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RESEARCH ARTICLE

Response of Some Varieties of Faba beans (Vicia faba L.) for Chemical mutagen and Regulator Growth on Yield, Yield Components and Protein Content

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Abstract

A field trial conducted at the Experimental Station of the Field Crops Sciences-Department-College of Agriculture, University of Baghdad, during 2010 to study the effect of mutagen nitrous acid, Gibberellic acid, Scarification and soaking in water on seed yield, yield components and quality of three Faba bean varieties(Zaina, Aguadulce and Local). To find out the effect of these factors in different yield,yield components and protein yield and how they respond to the varieties of these factors. Factorial experiment was used according to randomized complete block design RCBD with three replicates to each treatment. The results showed that, soaking seeds in mutagen nitrous acid for 24 hours gave a significant increases of number of branches/plant 12.40, number of pods/plant 29.66, seed weight rate 1.5144(g), seed yield 6629 (kg/ha) and protein yield 1362.7 (kg/ha) compared as a mean of varieties with other treatments. The highest average number of seeds/ pod was 4.456 and 4.489 when seeds soaked in Gibberellic acid at 100,50 ppm, respectively. Local variety was superior in most yield components. significantly showed highest interaction between varieties and treatments 7577(kg/ha), Zaina variety gave the highest seed yield 7577(kg/ha) and protein yield, 1433.1(kg/ha) when soaking seeds in mutagen nitrous acid for 24 hours.

Introduction

Nitrous acid has been shown to deaminate nucleobases *in vivo* in DNA, and investigated the pathway of reverse mutations induced with nitrous acid in *Saccharomyces cerevisiae*, mutation frequencies induced with nitrous acid[1]. Sakugawa and Cape [2] studied the effects of atmospheric nitrous acid on the physiological of pine trees. They found that exposure to HONO over 2 months affects photosynthesis and nutrient status of pine trees, by an increasing in the carbon to nitrogen ratio (C/N). Previous studies have described the growth-modulating properties of NO and its interaction with auxin in modulating root growth and developmental processes [3]. Extensive research has shown that NO is involved in the promotion of seed germination, photomorphogenesis, mitochondrial activity, leaf expansion, root growth, stomatal closure, fruit maturation, senescence, and iron metabolism, NO also is important for defense response, playing key roles in the activation of defense genes (e.g., pathogenesis-related protein 1) [4]. Plant growth regulators (PGRs) are organic compounds, other than nutrients, that modify plant physiology .PGRs, called biostimulants or bioinhibitors, act inside plant cells to stimulate or inhibit specific enzymes or enzyme systems and help regulate plant metabolism, They normally are active at very low concentrations in plants [5].One of the important function of gibberellins is synthesis of the α-amylase enzyme in the aleurone layer surrounding the endosperm of cereal grains during germination. This enzyme hydrolysis starch to form simple sugars which are then translocated to growing embryo to provide energy source [6].keller and Bellucci [7] showed an increased in the number of pods /plant 27% and seeds yield 40% when sprayed faba beans var. Herzfryza with GA_3 at $3x10^{-4}$,$3x10^{-4}$ M . Barratt [8] found that the use of gibberellins lead to increased the seeds yield of (*vicia faba* L.) due to increased seed weight by enhance the rate of photosynthesis process during the period of full seeds. Attiya *et al.*[9] found that foliar application of GA_3 (200ppm) on five faba bean cultivars reduced

flower abortion by 17%, pod abortion25%,and increase plant height 24%,number of branches 16%, vascular band 20%,stem diameter 25%,total dry weight 15%, seed yield 42% and harvest index 13%. They concluded that seed yield of local cultivars could be increased, by applying GA_3 200ppm before flowering. Scarification of seed is the process of scratching the seed coat to allow moisture to enter the seed, many members of the pea family (legumes) benefit from scarification. Suthar *et al.* [10] found that mechanical scarification with needle, sand paper and mortar-pestle methods shows the maximum percentage of seed germination(72-78%) in *solanum nigrum* Linn, while fresh seeds shows 52% germination**.** Ates [11] found that mechanical scarification, and chemical scarification improved the germination ratio of clover by 80%. Seeds soaking in water of leguminous seeds is a classical method in agriculture. The rupture of the coat wall allowing water to permeate the seed tissues causing physiological changes and subsequent germination of embryo[12,13 and14]. Studies that dealt with the effect of mutagen nitrous acid on faba bean crop were a few, so this study was conducted to illustrate how nitrous acid can affect productivity and protein yield of three varieties of faba bean in conjuction with Gibberellin and scarification and the possibility of use in programs development productivity of the crop.

Materials and Methods

A field trial was conducted in the Experimental Station of the Field Crops Departments , Collage of Agriculture in Adu-Ghraib, University of Baghdad, during winter (2010-2011), The experiment was arranged in Randomized Complete Block Design(RCBD) with three replicates for each treatment. The area of experimental unit was 10 m^2, contain five lines, space between lines were 0.70m and between plants was 0.30m, with planting densities 47619 plant/ha. Seeds sowing at 21 October . The fertilizer Superphosphate(P_2O_5 20%) at a rate of 80(kg/ha) was added to the soil before seeds sowing[15]. Also ,nitrogen fertilizer (N 46%) at rate of 50 (kg ha^{-1}), was applied before the first irrigation in a form of urea[16]. The other required culture practices for growing faba bean were followed as recommended. Nitrous Acid preparation: the acid was an unstable ,weakly acidic compound and decomposes rapidly, therefore it has been prepared immediately in the form of cold. It includes tow mixtures, the first was prepared by adding 600 ml of HCl slowly to 600 ml of distilled water, in ice bath to get mix, its volume of 1200 ml, and the second mixture prepare by diluting 160 g of sodium nitrite $NaNO_2$ with 400 ml of distilled water. Then first mixture was added to the second mixture in ice bath, to get nitrous acid solution as following equation: HCl + $NaNO_2$ ------- HNO_2 + NaCl. Seeds were soaked in nitrous acid for 24 hrs and kept in ice bath[17].

In this study, the seeds were treated by using nitrous acid, Gibberellin and scarification as following:

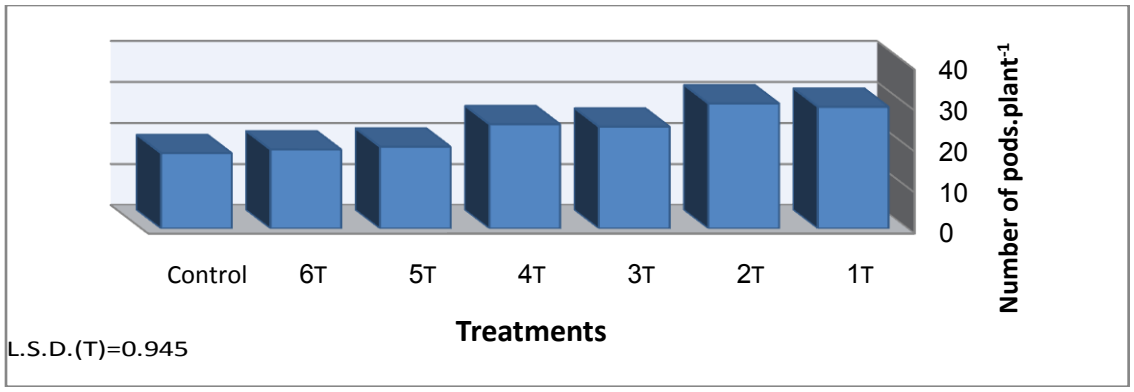
T1: Seeds were soaked in nitrous acid for 24 hours and kept in ice bath.
T2: Seeds were soaked in nitrous acid for 12 hours and kept in ice bath .
T3: Seeds were soaked in gibberellic acid (100 ppm) for 24 hours and kept in room temperature .
T4: Seeds were soaked in gibberellic acid (50 ppm) for 24 hours and kept in room temperature.
T5: Seeds were scarified by knife for making a tiny cut through the seed coating .
T6: Seeds were soaked in tap water for 24 hours and kept in room temperature.
Control: Dry seed planted directly .

Yield and yield components:

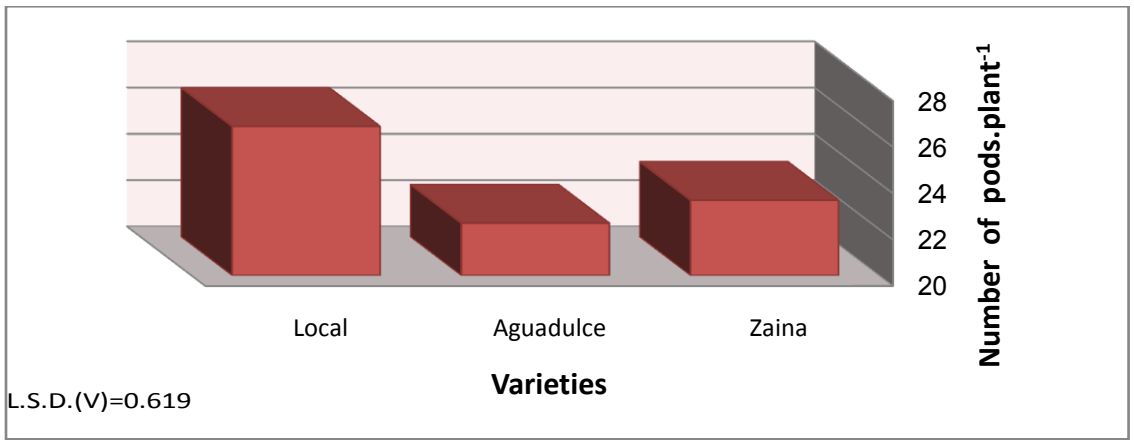
Five plants were randomly chosen in each plot, from three inner rows the following characters were recorded :- Number of branches /plant , number of pods/plant, number of seeds/pod, seed weight rate (gm): 50 dry seeds were randomly counted and weighted, then the average was taken., Seeds yield (kg/ha): Plants of the inner rows were harvested from each experimental unit and the weight of seeds were taken, on the basis of the experimental unit area the seed yield was converted to kg per hectare., protein percentage and protein yield (kg/ha) was calculated by multiplying the protein percentage by seed yield (kg/ha).

Results and Discussion

Number of pods per plant as an important for seeds yield component of faba bean. Variations in pods number among treatments were significantly for both T2(seeds soaked in nitrous acid for 12 hours) and T1(seeds soaked in nitrous acid for 24 hours) average 30.48 and 29.66pods/plant, respectively compared to control 18.37pods/plant (Fig.1). This increase in pods number might be due to nitric oxide, NO controls the floral induction, and production floral buds[18], also NO operates the auxin signals transduction, auxin caused reduction in the flower abscission percentage and then production the highest number of pods setting[19]. The results showed that Local variety had the highest number of pods per plant 26.44 compared to Zaina variety 23.25 and Aguadulce variety 22.26 (Fig.2), varieties differences for this character were also recorded by [20]**.** Interaction between (Local X T2) gave significantly highest number of pods per plant was 35.55, while (Zaina X control) had lowest interaction 18.22(Fig.3).



Figure(1) Effect of nitrous acid, gibberellic acid, scarification and soaking in water on number of pods/ plant.



Figure(2)Number of pods/ plant of three faba bean varieties.

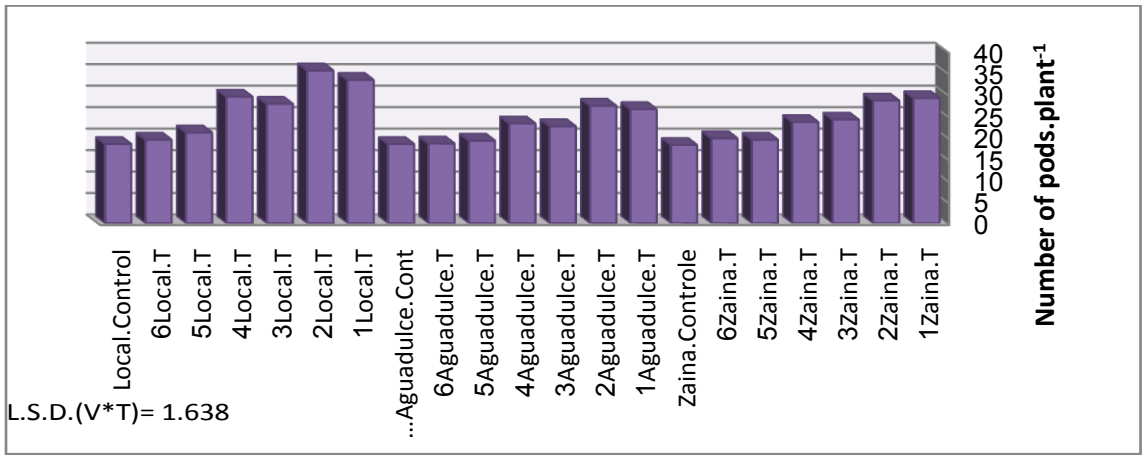
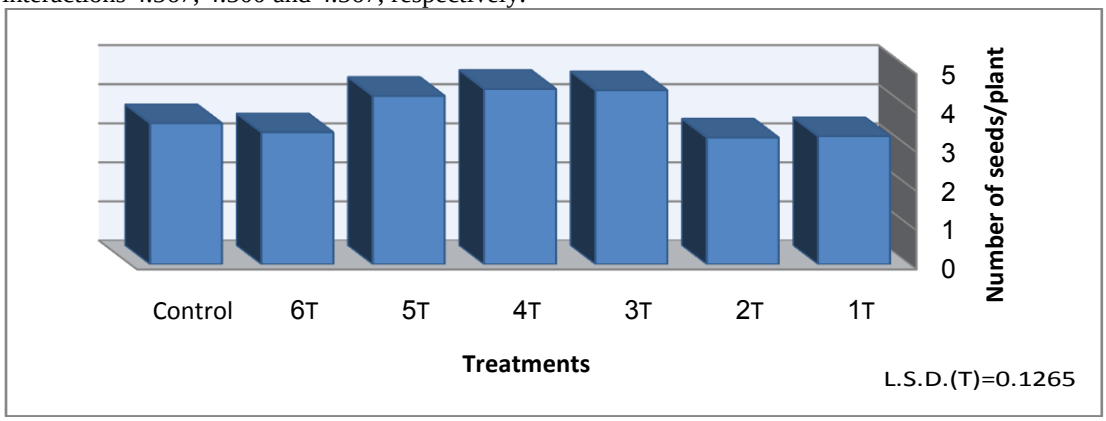


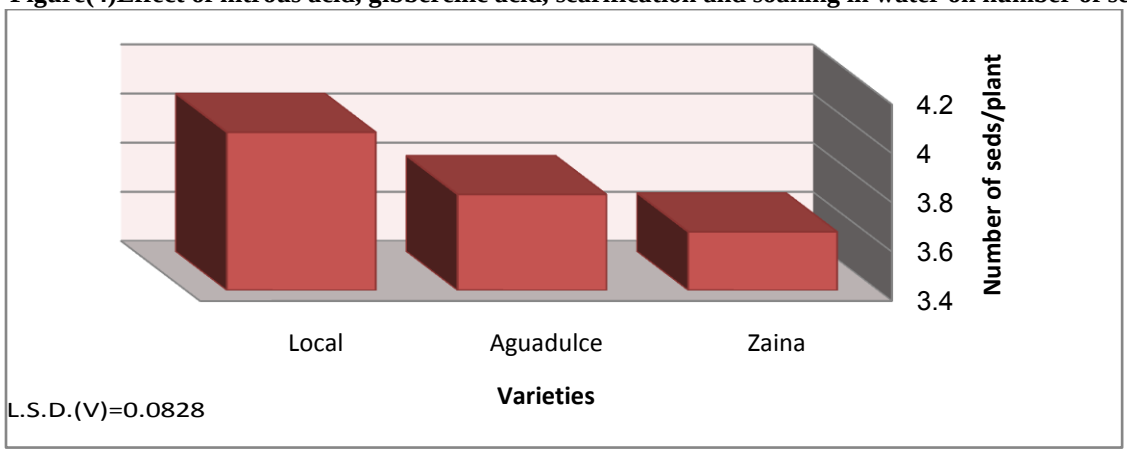
Fig.(3)Effect of the interaction between varieties and treatments on number of pods/plant.

The number of seeds per pod reflects a number of fertilized ovules which grow to seeds. Results recorded in (Fig.4) show that T3(seeds soaked in Gibberellic acid 100ppm) and T4(seeds soaked in Gibberellic acid 50ppm) revealed significant increase in number of seeds per pod 4.456 and 4.489, respectively compared to less value of seeds number T2(seeds soaked in nitrous acid for 12hours) 3.244. In order to increase the number of seeds per pod, frequency of ovules fertilization should be increased. GA_3 increased the number of ovules per pod ,and reduced the number of seed abortion[9,,21,22,23]. Significant differences between varieties were observed in (Fig.5), Local

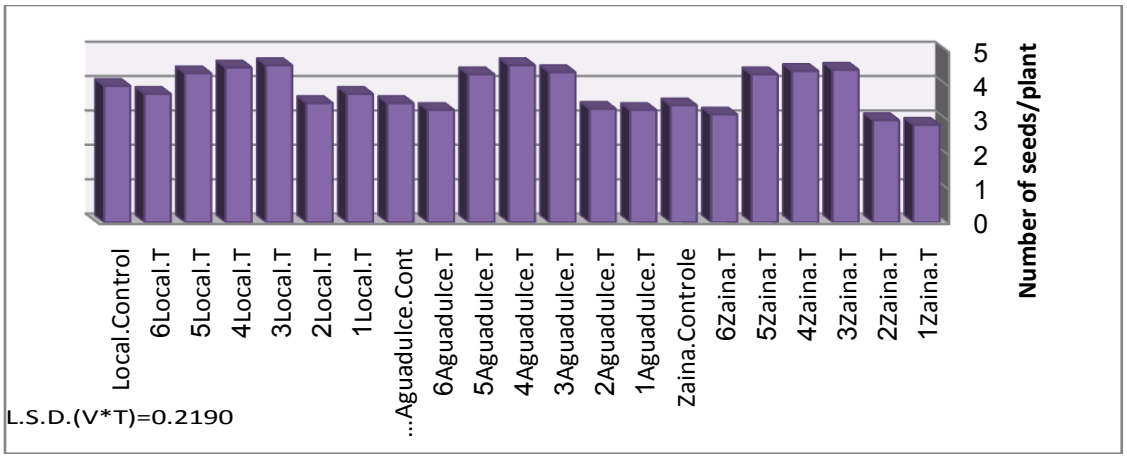
variety had highest average number of seeds per pod 4.043 while Aguadulce and Zaina varieties were 3.790 ,3.638, respectively. Combined results presented in (Fig.6) showed that the interaction between varieties and treatments had significant effect on number of seeds/ plant, (Local X T3) , (Local X T4) and (Aguadulce X T4) gave highest interactions 4.567, 4.500 and 4.567, respectively.



Figure(4)Effect of nitrous acid, gibberellic acid, scarification and soaking in water on number of seeds/plant.

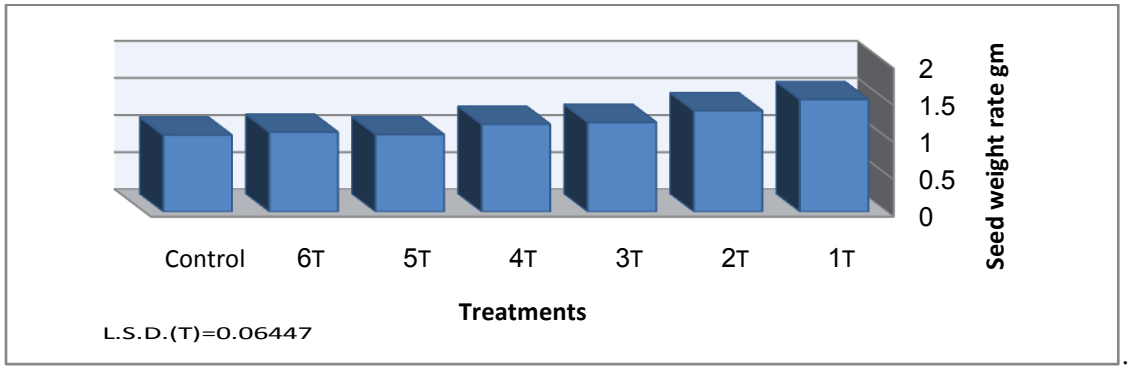


Figure(5) Number of seeds/plant of three faba bean varieties.

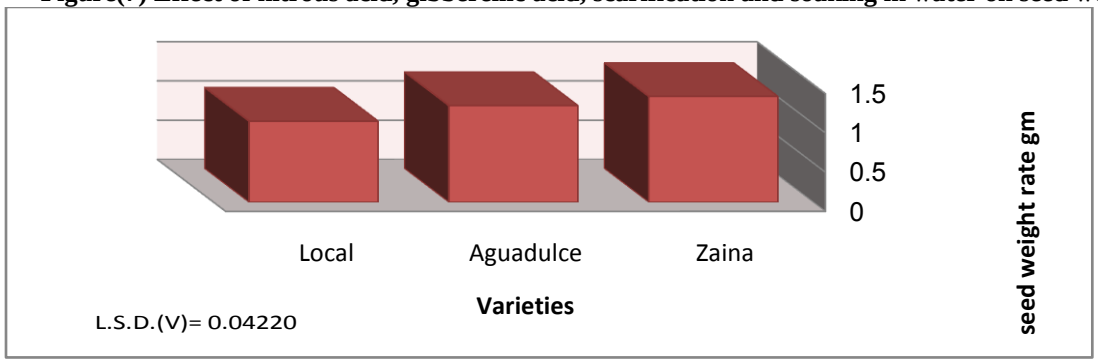


Figure(6)Effect of the interaction between varieties and treatments on number of seeds/pod.

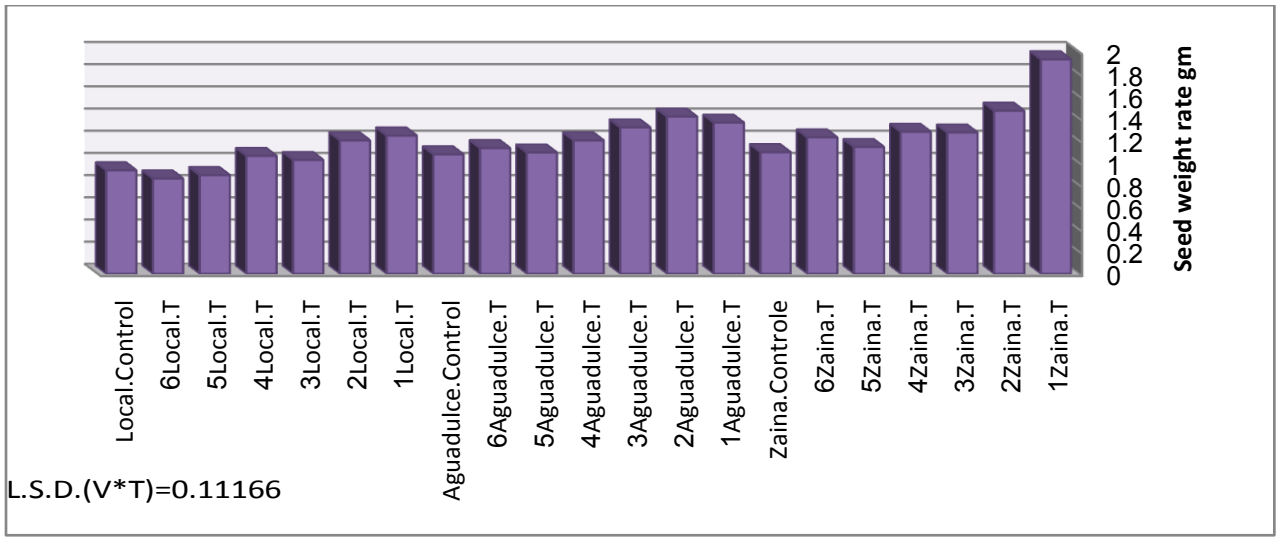
Data showed that T1(seeds soaked in nitrous acid for 24hours) caused significant increase in seed weight average 1.5144 g (Fig.7) whereas treatments T5 and T6 did not differ from control which gave a lowest rate of seed weight 1.0356gm. Increasing the rate of seed weight correlated adversely with the number of seeds\Pod, the greater number of seeds/pod increased competition for nutrients between them, that's leading to nutrients distribution to a large number of seeds, so the seed weight will decreases , These results were confirmed[24]. Results presented in (Fig.8) showed that there were significant differences between varieties, Zaina variety gave heaviest seed weight 1.3467gm, than Aguadulce and Local varieties 1.2295, 1.0319gm, respectively. Those varietal differences were in agreement with[25]. Data presented in (Fig.9) showed that there were significant interaction between faba bean varieties and treatments, (Zaina X T1) had heaviest seed weight 1.9333g compared with least seed weight interaction (Local X T6) 0.8600g, this interaction because Zaina variety and T1 had heaviest seed weight, as well as, interaction between them high.



Figure(7) Effect of nitrous acid, gibberellic acid, scarification and soaking in water on seed weight rate.

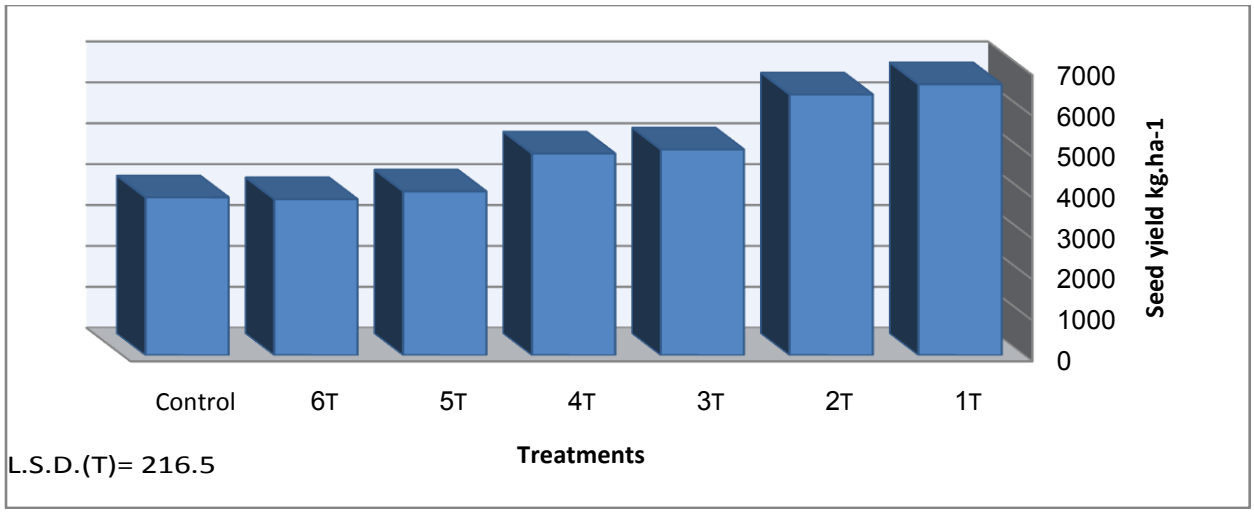


Figure(8) Seed weight rate of three faba bean varieties.

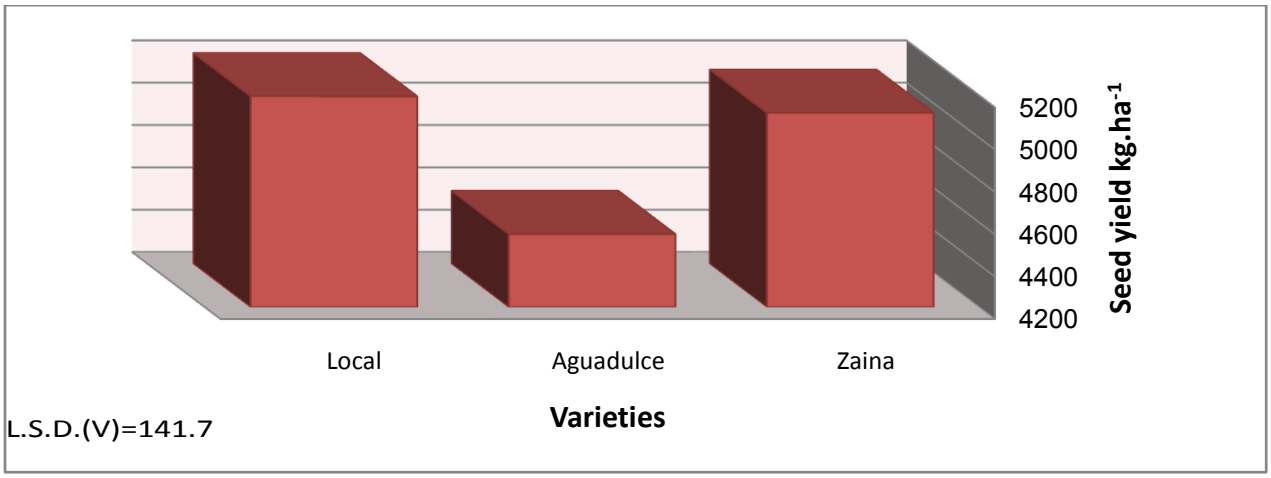


Figure(9)Effect of the interaction between varieties and treatments on seed weight rate.

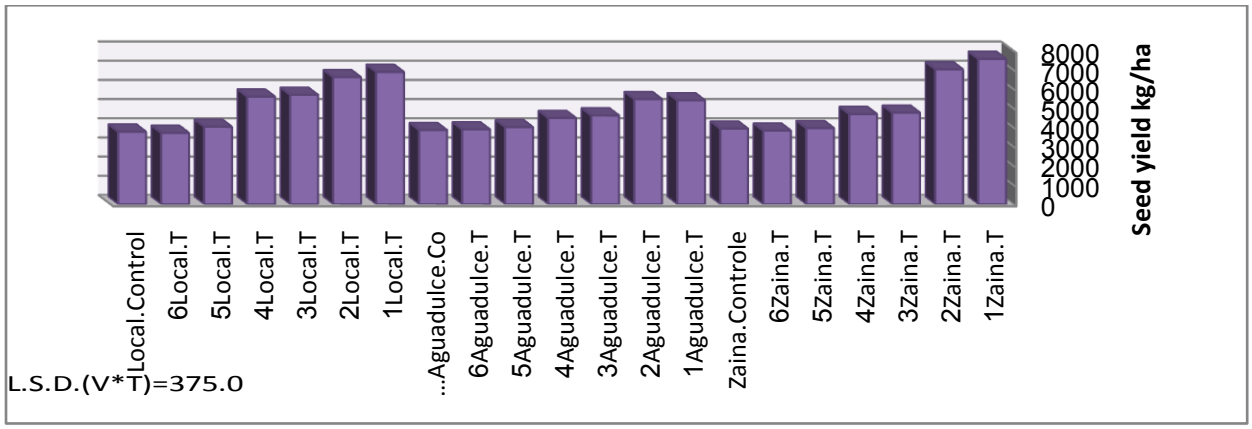
Seed weight are the most important factors in faba bean to decide seeds yield[8,26]. The effects of treatments on seeds yield are shown in (Fig.10), T1(seeds soaked in nitrous acid for 24hours) had a significant effect on seeds yield 6629(kg/ha) compared with less value of seeds yield T6(seeds soaked in water) 3818(kg/ha). The increase in seeds yield recorded in T1 could be a reflection of the effect of nitrous acid on growth and development, which provided a chance to the plants to produce more flowers, pods and hence more seeds , increase the number and weight of pods. (Fig.11) indicated that seed yield differed significantly between varieties due to genetic character, the greater seed yield was obtained by Local and Zaina varieties 5196, 5118 (kg/ha), respectively. This result could be due to the high adaptation of this genotypes to the environmental conditions, these results of genetic variation between varieties are in agreement with finding [27].(Zaina X T1) significantly showed highest interaction between varieties and treatments 7577(kg/ha), while (Local X T6) was lowest interaction between varieties and treatments 3719 kg/ha (Fig.12).



Figure(10) Effect of nitrous acid, gibberellic acid, scarification and soaking in water on seeds yield.

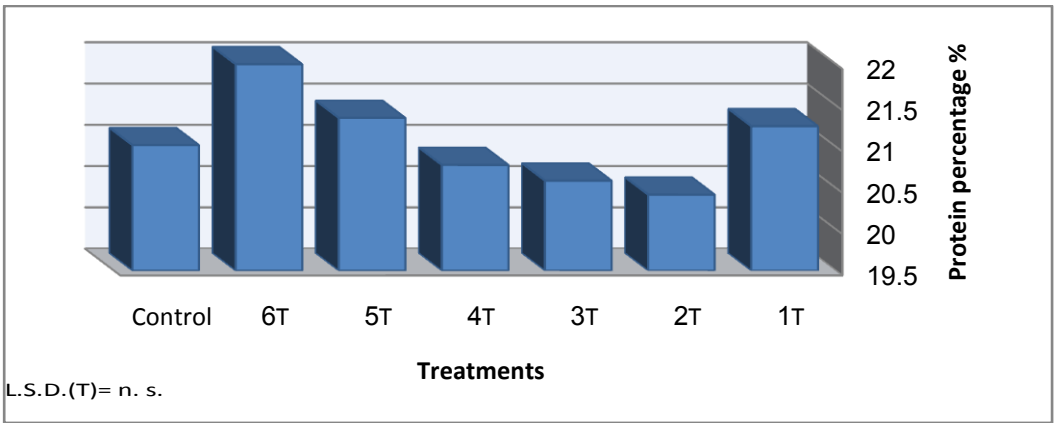


Figure(11) Seeds yield of three faba bean varieties.

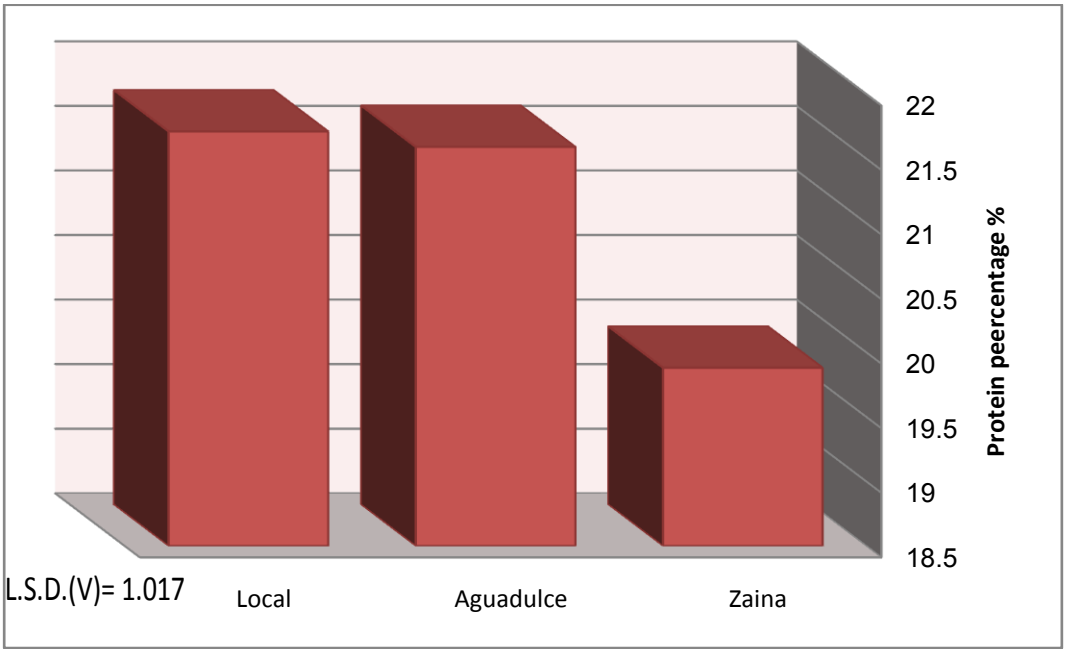


Figure(12) Effect of the interaction between varieties and treatments on seeds yield.

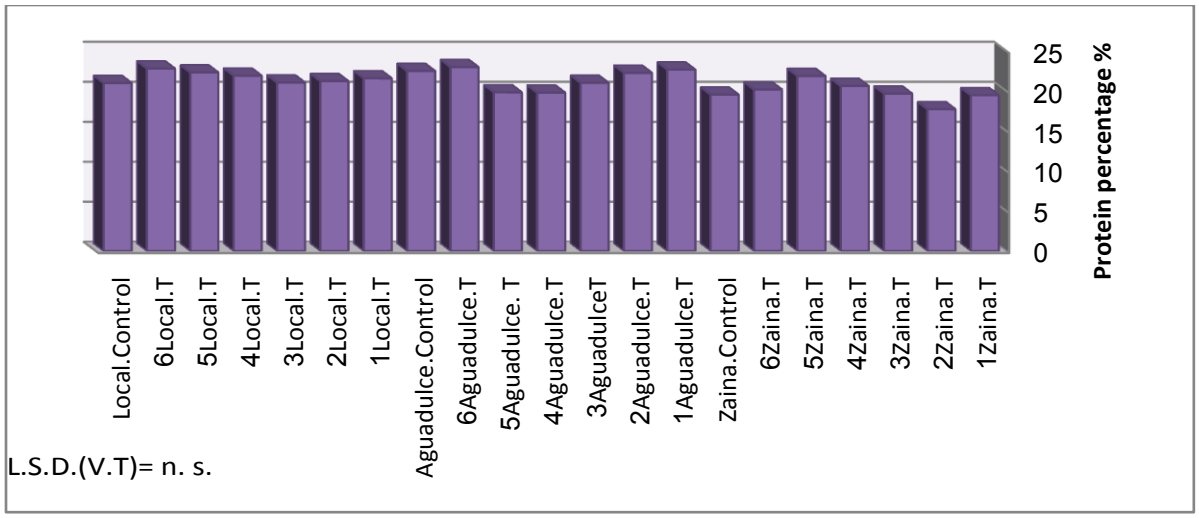
The total protein content in seed is the character that plays an important role in the nutritional value of the crop. As shown in (Fig.13,15) protein percentage was not affected by different treatments. There is also no significant differences between the interaction between varieties and treatments .Results in (Fig.14) indicated that there were significant differences between varieties, Local and Aguadulce varieties gave highest protein percentage the differences was not significantly between them 21.71 and 21.59%, respectively. these results are in agreement with those obtained[24,28]. while Zaina variety gave lowest protein percentage 19.88% .Protein content in seeds is highly heritable, heritability values were reaching to 99% which is difficult to be affected by environmental factors[25], Variations in protein content among varieties of faba bean were observed[29,30 and31].



Figure(13)Effect of nitrous acid, gibberellic acid, scarification and soaking in water on protein percentage.

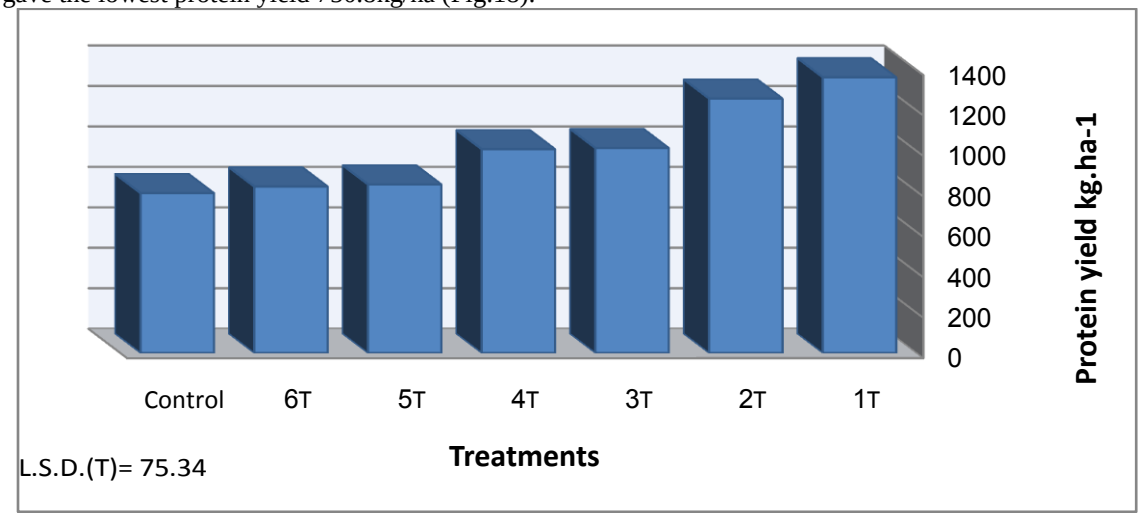


Figure(14) protein percentage of three faba bean varieties.

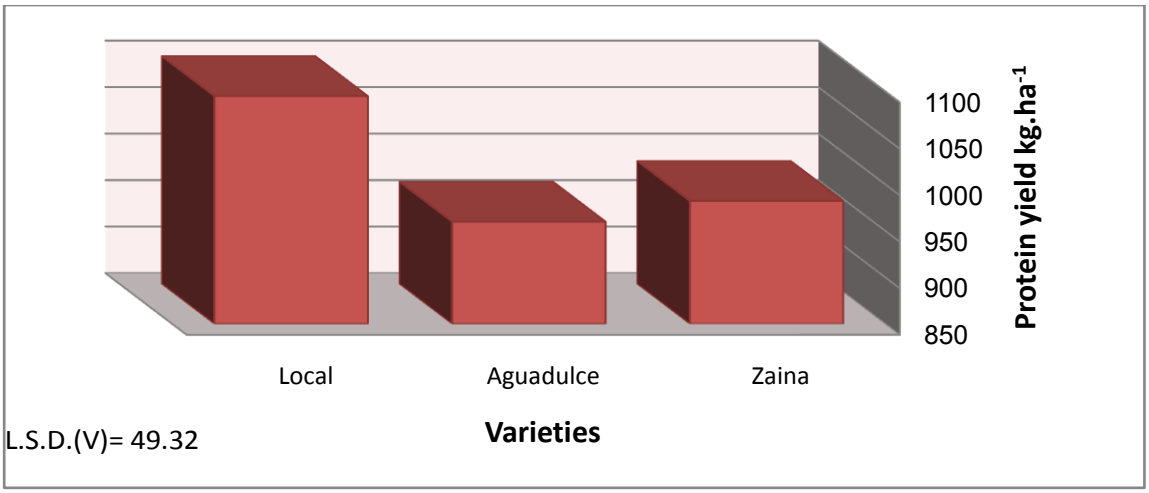


Figure(15)Effects of the interaction between varieties and treatments on protein percentage.

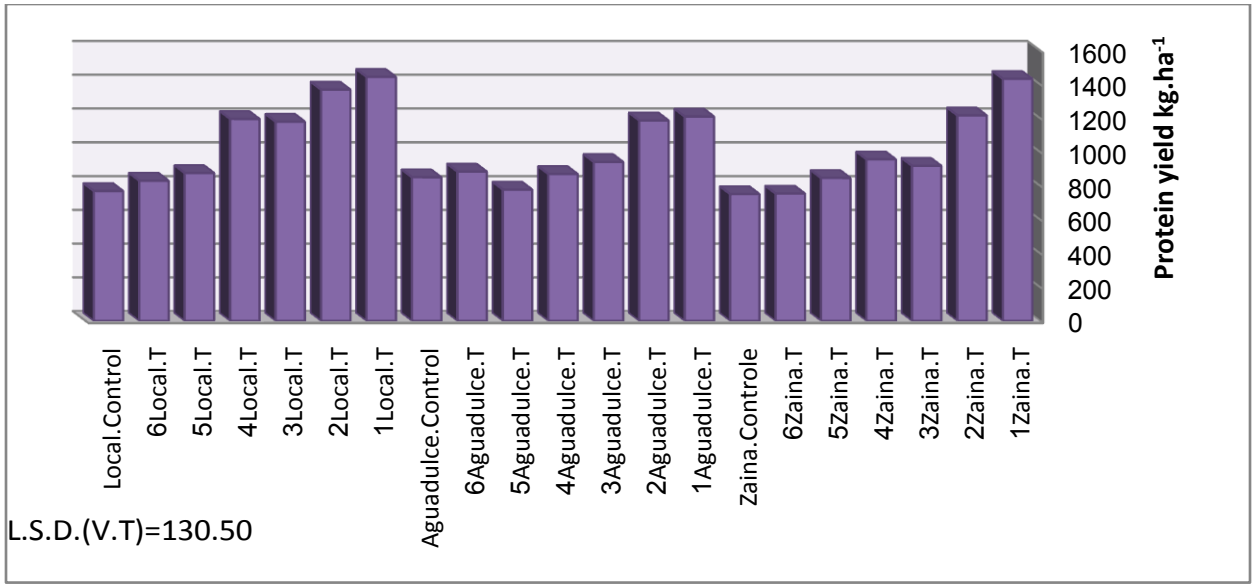
Significant differences were detected between treatments(Fig.16), T1(seeds soaked in nitros acid for 24hours) had highest value of protein yield 1362.7 (kg/ha) compared to control 790(kg/ha), The increase in protein yield mainly attributed to the increase in seeds yield (kg/ha)(Fig.10), under the same condition, the optimal way to increase protein yield per hectare is to increase seeds yield, These results were agreements with[32]. Significant differences were observed among varieties especially for Local variety which showed the highest of protein yield 1094.9(kg/ha) , it followed by Zaina and Aguadulce variety 982.2 and 959.9(kg/ha), respectively (Fig.17). This increasing is related to the increase seeds yield per hectare and protein percentage %, of Local variety, so protein yield high , these differences between varieties in agreement with the results of[24,32]. Interaction between varieties and treatments were significantly different, (Local X T1) and (Zaina X T1) gave highest interaction were 1444.9 and 1433.1 (kg/ha), respectively. Whereas (Zaina X T7) gave the lowest protein yield 750.8kg/ha (Fig.18).



Figure(16) Effect of nitrous acid , gibberellic acid, scarification and soaking in water on protein yield kg/ha.



Figure(17) Protein yield of three faba bean varieties.



Figure(18) Effect of the interaction between varieties and treatments on protein yield.

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