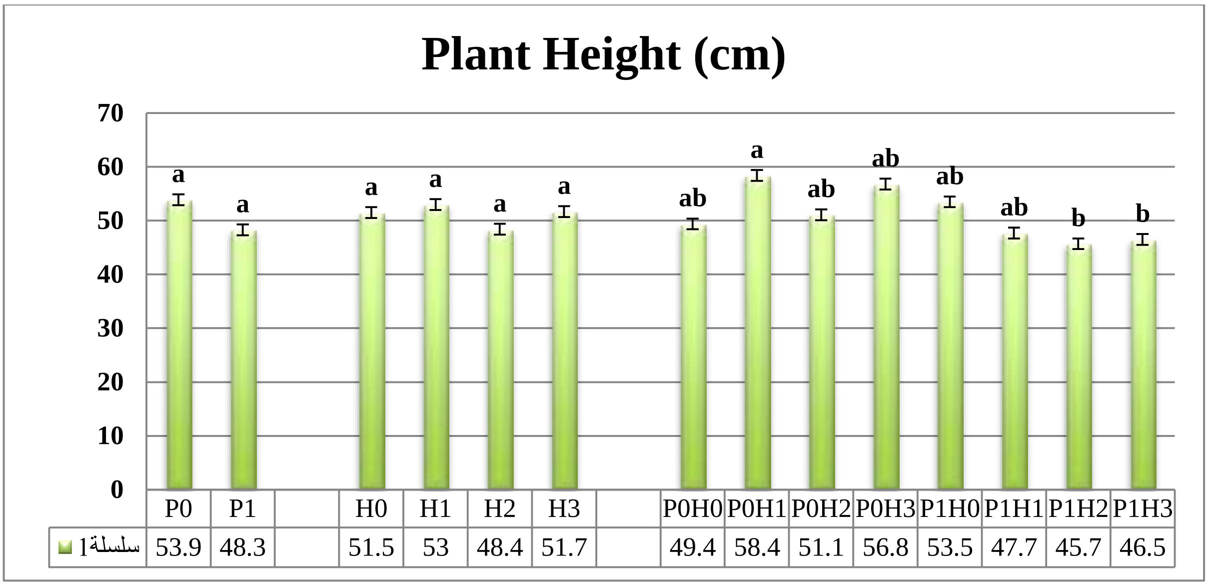

Figure 1: Single and interaction effect of pruning and humic acid on plant height of soybean.

Lowest pod height (cm)

All treatments for this parameter has approximately the same value highest and lowest value was (6.5 and 6.2) cm for pruned and none-pruned plots. Humic application also was not significant control treatment has 6.7 cm of lowest pod height as compared to other treatments. In addition, P0H0 has 7.9 cm for the lowest pod height, while for the interaction of factors P1H0 has minimum pod height of 5.5 cm and P0H2 and P0H3 both has 5.6 cm of pod height (Figure 2). Same results showed by [23] in which nipping reduced the first pod height. According to [10] removing the terminal bud may have triggered latent axillary buds, leading to the formation of new latitudinal branches and shoots, resulting in the lowest pod height. [17] exposed that pruning lowered the height of first capsule as compared to not pruned sesame plant.

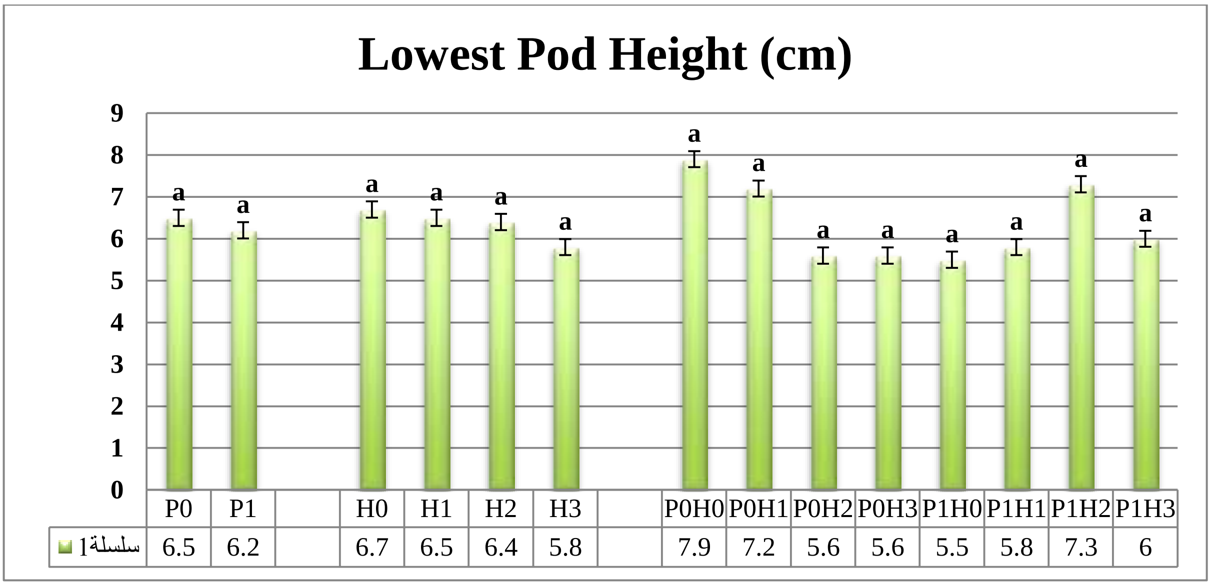

Figure 2: Single and interaction effect of pruning and humic acid on lowest pod height of soybean.

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Number of branches plant^{-1}

This parameter also not affected by humic acid, while number of branches plant^{-1} increased in treatments when pruning was done 4.4 branches recorded as compared to treatments with no pruning was 3.8 branches plant^{-1}. In interaction of factors P1H0 and P0H3 has 4.7 and 3 branches plant^{-1}, respectively (Figure 3). This study supports the findings of [13], who found that pruning soybean shoot tips throughout the vegetative stages and up to the blooming date had a significant impact on branch growth, [22] in green gram.

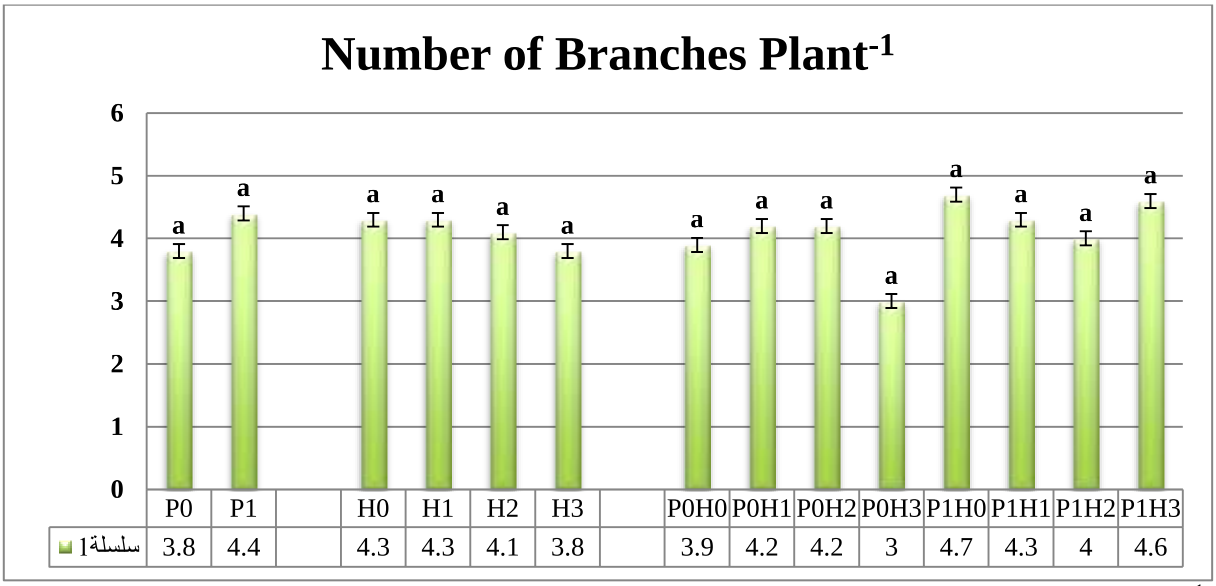

Figure 3: Single and interaction effect of pruning and humic acid on number of branches plant^{-1} of soybean.

Number of pods plant^{-1}

Figure 4 indicates that application of humic acid and pruning not affected number of pods plant^{-1}. However, in the interaction of factors number of pods increased to 131.9 pods plant^{-1} for P1H0 as compared to P1H3 which was 104.2 pods. These results in agreement with [16] demonstrated that number of pods increased plant^{-1} by nipping in cowpea. Nipped chickpea plants produced more pods per plant compared to non-nipped plants. The increased number of pods per plant in nipped plants may be attributed to the commencement of more branches and flower buds, leading to more pods [12].

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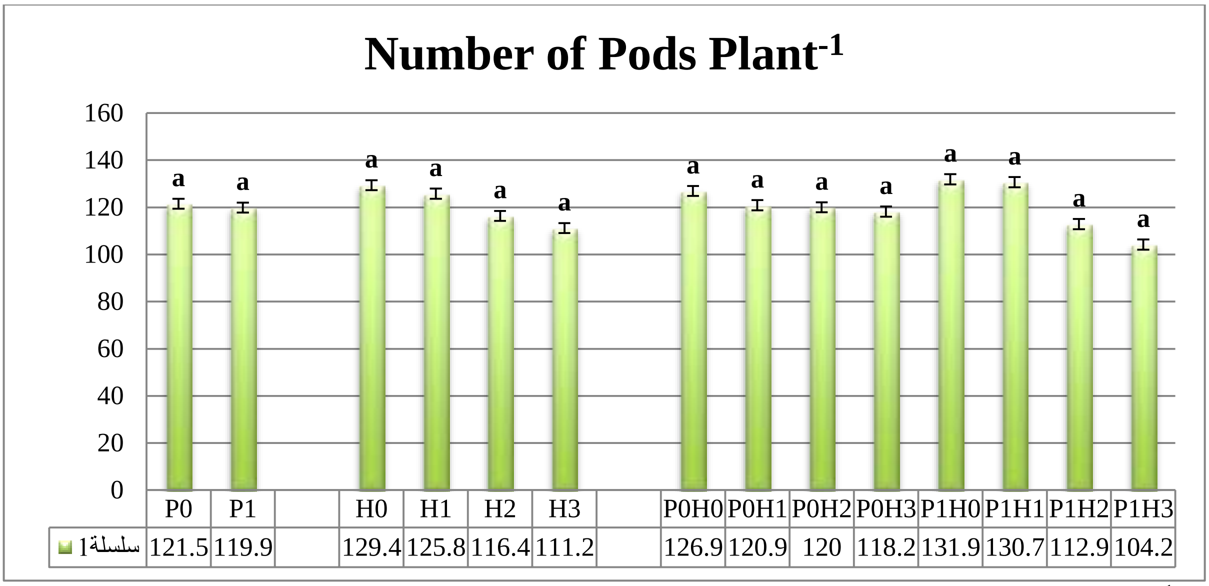

Figure 4: Single and interaction effect of pruning and humic acid on number of pods plant^{-1} of soybean.

Weight of pods plant^{-1} (g)

Weight of pods plant^{-1} in pruned and none-pruned plots was (48 and 45.4) g pod plant^{-1}, respectively. While, control treatment with no humic acid has highest number 51.8 g pods as compared to other treatments. By increasing the number of pods plant^{-1} as mentioned before the weight of pods plant^{-1} will also be increased by the same treatment pruning with no humic acid (P1H0) to 63.3 g of pods plant^{-1}, while 36.8 g recorded as minimum weight of pods plant^{-1} by P1H3 (Figure 5). These results in contrast with [3,7] told that pruning enhanced weight of pods plant^{-1} compared to no pruning in chickpea.

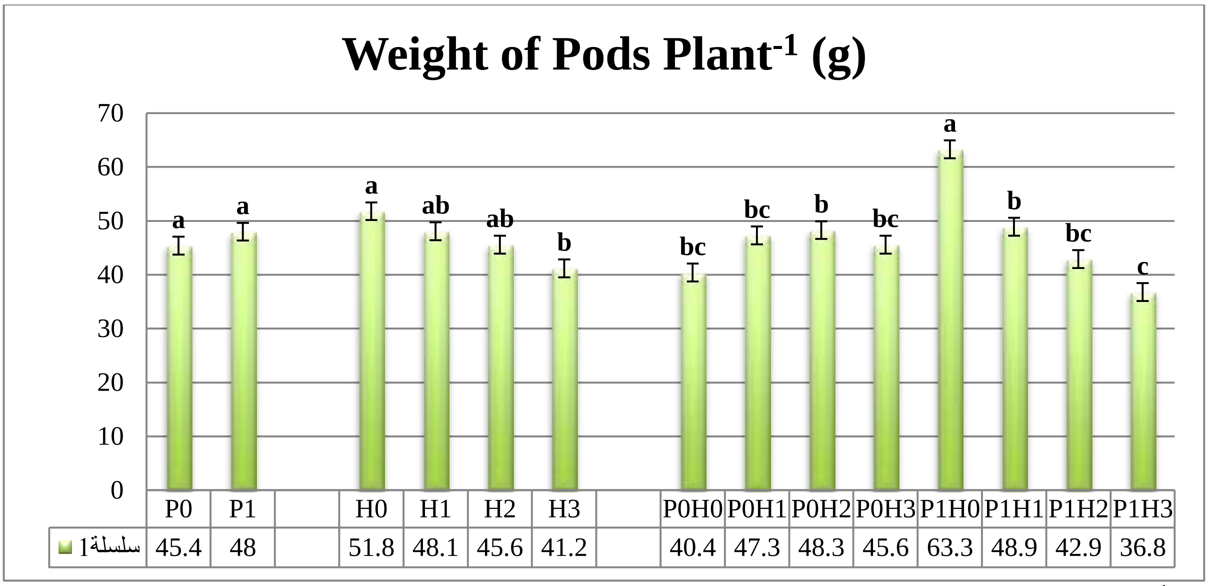

Figure 5: Single and interaction effect of pruning and humic acid on weight of pods plant^{-1} of soybean.

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Number of seeds pod^{-1}

The number of seeds was not significantly affected by either factor maximum number of seeds pod^{-1} was 27.3 and 27.9 seeds for P1 and H2, respectively as compared to other treatments. However, the highest number of seeds per pod was observed in the pruned plots, with treatments of 1 g/L and 1.5 g/L of water (P1H2 and P1H3) both producing an average of 28.3 seeds per pod, compared to the control (Figure 6). [12,14] also reported that number of seeds pod^{-1} were none significance for nipping in chickpea.

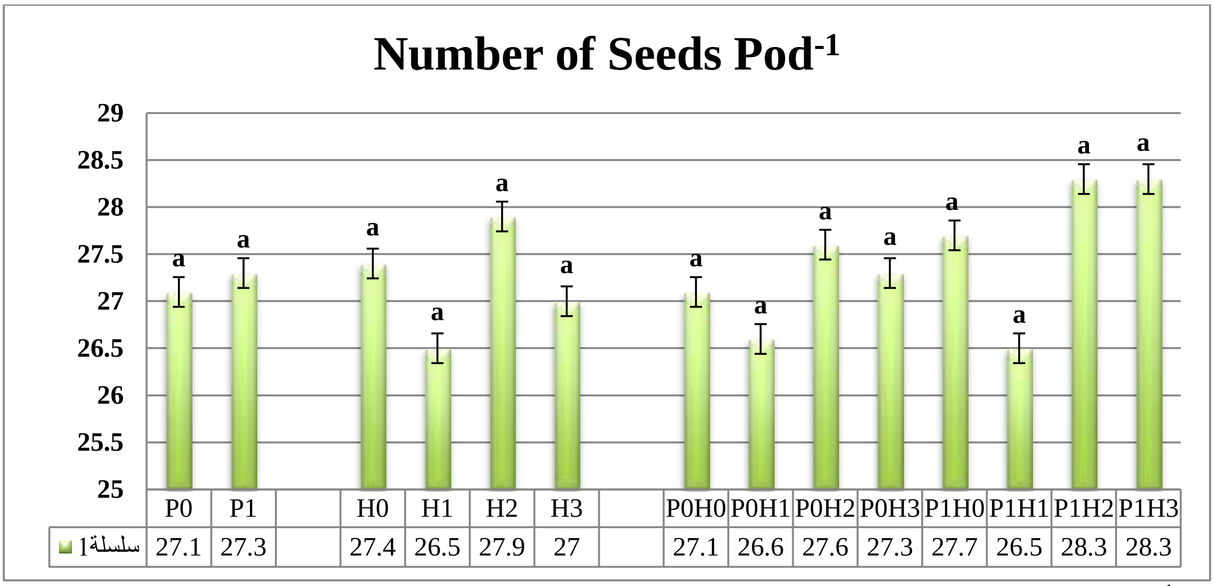

Figure 6: Single and interaction effect of pruning and humic acid on number of seeds pod^{-1} of soybean.

Weight of seeds pod^{-1} (g)

Figure 7 show that all treatments have approximately the same value. P1 has 2.9 g of seeds pod^{-1} as compared to P0, weight of seeds pod^{-1} was 3 g in control treatment this means humic acid not affected weight of seeds. While with the interaction of pruning weight of seeds pod^{-1} increased as compared to control or other treatments. Minimum and maximum weight of seeds pod^{-1} was (3.3 and 2.7) g for (P1H0 and P0H0), respectively.

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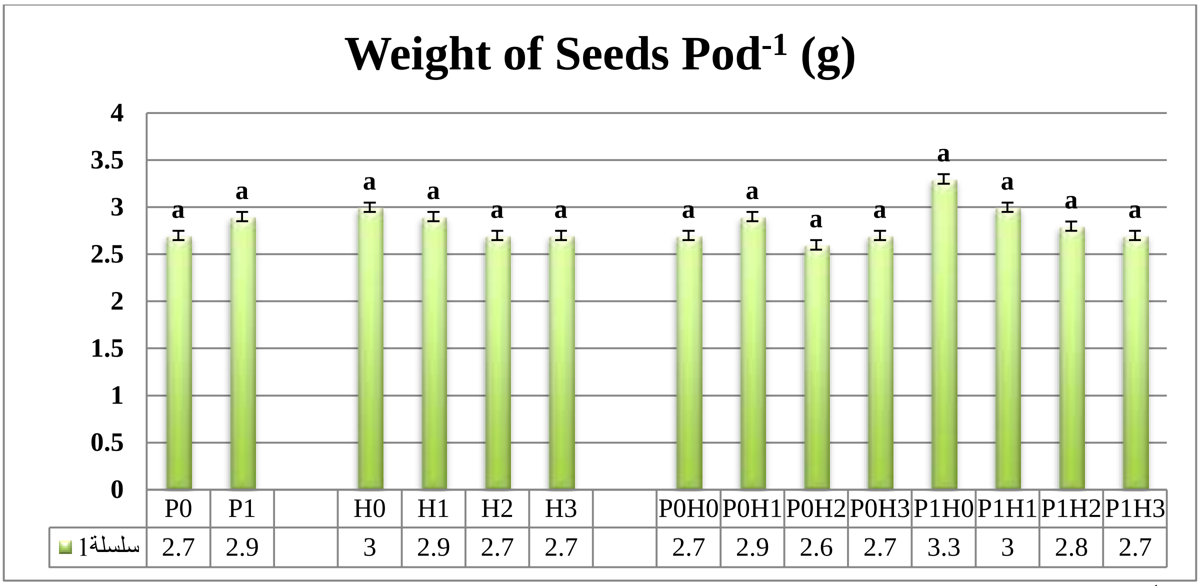

Figure 7: Single and interaction effect of pruning and humic acid on weight of seeds pod^{-1} of soybean.

Number of seeds plant^{-1}

Pruned and none-pruned plants have 266.4 and 267.3 seeds plant^{-1}, respectively. In controlled plots when no humic acid number of seeds plant^{-1} was 284.9 as compared to plots when humic acid was applied. However, in interaction of factors the greatest and lowest value for the number of seeds plant^{-1} which was 313.7 and 198.4 seeds plant^{-1} recorded by P1H0 and P1H3, respectively (Figure 8). This means that pruning enhanced the number of seeds plant^{-1}. In other studies [11] indicated that for both untreated and treated plants with humic acid, there were significant relationships between yield per plant and pods plant^{-1} and seeds plant^{-1}.

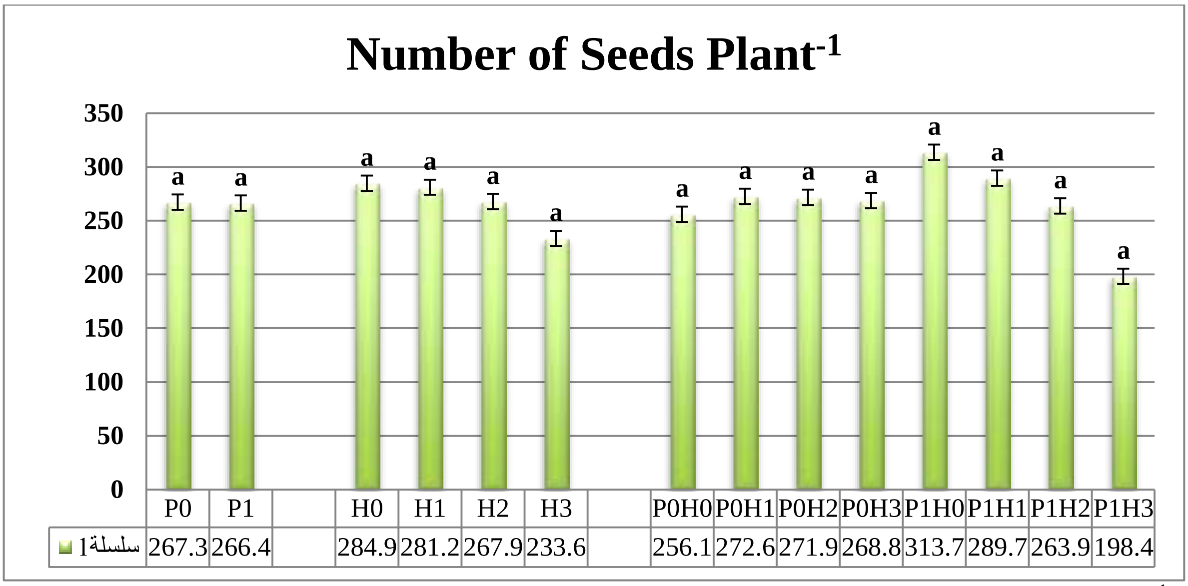

Figure 8: Single and interaction effect of pruning and humic acid on number of seeds plant^{-1} of soybean.

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Weight of seeds plant^{-1} (g)

Since this parameter is directly related to yield, therefore it's important to be increased. Pruning increased weight of seeds plant^{-1} to 28.1 g as compared with no pruning. Control treatment has 30.7 g of seeds while 23.9 g of seeds plant^{-1} when 1.5 g/ L water of humic acid was applied. Thus, in interaction of factors weight of seeds plant^{-1} increased to 38.2 g with P1H0 in comparison to P0H0 which was 23.17 g (Figure 9). [11] demonstrated that humic acid improved yield over time by improving pod retention without affecting seed weight. Whereas, nipping increased chickpea seed yield plant^{-1} [3,7].

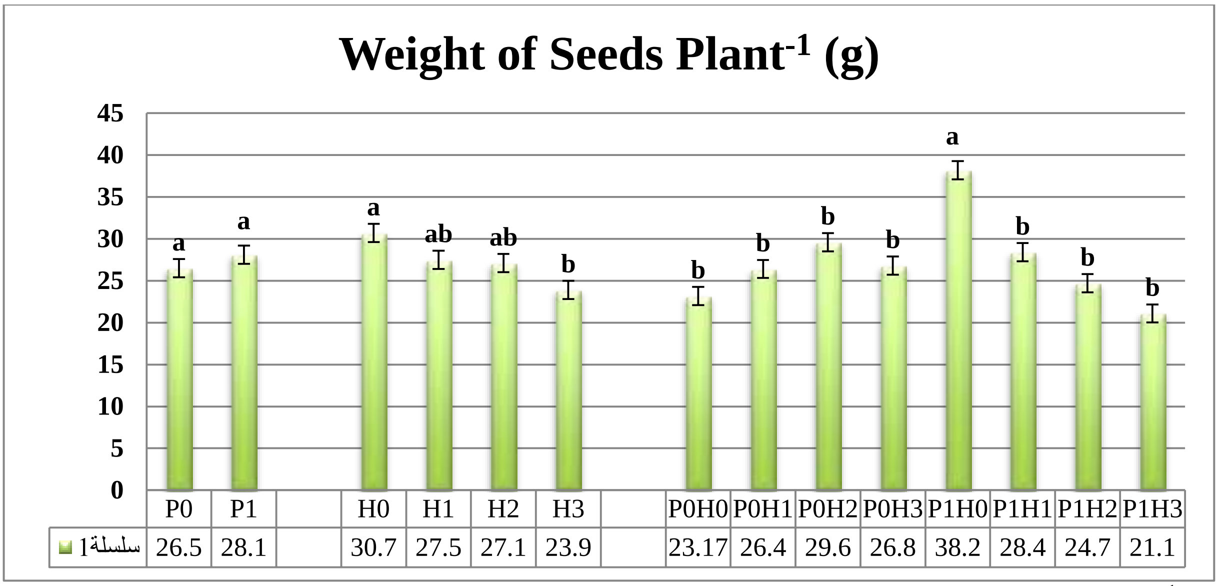

Figure 9: Single and interaction effect of pruning and humic acid on weight of seeds plant^{-1} of soybean.

100 seed weight (g)

100 seed weight was 10.1 g for P1 and 10.9 g for H0 as compared to other plots. In interaction of factors 100 seed weight was higher under P1H0 12.3 g as compared to P0H0 which was 9.5 g. On the other hand, lowest value for 100 seed weight was 8.9 g for P0H2 (Figure 10). Other researchers also found that pruning improved 100 seed weight in chickpea [14], and [17] in sesame.

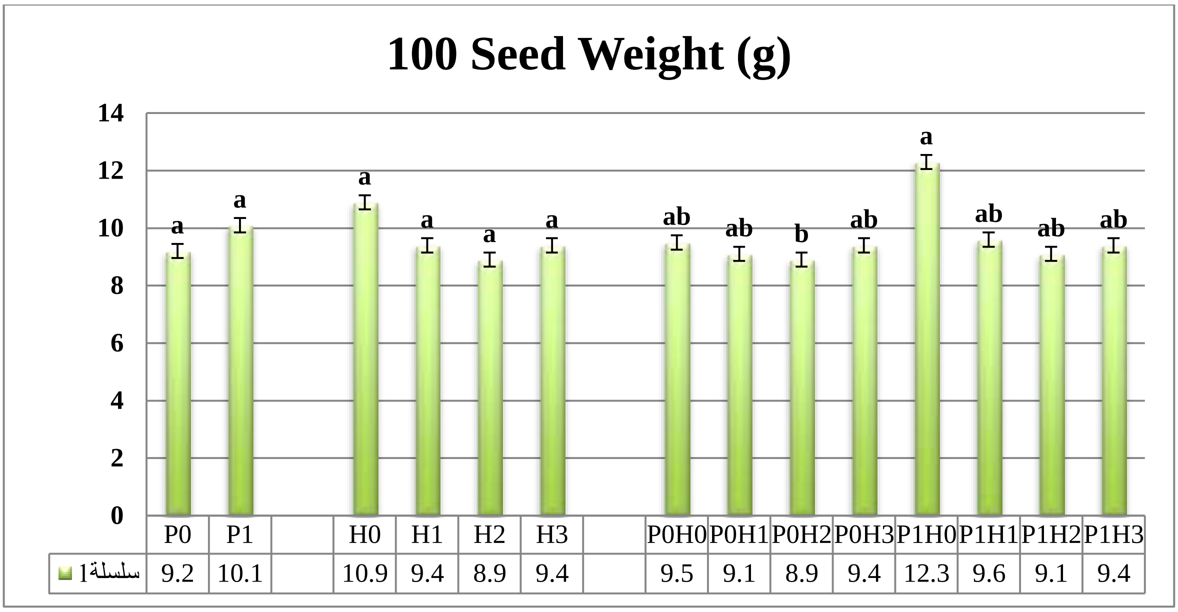

Figure 10: Single and interaction effect of pruning and humic acid on 100 seed weight of soybean.

Seed yield kg ha^{-1}

Figure 11 for seed yield exposed that highest and lowest value was by P1 and P0 (6967 and 6567) kg ha^{-1}, respectively. On the other hand, humic acid application not increased seed yield in which maximum yield was by control 7600 kg ha^{-1} in comparison to other treatments when humic acid applied. There more, in interaction of factors P1H0 and P0H0 have (9500 and 5700) kg ha^{-1} of seed yield, respectively. Pruning increased seed yield as compared to treatments with no pruning. These results in agreement with [12] reported improved yield in various legume species. Terminal bud pruning may boost soybean yield by expanding lateral branches and dispersing carbohydrates, leading to more pods and higher yield in sesame [17,21]. Significantly higher yield about 32 % is obtained with pruned chickpea plants [14].

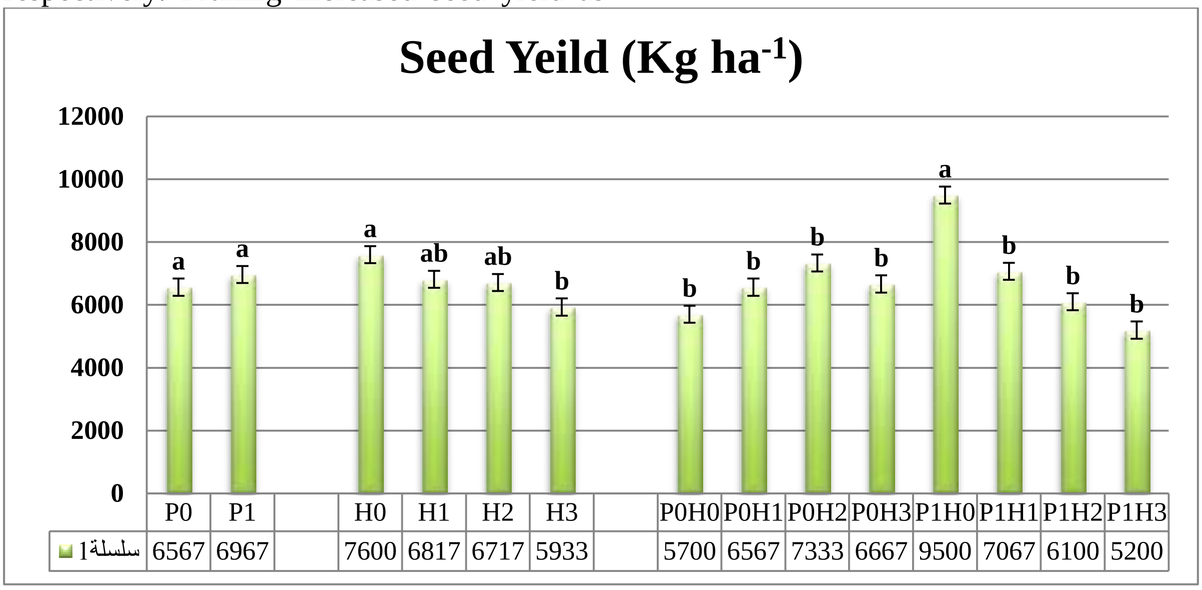

Figure 11: Single and interaction effect of pruning and humic acid on seed yield of soybean.

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Conclusion

The results of this current study revealed that pruning and foliar applied humic acid both increased the growth and yield of soybean plant, in which foliar application of humic acid enhanced plant height and lowest pod height. In addition, pruning increased number of branches plant^{-1} and this means more number of pods plant^{-1} and more seeds plant^{-1} which in turn increases the seed yield kg ha^{-1}. In the interaction of factors number of seeds pod^{-1} increased in plots of P1H2 and P1H3. Therefore, it's important for soybean plant which and when agronomic practices should be applied for increasing growth and yield of the crop.

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