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Influence of row density and foliar humic acid application on growth parameters, yield and yield components of Niger (Guizotia abyssinica Cass.) in Erbil

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ABSTRACT

A field experiment was undertaken during the Autumn growing season of 2020 at the experimental farm of Qalamurtga - Erbil to study the effect of three Niger cultivars (Bengalnuglue, Karal and Animax, two plant geometry (45 and 60)cm between rows and three levels of humic acid (0, 350 and 700 mg L^{-1}) on Niger (*Guizotia abyssinica* Cass.) growth, yield and its component using factorial RCBD experimental design with three replicates. The results indicated that Animax cultivar, 60 cm plant spacing and 700 mg L^{-1} humic acid foliar application obtained the highest value of chlorophyll content (SPAD) and number of capita plant $plant^{-1}$ with values of (40.31, 39.98 and 40. 52) and (30.49, 27.88, 27.91) respectively, while seed yield values (278.34, 301.30 and 282.73) kg ha^{-1} for Animax cultivar, 45cm distance between rows and spraying of 700 mg L^{-1} humic acid respectively. The combination between Animax cultivar – 45cm between rows -700mg L^{-1} humic acid ($C_3 \times G_1 \times HA_2$) recorded the highest value for seed yield which was 360.41 kg ha^{-1}. The interaction treatment ($C3xG_2xHA_2$) recorded the highest value of primary and secondary branches, leaf area and leaf area index, number of capita $plant^{-1}$ and weight of 1000 seeds (g) with the values (19.66 branch $plant^{-1}$, 30.00 branch $plant^{-1}$, 49.01 cm^2, 0.37, 37.70 capita $plant^{-1}$ and 2.70g) respectively.

1.Introduction

Oilseed crops are the second most important agricultural commodity in the world, after grains. The production of oilseeds is essential to the agricultural economies of many nations, and the present agro-ecological conditions in Kurdistan are conducive for the production of more than oilseeds (edible and non-edible) (Muhammadamin, 2022).

Niger (*Guizotia abyssinica* Cass.) is one of the most significant oilseed crops in the world. The genus Guizotia is a member of the Asteraceae family, it is a short day, photoperiod sensitive and cross-pollinated plant, mainly grown as spring and autumn crop depending on onset of north-eastern monsoon (Getinet and Sharma, 1996). Niger is mainly used for extraction of oil. Its oil is mainly used for culinary purposes, manufacture of cosmetics, soaps, paints, lighting, lubrication. Its seed are used as bird feed (Abdulla and Khalaf, 2014). Nonetheless, due to its good economic value and possibility of exporting its seeds, it is a valuable oilseed and has therapeutic qualities. (Adarsh et al., 2014).

One of the most notable characteristics of this crop, it produces a satisfactory seed yield even in poor growing conditions and requires little care, expenditure. In addition, Niger crop has a high economic values and its seed is possible for exporting, which contains (35- 40 %) oil, 20 % protein, (12-18 %) soluble starch, 10 % crude fiber, (4-5.8 %) ash, fatty acid which included (75 -80 %) linoleic acid, (5- 8 %) oleic acid and (7-8 %) palmitic and stearic acid.

Due to the fact that the production and productivity of oil seed crops are dependent on different agro-climatic conditions, a number of physiological processes, which are influenced by both genetic composition and environmental factors, are responsible for determining the production potential of different cultivars. (Giri and Beura, 2020).

plant geometry (the area covered by each plant) is one of the most important objectives in agriculture to determine the optimal plant density for producing the required yield (Purcell et al., 2002). Farmers altered plant density and row spacing to get the goal of increasing the amount of light that was absorbed by the plants for increasing plant productivity (Maddonni et al., 2001). As to generate a yield comparable with the yield produced by optimal plant density, which is the reason for their popularity among researchers and farmers. One of the major necessities in crop planning for high yield and quality achievement is the evaluation of plant nutrition systems, because of the problems such as high soil CaCO3 content, low organic matter, and severe deficiency of micronutrients (Paungfoo et al., 2012).

A vital important component of the bio liquid complex is humic acid, it has a broad variety of favorable impacts on agricultural yield as a consequence of its molecular structure, which is unique, it also stimulates the growth of microflora populations in soils. Although humic acid is not a fertilizer, it may be used in conjunction with fertilizer to enhance its effectiveness (Mackowiak et al., 2001).

Since available knowledge on this crop in Iraq and Kurdistan and the aforementioned elements is limited or there is no-investigations on it, the current study was done to investigate the effect of Niger cultivars, plant density, humic acid foliar and their interactions on growth, yield and its components in an autumn season planting study in Kurdistan region.

2.MATERIALS AND METHODS

Afield experiment was conducted in Erbil governorate at Qalamurtga farm (Latitude 36^{o} 20$^{¢}$ 53.81" N, altitude 44^{o} 06$^{¢}$ 20.76"), during autumn growing season of (2020) to investigate the effect of plant density, levels of humic acid spraying and their interactions on the phonological traits, yield, and yield component of three Niger cultivars. The representative soil sample was taken from various locations of the field at (0-30 cm) depth after tillage process. These samples were air dried, sieved using 2 mm sieve, then packed and stored for analysis, Table (1).

A factorial experiment was done utilizing Randomized Complete Block Design (RCBD) with three replicates, the field was divided into three blocks, the plot dimensions were (2m x 1m) with five rows per plot in the case of first geometry (45cm) and four rows in the second geometry (60 cm) between rows while 20 cm distance between plants to achieve (125.000 and 100.000 plants per hectare), respectively. The distance between experimental units within the block was 0.5 m, while the space between blocks was 1m. The studied factors were three Indian Niger cultivars, which imported from research center of Suleimani governorate:

C_1 = Bengalnuglue cultivar.

C_2 = Karal cultivar.

C_3 = Animax cultivar.

The second factor included two plant density: G_1 = 45 cm distance between rows which included 25 plants plot $^{-1}$ and G_2= 60 cm distance between rows which included 20 plants plot $^{-1}$. The third factor represented humic acid application encompassed the following level which applied in split of 10 days' interval. HA_0 = Control, HA_1 = 350 mg L^{-1}. HA_2 = 700 mg L^{-1}. Required irrigation method was applied during the experiment, temperature data, sunshine and humidity were shown in Figure 1.

Table 1: Some selected physical and chemical properties for the upper 30 cm of the soil at the experimental site.

Soil Property		Unit	Average value
Particle size distribution	Sand	g kg^{-1}	145
	Silt		309
	Clay		546
	Textural Name		Clay
pH			7.64
ECe		dSm^{-1}	0.30
Organic Matter		g kg^{-1}	5.0
Calcium carbonate equivalent			0.18
Major nutrient content	Total Nitrogen	g kg^{-1}	13
	Available Phosphorus	mg kg^{-1}	4.70
	Available K	Cmol $_c$ $liter^{-1}$	1.00

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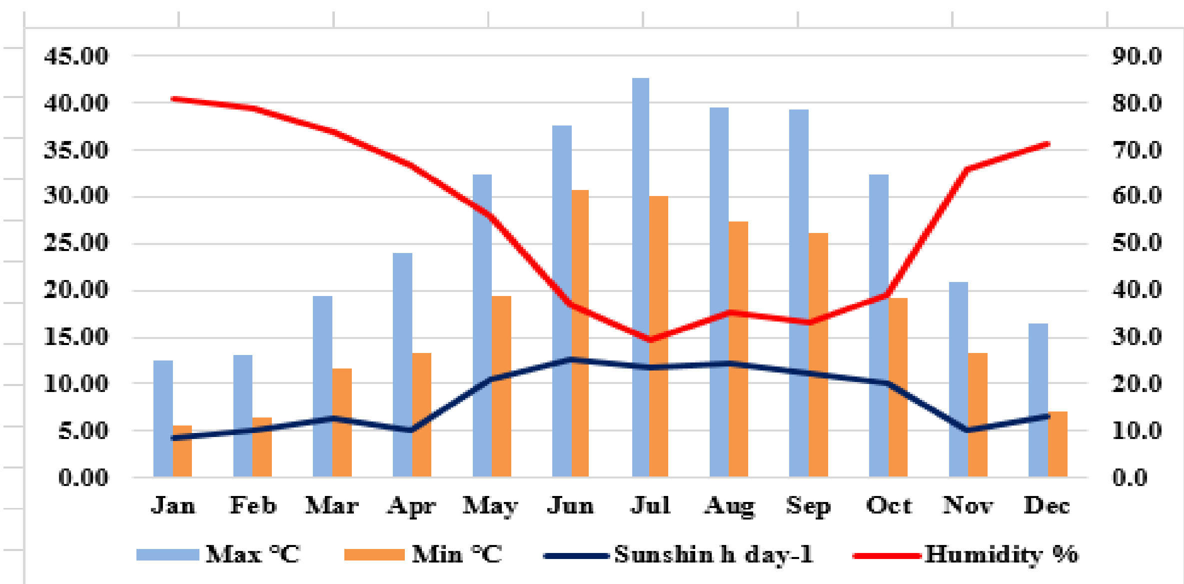


Figure 1. Meteorological record for Qalamurtga field during growing season of 2020.

Niger Trait Determination

Vegetative Growth characteristics

1. Plant height (cm).
2. Number of primary and secondary branches plant^{-1}.
3. Leaf area (cm^2 plant^{-1}) measured by types of image (J) software (Easlon and Bloom, 2014)
4. Leaf Area Index:

The leaf area index calculation was done by an App for measuring grapevine canopy architecture (Viticanopy application) for 15 leaves selected randomly.

$$\textbf{Leaf area index} = \frac{\text{plant total leaf area}}{\text{Average land area occupied by plant}}$$

5. Chlorophyll Content (SPAD) Index:

Leaf chlorophyll contents were measured using Minolta SPAD chlorophyll meter as a hand-held device At LEAF CHL STD, PN: 0131-010, 02224400804, FT Green LIC-Wilmington(DE), Assembled in USA, has been used for recording an index of chlorophyll concentration in leaves before blooming (Thakur et al., 2018).

Maturity traits (Yield and its component)

Ten plants were randomly chosen in the middle lines, total number of capita where recorded and calculate the mean of capita.

Number of Seed Capita-1

For determining number of seeds capita^{-1} 50 capita were taken randomly from each experimental unit of the selected plants, swathed by hand then mean number of seeds were calculated.

Weight of 1000 Seeds (g)

Seed Yield (ton. ha-1)

After cleaning the seeds, the yield of each plot was weighed separately in g per plot and converted in terms of seed yield in kilogram per hectare.

Biological Yield (ton. ha-1)

Total above ground plant weight converted to kg ha $^{-1}$ according to (Donald and Hamblin, 1976). Biological yield = Seed yield + Straw yield

Harvest Index (HI) (%)

The harvest index was calculated according to (Hunt and Lioyd, 1987) as follow:

$$\textbf{HI} = \frac{\text{Seed yield kg.ha}-1}{\text{Biological yield kg.ha}-1} \times 100$$

Statistical Data Analysis:

The data were statistically analyzed for the field experiment according to the technique of analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) using IBM SPSS program version (26). For the difference among means of treatments was tested using Duncan's multiple range test at 5% level of significant (Duncan, 1955). Eventually, the statistical charts and spider charts were drawn using excel computer software package. Simple correlation coefficient was calculated among all the studied traits (Al-rawy and Kalafallah, 1980).

RESULTS

Plant Height (cm):

Table (2) shows the influence of cultivars , plant geometry , levels of HA and their interactions. The statistical analysis indicated that the significant impact of cultivars on the plant height, the highest and lowest values (41.55 and 34.16 cm) were recorded by C_1 and C_2, respectively. The row density also affected on plant height, the highest value (41.96 cm) was recorded from G_2, while the lowest value (33.72 cm) was obtained from G_1.

The interaction treatments affected significantly on plant height. The highest values (47.33, 42.66, 44.11 and 48.66 cm) were recorded from interaction treatments of (C_1xG_2, C_1xHA_2 , G_2xHA_2 and $C_1xG_2xHA_2$), respectively. While the lowest values (31.00, 32.50, 32.27 and 29.00 cm) were recorded from (C_2xG_1 , C_2xHA_0 ,G_1xHA_0 and $C_2xG_1xHA_0$) respectively.

Table 2. Effect of cultivars, Row density, humic acid and their interactions on plant height (cm)

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	35.00 ^{cde}	46.00 ^{a}	40.50 ^{abc}	41.55 ^{a}	HA_0	36.02 ^{c}
	HA_1	35.66 ^{cde}	47.33 ^{a}	41.50 ^{ab}			
	HA_2	36.66 ^{cde}	48.66 ^{a}	42.66 ^{a}			
Karal	HA_0	29.00 ^{g}	36.00 ^{cde}	32.50 ^{d}	34.16 ^{c}	HA_1	37.77 ^{b}
	HA_1	30.66 ^{g}	37.33 ^{cd}	34.00 ^{cd}			
	HA_2	33.33 ^{def}	38.66 ^{bc}	36.00 $^{a-d}$			
Animax	HA_0	32.83 ^{ef}	37.33 ^{cd}	35.08 ^{bcd}	37.80 ^{b}	HA_2	39.72 ^{a}
	HA_1	34.33 ^{def}	41.33 ^{b}	37.83 $^{a-d}$			
	HA_2	36.00 ^{cde}	45.00 ^{a}	40.50 ^{abc}			
Mean of G		33.72 ^{b}	41.96 ^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		35.77 ^{cd}	47.33 ^{a}	31.00 ^{e}	37.33 ^{c}	34.38 ^{d}	41.22 ^{b}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		32.27 ^{c}	33.55 ^{c}	35.33 ^{c}	39.77 ^{b}	42.00 ^{ab}	44.11 ^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg $L^{-1}$and HA_2=700 mg L^{-1}

Number of Primary and secondary Branches per Plant:

Table (3 and 4) shows that Animax cultivar produced statistically, the highest number of primary and secondary branches plant^{-1} (15.66 and 27.05) followed in order by Benglanuglue and Karal cultivars. The lowest values (7.72 and 21.94) branches plant^{-1} was produced by Karal cultivar.

Number of both branches plant^{-1} was significantly superior in (G_2) spacing (13.07 and 26.07) branch plant^{-1}. The presented results in Table (3 and 4) indicated the significant effect of spraying humic acid on number of primary and secondary branches plant^{-1}. The highest value (12.55 and 26.11) branch plant^{-1} was obtained from spraying with (700 mg L^{-1}) humic acid while the lowest number (8.94 and 22.50) branch plant^{-1} noted from control (HA_0) treatments.

The interactions between (C×G) affected significantly, the highest and lowest values (17.88 and 5.55) and (41.22 and 31.00) were recorded from interaction treatments of (C_3 x G_2 and C_2 xG_1), for both primary and secondary branches respectively. The second interaction (C x HA) affected significantly on both traits, the highest and lowest values (17.67 and 5.83) branches plant^{-1} were recorded from the interaction treatments (C_3 x HA_2) and (C_2 x HA_0), respectively. Table (4) shows the same manner with value (28.33and 20.16) branch plant $^{-1}$. Furthermore, the interaction between (G x HA) was significantly affected, the highest and lowest value (15.55 and 7.11) and (27.77 and 21.11) branch plant $^{-1}$ were recorded for (G_2 xHA_2) and (G_1 xHA_0), for both branches respectively.

Finally, the interactions among the three studied factors (C×G×HA) had significant effect the highest and lowest number of primary branch (19.66 and 4.33) and secondary branch (30.00 and 18.00) were obtained from interaction treatments of (C_3xG_2xHA_2) and (C_2xG_1xHA_0) respectively.

Leaf area (cm2):

Table (5) Explains the role of the single studied factors in leaf area traits, the highest values (44.53, 39.39, 39.96) cm^2 were recorded from C_3, G_2, HA_2 respectively, and the lowest values postulated (33.24, 35.94 and 35.35) cm^2 for C_1, G_1 and HA_0 respectively.

The interaction between cultivars and plant geometry also affected significantly on leaf area the highest and lowest values (46.43 and 30.80) cm^2 attained from the interaction treatment of (C_3xG_2) and (C_1xG_1), respectively. Leaf area was significantly affected by the interaction between cultivar and spraying of humic acid application. The interaction treatments (C_3×HA_2) showed the maximum leaf area of 46.40 cm^2 whereas the minimum value of 30.31 cm^2 was recorded by the (C_1×HA_0).

Furthermore, the impact of interaction treatments between plant geometry and humic acid was significant for this trait. (G_2×HA_2) performed the best result which was 42.06 cm^2 while the smallest leaf area 34.01 cm^2 was recorded by (G_1×HA_0). The interaction among the studied factors of cultivar, plant geometry and humic acid showed a positive effect on leaf area. The maximum leaf area of 49.01 cm^2 was recorded from the interaction treatment (C_3×G_2×HA_2), whereas the minimum leaf area of 28.18 cm^2 was obtained by (C_1×G_1×HA_0).

Leaf Area Index (LAI):

It is clear from Table (6) that the leaf area index affected significantly by Niger cultivars, the highest and lowest value (0.30 and 0.24) were recorded with Animax and Karal cultivars, Additionally, leaf area index affected significantly by plant geometry (G), the highest value was obtained in G_2 (0.30), while the lowest value (0.25) was recorded for 45 cm (G_2).

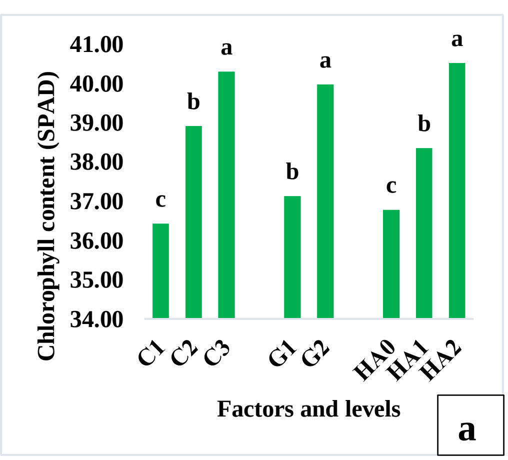
The statistical analysis of the data indicated that the interaction treatment between cultivar and plant geometry had a substantial impact on the Niger leaf area index, the value 0.32 was attained from the interaction treatment (C_3×G_2), and the minimum value 0.23 was obtained from (C_1×G_1) and (C_2×G_1) treatment. Other second interaction treatment (C_3×HA_2) showed the maximum leaf area index of 0.33 whereas the lowest value 0.24 was recorded from (C_1×HA_0).

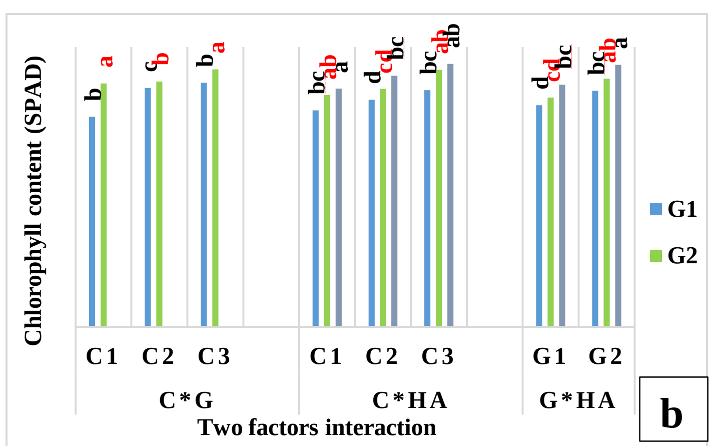
In addition, the influence of interaction treatment between plant geometry and humic acid (G×HA) was significant for this trait. The best result was performed for (G_2×HA_2) which was (0.32) while (G_1×HA_0) performs the lowest value which was (0.21). Table (6) shows the third interaction treatment effect of the studied factors on the leaf area index, the highest value of 0.37 was obtained from the interaction treatment of (C_3×G_2×HA_2), while the lowest value of 0.17 was recorded from the combination treatment of (C_1×G_1×HA_0).

Chlorophyll Content (SPAD) in Autumn Season:

Figure (2) explains the influence of SPAD reading by the studied factors and their interactions, it is clear that the studied factors had the same manner with chlorophyll content in spring season as mentioned by (Muhammed, 2021). The highest SPAD values (40.31, 39.98, 40.52) were recorded from (C_3, G_2, HA_2). As per finding, a sustainable difference was found between the interaction treatments for producing SPAD values, the highest value (41.37, 42.26, 42.10 and 43.36) was obtained for the interaction treatments (C_3xG_2, C_1 x HA_2, G_2 x HA_2 and C_1 x G_2 x HA_2), respectively. While the lowest values (36.44, 37.13, 36.79, 33.75, 34.81, 35.61 and 32.53) SPAD were recorded from (C_1, G_1, HA_0, C_1 x G_1, C_1 x HA_0, G_1xHA_0 and C_1 x G_1 x HA_0), respectively.

Table (13) shows positive significant correlation between chlorophyll content and each of no. of primary branch (r =0.55*), no. of secondary branch (r= 0.62**), leaf area r= (0.80**), leaf area index (r=0.68**), and no. capita $plant^{-1}$, no. seed $capita^{-1}$, 1000-seed weight (g) with correlation coefficient values of (r =0.60**, r =0.63** and r = 0.64**), respectively.





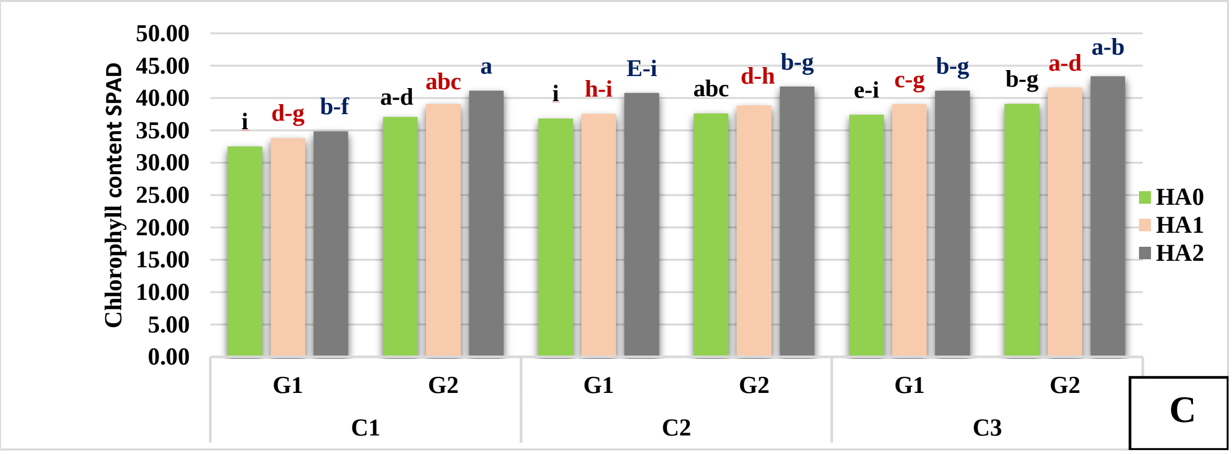


Figure 2. SPAD reading as affected by studied factors (a) , two factor interaction (b) and the three factor interaction (c).

Number of Capita per Plant:

Table (7) indicates number of capita palnt^{-1} as affected by the three studied factors and their interactions. The highest values (30.49, 27.88, 27.91) capita plant^{-1} was noted from the following factors (C_3, G_2, HA_2) while the lowest values (22.08 ,24.24 and 24.28) capita plant^{-1} were attained from (C_2, G_1, HA_0). Among the two factor interaction, this trait was affected significantly by (C_3 x G_2, C_3 x HA_2 and G_2x HA_2) with recorded values (33.36, 32.61, 30.64) capita plant^{-1}, The results also revealed that the lowest value (20.92 ,20.55 and 23.23) obtained from (C_2 x G_1, C_2 x HA_0 and G_1 x HA_0).

The interaction among the studied factors (cultivars, geometry and humic acids) had a significant effect on Number of Capita per Plant, the highest and lowest value (37.70 and 19.25) capita plant^{-1} from the interaction treatments (C_3 x G_1 x HA_0) and C_2 x G_2 x HA_2) respectively.

Table (13) shows significant correlation between number of capita plant^{-1} and each of plant height (r = 0.60**), no. primary branches (r = 0.85**), no. secondary branches (r = 0.88**), leaf are (r = 0.83**), leaf area index (r = 0.81**) and chlorophyll content (r = 0.60**), no. of seed capita^{-1} (r =0.48*), weight of 100 seed (r = 0.88**).

Number of Seed per Capita:

As can be seen in Table (8) an improvement in Number of Seed per Capita upon cultivars geometry and the application of humic acids in single form or in combination was noticed, it seems that the cultivars affected significantly on number of seed capita^{-1}. The highest value 1.54 was recorded for Animax (C_3), while the lowest value 1.27 was recorded from (C_1). Furthermore, the highest and lowest value (1.51 and 1.36) were recorded from G_2 and G_1, respectively. Whereas, the application of HA_2 with 46.28% increase in the number of seeds pod^{-1} which differ significantly with the control treatment. Other levels of humic acid cause 24.45% increase comparing with control treatment.

The interaction between cultivar and plant geometry influence significantly on number of seeds capita^{-1}, the interaction treatments (C_2 x G_2) recorded the highest value 1.76 seeds capita^{-1}, while the lowest value 1.05 seeds capita^{-1} was obtained from (C_1 x G_2).

By contrast, it was noticed that there are no significant differences between the interaction (C x HA) while the interaction (G×HA) was significant with highest and lowest number of seed capita^{-1} (1.71 and 1.11 seeds capita^{-1}) were recorded form (G_2×HA_2) and (G_1×HA_0), respectively.

Furthermore, the interactions among the three studied factors affected significantly on number of seed capita $^{-1}$. The treatment combination of (C_2×G_2×HA_2) showed the highest values 2.26 while the lowest value 0.50 seeds capita^{-1} noted from (C_1×G_1×HA_0).

Weight of 1000- Seeds:

The presented data in Table (9) depicts that a significant effect of the studied factors were on the 1000-seeds weight, the highest values (2.37, 2.30 and 2.15) g were recorded from (C_3, G_2 and HA_2), while the lowest value (1.67, 1.72 and 1.89) g obtained from (C_2, G_1 and HA_0)

treatments.

Contrary to above results, analysis of data revealed that significant differences occurred on 1000-seed weight due to the interaction between cultivars and levels of HA, the highest value 2.51 g and lowest value 1.55 g were recorded from interaction treatments of (C_3 × HA_2) and (C_2 × HA_0), respectively.

The weight of 1000 seeds affected significantly by the interaction between (C × G) and (G x HA) the highest value was recorded for (C_3 x G_2) and (G_2 x HA_2) with values of (2.61 and 2.420) g, Whilst, the interaction (C_2 x G_1) and (G_1 x HA_0) recorded the lowest value (1.35 and 1.60) g On the other hand, (2.70 and 1.23) g was obtained from the interaction of (C_3 x G_2 x HA_2) and (C_3 x G_2 x HA_2) as a highest and lowest weight.

Seed Yield (ton. ha-1):

As per the findings in Table (10) a substantial difference was found among the three treatments for seed yield (kg ha^{-1}), its range was from (278.34 to 229.60) as a highest and lowest value for C_3 and C_1 respectively. The geometry treatment also affected on the seed yield significantly, the highest and lowest values (301.30 and 195.22) kg ha^{-1} were noted from (G_1 and G_2), respectively.

The increase in levels of applied HA caused significant increase in seed yield the highest values 282.73 kg ha^{-1} were observed from HA_2, whilst the minimum seed yield 206.38 kg ha^{-1} exhibited on HA_0. Overall the 45 cm row spacing increase seed yield 54.33 % compared with 60 cm, in addition, it can be observed that humic acid (700 mg L^{-1}), increase seed yield (36.99 %) comparing with control treatment.

The two-factor interactions found to be significant on seed yield, the highest values (326.80, 315.00, 344.02) kg ha^{-1} were recorded from (C_3 x G_1, C_3 x HA_2, G_1 x HA_2), whilst the minimum values (175.00, 188.33, 168.00) were observed from the interaction treatments (C_1 x G_2, C_2 x HA_0, G_2 x HA_0).

Furthermore, the interaction among the three studied factors had a positive effect on seed yield. The treatment combination of C_2 x G_2 x HA_0 gave the highest value which was 360.41 kg ha^{-1}, While, the interaction C_2xG_2xHA_0 recorded the lowest value 153.33.

Biological Yield (kg ha-1):

Table (11) explains the significant effect of the studied factors and their interactions on biological yield. The highest values (1717.00, 1777.26 and 1667.00) kg ha^{-1} was obtained from (C_3, G_1, HA_2). Close examination of Table (11) shows that the interaction treatment between cultivars and geometry affected significantly the highest and lowest values (1967.00 and 1209.00) kg ha^{-1} were distinguished from interaction treatments of (C_3xG_1) and (C_1xG_2). On the other hand, the biological yield significantly affected by the interaction between cultivar and humic acid (C x HA). The maximum biological yield 1847.50 kg ha^{-1} was attained from (C_2×HA_2) whereas; the lowest biological yield 1277.00 kg ha^{-1} was noted from (C_2 × HA_0).

The same table shows significant effect of the interaction between plant geometry and humic acids, the highest and lowest values was obtained from (G_1xHA_2 and G_2xHA_0) with the recorded values (1936.000 and 1196.22 kg ha^{-1}), respectively. Finally, the third interactions of (C_3 x G_1 x HA_2) and (C_2 x G_2 x HA_0), recorded the highest and lowest values (2108.33 and 1120.00) kg ha^{-1} respectively. Table (13) shows positive significant correlation between biological yield, seed yield and harvest index and negative correlation with plant height with correlation coefficient r= 1.00, 0.88 and - 0.49* respectively.

Harvest Index (%):

As with most of the yield contributing traits the plant geometry also affected the harvest index, the highest and lowest values (17.00 and 15.12) % were achieved from (G_1 and G_2), respectively as shown in Table (12). The same table illustrated to the significant effects increase in humic acid caused increase in harvest index. The highest average values of the harvest index were registered at HA_2 which was 17.05%, while the lowest average values of the harvest index 15.00 % were registered for HA_0.

According to the data presented in the same table, shows the significant effect of interaction treatments between (C X GX HA) on harvest index. The highest values (17.45, 17.11 and 17.90) % illustrated from (C_1 x G_1, C_1xHA_2 and G_1 x HA_2), respectively. While the lowest harvest index (14.46 ,15.00 and 14.04) % was observed from treatments and interaction treatments of (C_1 x G_2, C_{1x} HA_0 and G_2 x HA_0), respectively. Finally, the three interaction treatments affected significantly on this traits, the highest and lowest harvest index attained from (19.07 and 13.75) % with the interaction treatments (C_1 x G_{1x} HA_2) and (C_1 x G_{2x} HA_0) respectively.

3.DISCUSSION

The variation in niger cultivars in plant height as illustrated in Table (2) may due to the genetic factor in addition to environmental factors. These equivalent results were obtained by Omidi and Sharifmogadas, (2010) , in addition ,there were differences in cultivars even in growing seasons spring and Autumn as mentioned by (Muhammed, 2021).

The increase in concentration of HA caused significant increase in plant height by 10.27 % compared with control treatment. This result agrees with those obtained by (Gürsoy et al., 2016). The effect of interaction treatments on plant height may be due to their role in creating different growth coditions for plant (Darwesh, 2007) and (Gürsoy et al., 2016).

Variation in number of primary and secondary branches plant^{-1} may be due to density treatment Table (3 and 4) as there are more competition for light, space, and nutrients among plants at closer spacing led to vertical development of the plant rather than horizontal growth, which may account for the relative reduction in the number of branches seen at closer spacing ,These results are in conformity with the findings of (Priya, 2007) and (Ukale, 2014). The interaction between second geometry 60 cm spacing and high concentration of HA led to increase in branches in Niger, the finding was in harmony with (Muhammed and Mahmood, 2021).Additionally the interaction treatments of cultivar and geometry led to increase in no of branches which is confirm with, Kumar, (2013) The second and third interactions caused significant differences in no. of branches which is in agreement with (Ouzouni et al., 2007).

The sole factors in table (5 and 6) refers to significant differences on leaf area and LAI ,this is equivalent results which were obtained by Getinet and Sharma, (1996) and Ahmed ,(2019) they revealed that there are differences in leaf area and LAI between Niger cultivars, This finding revealed that the LAI increased as the plant density increased due to more leaf area occupied per unit ground area for maximum light interception and photosynthesis, low plant population tended to enhance vegetative growth resulting in the development of large leaf area compared to the high and moderate plant populations resulting in sink limitation to photosynthesis, similar results were reported by (Meti, 2002) and (Ukale, 2014).

Furthermore , (Kumar and Kubsad, 2014), and (Sandeep and Kubsad, 2017) recorded highest leaf area in (60 cm) row spacing while Ukale, (2014) noticed that LAI is negatively associated with the planting density. Additionally humic acid affected significantly on LA and LAI , (Khalaf and Assal, 2021). Has documented that (6 ml L^{-1}) obtained the highest leaf area 0.52 cm^2 $plant^{-1}$ followed by 4 ml L^{-1}. These results clearly indicate that increasing photosynthetic area of the crop might result in increasing leaf area which in turn resulted in increasing growth and yield parameters (Sandeep and Kubsad, 2017).

The studied factors have the same manner in chlorophyll content during spring and fall season (Muhammed, 2021), humic acid caused increase in chlorophyll content (Fig 2), this may be due to the role of humic acid which amplified permeability of cell membrane and thereby facilitated the entrance of potassium (K) into the cell which accordingly raises the pressure inside the cell and cell division. On the other hand, increasing energy inside the cells would lead to chlorophyll production and photosynthesis rate increase. Then, the growth process is accelerated, nitrogen absorption into the cells is intensified, nitrate production is diminished, and finally the production is improved this was in harmony with (Giasuddin et al., 2007). Additionally, El-shafey and El mantawy (2020) revealed that the most profound influence of foliar application of third levels of humic acid on leaf chlorophyll content comparing with control treatment.The increase in number of capita may be due to the increase in secondary branches (Table 4) which affected by the studied factors which lead to increase in number of capita plant^{-1}. (Downey et al., 1989) clarified that number of capita is between (20 – 40) this is in pair with our results. The interaction between C_2 and G_2 obtained the highest no capita plant^{-1} these results is in harmony with (Sharifi et al., 2012). Number of seeds capita^{-1} increased under the impact of wide spacing between rows (Table 7) similar trend was also determined by Ukale, (2014). It can be concluded that the increase in number of seeds capita $^{-1}$ as affected by humic acid applications is resulted from improving plant growth conditions and increasing the nutrients, this result in agreement with Tadayyon et al., (2017) they reported that the application of humic acid increased number of seeds capita^{-1} in Niger plant. The studied treatments created the best growth conditions for plant, these may be due to genetic variation, the role of plant density in additional to the significant role of HA in increasing nutrient availability for plant which caused increase in weight of 1000-seeds. Equivalent results were obtained by (Ahmed, 2019). Weight of 1000 seed for Niger crop in our study was (1.23-2.70) g whilst as Abdulla and Khalaf, (2014) mentioned that the weight was between (2.46 - 3.81) g obtained from their study on bird seed mixtures. Humic acid positively affects various aspects of photosynthesis and improves the quantity and quality of the food crops (Poudineh et al., 2015). Seed yield increased may be due to increase in no of primary and secondary branches, no. of capita, no seed per capita table (3,4,6,7) due to the application of humic acid, similar result was found by (Moraditochaee, 2012) and (Tadayyon et al., 2017).Animax cultivar has the same response with the study factors in two growing seasons obtained by (Muhammed and Mahmood, 2021). Humic acid increase the seed yields, these may due to its role in increasing availability of plant nutrients then growth increase, similar results were recorded by (Safaei et al., 2014) and (Ahmed, 2019).

The interaction between the studied factors affected significantly on seed yield, these results supported by previous study (Emam and Awad, 2017) and (Naseri et al., 2012). The single studied factor C_3, G_1 HA_3 affected on biological yields table (10) this is in confirm with Ukale, (2014) and Ahmed, (2019). HA_3 led to increase HI similar result was found by (Musazadeh et al., 2009 and Fakirah et al, 2017. This can be justified by the fact that the interaction treatment of spraying with humic acid was in all aspects superior in promoting yield parameters table (1) than the treatment without spraying humic acid application. These results agreed with (Nasiri et al., 2017).

Table 3. Effect of cultivar, plant geometry, humic acid and their interactions on number of primary branches per plant

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	5.66^{ij}	9.00^{fgh}	7.33^{de}	8.77^{b}	HA_0	8.94^{c}
	HA_1	6.00^{ij}	11.33^{ef}	8.66^{de}			
	HA_2	6.66^{g-j}	14.00^{cde}	10.33^{cd}			
Karal	HA_0	4.33^{j}	7.33^{ghi}	5.83^{e}	7.72^{c}	HA_1	10.66^{b}
	HA_1	6.00^{ij}	9.33^{fg}	7.66^{de}			
	HA_2	6.33^{hig}	1.30^{de}	9.66^{de}			
Animax	HA_0	11.33^{ef}	16.00^{bc}	13.66^{bc}	15.66^{a}	HA_2	12.55^{a}
	HA_1	13.33^{cde}	18.00^{ab}	15.66^{ab}			
	HA_2	15.66^{bcd}	19.66^{a}	17.67^{a}			
Mean of G		8.37^{b}	13.07^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		6.11^{d}	11.44^{bc}	5.55^{d}	9.88^{c}	13.44^{b}	17.88^{a}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		7.11^{c}	8.44^{c}	9.55^{bc}	10.77^{bc}	12.88^{ab}	15.55^{a}

Note:Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 4. Effect of cultivar, plant geometry, humic acid and their interactions on number of secondary branches per plant.

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	21.00 ^{fg}	23.00 ^{def}	22.00 ^{cd}	23.94 ^{b}	HA_0	22.50 ^{c}
	HA_1	22.33 ^{ef}	24.66 ^{cd}	23.50 ^{bc}			
	HA_2	25.66 ^{cd}	27.00 ^{bc}	26.33 ^{ab}			
Karal	HA_0	18.00 ^{h}	22.33 ^{ef}	20.16 ^{d}	21.94 ^{c}	HA_1	24.33 ^{b}
	HA_1	18.33 ^{gh}	25.66 ^{cd}	22.00 ^{cd}			
	HA_2	21.00 ^{fg}	26.33 ^{bc}	23.66 ^{bc}			
Animax	HA_0	24.33 ^{cde}	26.33 ^{bc}	25.33 ^{abc}	27.05 ^{a}	HA_2	26.11 ^{a}
	HA_1	25.66 ^{cd}	29.33 ^{ab}	27.50 ^{a}			
	HA_2	26.66 ^{bc}	30.00 ^{a}	28.33 ^{a}			
Mean of G		22.55 ^{b}	26.07 ^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		23.00 ^{c}	24.88 ^{bc}	19.11 ^{d}	24.77 ^{bc}	25.55 ^{b}	28.55 ^{a}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		21.11 ^{d}	22.11 ^{cd}	24.44 ^{bc}	23.88 ^{bcd}	26.55 ^{ab}	27.77 ^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 5. Effect of cultivar, plant geometry, humic acid and their interactions on leaf area (cm^2)

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	28.18 ^{h}	32.45 ^{fg}	30.31 ^{d}	33.24 ^{c}	HA_0	35.35 ^{c}
	HA_1	30.54 ^{gh}	35.98 ^{ef}	33.26 ^{de}			
	HA_2	33.66 ^{fg}	38.61 ^{de}	36.14 ^{cd}			
Karal	HA_0	32.44 ^{fg}	33.59 ^{fg}	33.02 ^{de}	35.28 ^{b}	HA_1	37.69 ^{b}
	HA_1	34.60 ^{f}	36.05 ^{ef}	35.32 ^{cd}			
	HA_2	36.16 ^{ef}	38.57 ^{de}	37.36 ^{c}			
Animax	HA_0	41.43 ^{cd}	44.00 ^{bc}	42.71 ^{b}	44.53 ^{a}	HA_2	39.96 ^{a}
	HA_1	42.68 ^{bc}	46.29 ^{ab}	44.48 ^{ab}			
	HA_2	43.77 ^{bc}	49.01 ^{a}	46.40 ^{a}			
Mean of G		35.94 ^{b}	39.39 ^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		30.80 ^{d}	35.68 ^{c}	34.40 ^{c}	36.07 ^{c}	42.62 ^{b}	46.43 ^{a}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		34.01 ^{b}	35.94 ^{b}	37.86 ^{ab}	36.68 ^{ab}	39.44 ^{ab}	42.06 ^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 6. Effect of cultivar, plant geometry, humic acid and their interactions on leaf area index

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	0.17 ^{i}	0.31 ^{bc}	0.24 ^{c}	0.27 ^{b}	HA_0	0.24 ^{c}
	HA_1	0.26 ^{efg}	0.31 ^{b}	0.28 ^{abc}			
	HA_2	0.28 ^{cde}	0.32 ^{b}	0.30 ^{ab}			
Karal	HA_0	0.22 ^{h}	0.25 $^{e-h}$	0.24 ^{c}	0.24 ^{c}	HA_1	0.27 ^{b}
	HA_1	0.24 ^{fgh}	0.25 ^{efg}	0.25 ^{c}			
	HA_2	0.24 ^{gh}	0.27 $^{d-g}$	0.25 ^{bc}			
Animax	HA_0	0.25 ^{efg}	0.28 ^{cde}	0.26 ^{bc}	0.30 ^{a}	HA_2	0.29 ^{a}
	HA_1	0.27 ^{def}	0.32 ^{b}	0.29 ^{ab}			
	HA_2	0.30 ^{bcd}	0.37 ^{a}	0.33 ^{a}			
Mean of G		0.25 ^{b}	0.30 ^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		0.23 ^{c}	0.31 ^{a}	0.23 ^{c}	0.26 ^{bc}	0.27 ^{b}	0.32 ^{a}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		0.21 ^{d}	0.26 ^{c}	0.27 ^{bc}	0. 28 ^{cd}	0.29 ^{ab}	0.32 ^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg $L^{-1}$and HA_2=700 mg L^{-1}

Table7. Effect of cultivar, plant geometry, humic acid and their interactions on number of capita per plant.

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	23.24 ^{fg}	25.30 ^{def}	24.27 ^{de}	25.61 ^{b}	HA_0	24.28 ^{c}
	HA_1	23.94 ^{efg}	27.08 ^{cde}	25.51 ^{cd}			
	HA_2	25.35 ^{def}	28.73 ^{c}	27.04 ^{cd}			
Karal	HA_0	19.25 ^{h}	21.86 ^{gh}	20.55 ^{f}	22.08 ^{c}	HA_1	25.99 ^{b}
	HA_1	20.82 ^{gh}	22.41 ^{fg}	21.61 ^{ef}			
	HA_2	22.69 ^{fg}	25.50 ^{def}	24.09 ^{de}			
Animax	HA_0	27.20 ^{cd}	28.83 ^{c}	28.01 ^{bc}	30.49 ^{a}	HA_2	27.91 ^{a}
	HA_1	27.53 ^{cd}	33.57 ^{b}	30.85 ^{ab}			
	HA_2	28.13 ^{cd}	37.70 ^{a}	32.61 ^{a}			
Mean of G		24.24 ^{b}	27.88 ^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		24.18 ^{c}	27.03 ^{b}	20.92 ^{d}	23.25 ^{c}	27.62 ^{b}	33.36 ^{a}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		23.23 ^{c}	24.30 ^{bc}	25.19 ^{bc}	25.33 ^{bc}	27.68 ^{ab}	30.64 ^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg $L^{-1}$and HA_2=700 mg L^{-1}

Table 8. Effect of cultivar, plant geometry, humic acid and their interactions on number of seeds per Capita

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	0.50^{d}	1.00^{cd}	1.03^{a}	1.27^{b}	HA_0	1.21^{b}
	HA_1	1.65^{abc}	1.95^{ab}	1.30^{a}			
	HA_2	2.00^{ab}	2.21^{a}	1.50^{a}			
Karal	HA_0	0.87^{cd}	1.40^{abc}	1.48^{a}	1.48^{a}	HA_1	1.52^{a}
	HA_1	1.53^{abc}	1.62^{abc}	1.56^{a}			
	HA_2	1.56^{abc}	2.26^{a}	1.58^{a}			
Animax	HA_0	1.50^{abc}	1.60^{abc}	1.05^{a}	1.54^{a}	HA_2	1.56^{a}
	HA_1	1.60^{abc}	1.70^{abc}	1.61^{a}			
	HA_2	1.90^{ab}	1.97^{ab}	1.80^{a}			
Mean of G		1.36^{b}	1.51^{a}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		1.50^{ab}	1.05^{b}	1.32^{ab}	1.76^{a}	1.70^{a}	1.27^{ab}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		1.11^{a}	1.32^{a}	1.35^{a}	1.42^{a}	1.70^{a}	1.71^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 9. Effect of cultivars, plant geometry, humic acid and their interactions on 1000- seed weight (g)

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	1.60^{jk}	2.16^{def}	1.88^{cd}	1.99^{b}	HA_0	1.89^{b}
	HA_1	1.70^{ijk}	2.26^{cde}	1.98^{bcd}			
	HA_2	1.76^{h-k}	2.46^{abc}	2.11^{abc}			
Karal	HA_0	1.23^{l}	1.86^{g-j}	1.55^{d}	1.67^{c}	HA_1	1.98^{b}
	HA_1	1.26^{l}	2.00^{e-h}	1.63^{d}			
	HA_2	1.56^{k}	2.10^{d-g}	1.83^{cd}			
Animax	HA_0	1.96^{f-i}	2.53^{abc}	2.25^{abc}	2.37^{a}	HA_2	2.15^{a}
	HA_1	2.10^{d-g}	2.60^{ab}	2.35^{ab}			
	HA_2	2.33^{bcd}	2.70^{a}	2.51^{a}			
Mean of G		1.72^{b}	2.30^{a}				
Mean of C *G		1.68^{d}	2.30^{b}	1.35^{e}	1.98^{c}	2.13^{bc}	2.61^{a}
Mean of G*HA		1.60^{c}	1.68^{c}	1.88^{bc}	2.18^{ab}	2.28^{a}	2.42^{a}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 10 Effect of cultivar, plant geometry, humic acid and their interactions on seed yield (kg ha^{-1}) in autumn season.

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	232.50^{d-g}	160.33^{gh}	196.41^{bc}	229.60^{b}	HA_0	206.38^{c}
	HA_1	297.00^{a-d}	176.66^{gh}	236.66^{abc}			
	HA_2	323.75^{abc}	187.66^{gh}	255.70^{abc}			
Karal	HA_0	223.33^{e-h}	153.33^{h}	188.33^{c}	236.83^{b}	HA_1	255.65^{b}
	HA_1	307.08^{abc}	182.00^{gh}	244.54^{abc}			
	HA_2	347.91^{ab}	207.33^{fgh}	277.62^{abc}			
Animax	HA_0	280.00^{b-e}	190.00^{gh}	234.41^{abc}	278.34^{a}	HA_2	282.73^{a}
	HA_1	340.83^{ab}	230.66^{d-g}	285.75^{ab}			
	HA_2	360.41^{a}	269.33^{c-f}	315.00^{a}			
Mean of G		301.30^{a}	195.22^{b}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		284.30^{a}	174.88^{c}	292.77^{a}	180.88^{c}	326.80^{a}	230.00^{b}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		245.00^{b}	315.00^{a}	344.02^{a}	168.00^{d}	196.44^{cd}	221.44^{bc}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1}and HA_2=700 mg L^{-1}

Table 11 Effect of cultivar, plant geometry, humic acid and their interactions on biological yield (kg ha^{-1}) in autumn season.

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	1457.00^{d-g}	1167.00^{g}	1320.83^{b}	1419.23^{b}	HA_0	1390.00^{b}
	HA_1	1700.00^{a-f}	1227.00^{g}	1463.33^{ab}			
	HA_2	1713.75^{a-f}	1233.33^{g}	1473.54^{ab}			
Karal	HA_0	1433.33^{d-g}	1120.00^{g}	1277.00^{b}	1489.00^{b}	HA_1	1568.47^{a}
	HA_1	1787.50^{a-e}	1233.33^{g}	1510.41^{ab}			
	HA_2	1985.83^{ab}	1373.33^{efg}	1680.00^{ab}			
Animax	HA_0	1842.00^{a-d}	1302.00^{fg}	1571.83^{ab}	1717.00^{a}	HA_2	1667.00^{a}
	HA_1	1950.00^{abc}	1513.33^{c-g}	1732.00^{ab}			
	HA_2	2108.33^{a}	1587.00^{b-g}	1847.50^{a}			
Mean of G		1777.26^{a}	1306.14^{b}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		1630.00bc	1209.00e	1735.55ab	1242.22de	1967.00a	1468.00cd
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		1583.33^{bc}	1812.50^{ab}	1936.00^{a}	1196.22^{d}	1324.44^{d}	1398.00^{cd}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1}and HA_2=700 mg L^{-1}

Table 12 Effect of cultivar, plant geometry, humic acid and their interactions on harvest index (%)

Cultivar	Humic acid	G_1	G_2	Mean of C*HA	Mean of Cultivar	Mean of Humic acid	
Benglanuglue	HA_0	15.83^{a}	13.75^{a}	15.00^{a}	15.95^{a}	HA_0	15.00^{b}
	HA_1	17.45^{a}	15.00^{a}	16.00^{a}			
	HA_2	19.07^{a}	15.16^{a}	17.11^{a}			
Karal	HA_0	15.52^{a}	13.80^{a}	15.00^{a}	16.01^{a}	HA_1	16.27^{ab}
	HA_1	17.27^{a}	15.65^{a}	16.46^{a}			
	HA_2	17.52^{a}	16.35^{a}	17.00^{a}			
Animax	HA_0	16.00^{a}	15.00^{a}	15.12^{a}	16.21^{a}	HA_2	17.05^{a}
	HA_1	17.51^{a}	15.28^{a}	16.40^{a}			
	HA_2	17.13^{a}	17.07^{a}	17.10^{a}			
Mean of G		17.00^{a}	15.12^{b}				
Mean of C *G		C_1*G_1	C_1*G_2	C_2*G_1	C_2*G_2	C_3*G_1	C_3*G_2
		17.45^{a}	14.46^{b}	16.77^{ab}	15.26^{ab}	17.00^{ab}	15.64^{ab}
Mean of G*HA		G_1*HA_0	G_1*HA_1	G_1*HA_2	G_2*HA_0	G_2*HA_1	G_2*HA_2
		16.00^{abc}	17.41^{ab}	17.90^{a}	14.04^{c}	15.13^{bc}	16.19^{abc}

Note: Mean values followed by the same letter are not significantly different at the 5% probability level according to Duncan test. C_1= Benglanuglue, C_2=Karal, C3=Animax , G_1=45 Cm and G_2= 60 cm , HA_0= 0 mg L^{-1} , HA_1=350 mg L^{-1} and HA_2=700 mg L^{-1}

Table 13 correlation coefficient (r) analysis among the traits of Niger crop

Studied traits	Seed yield kg ha^{-1}	Plant height cm	No Primary Branches	No Second Branches	Leaf area cm^2	LAI	Chloro. SPAD	No capita $Plant^{-1}$	No seed $Capita^{-1}$	1000 seed weight g	Bio yield kg ha^{-1}
Plant height cm	-0.49										
No primary branch	0.04	0.47									
No secondary branch	-0.06	0.62**	0.73**								
Leaf area cm^2	0.19	0.26	0.82**	0.77**							
LAI	-0.09	0.76**	0.71**	0.77**	0.68**						
Chloro. SPAD	-0.01	0.41	0.55*	0.62**	0.80**	0.68**					
No capita $Plant^{-1}$	0.05	0.60**	0.85**	0.88**	0.83**	0.81**	0.60**				
No seed $Capita^{-1}$	0.15	0.43	0.30	0.65**	0.53*	0.66**	0.63**	0.48*			
1000 seed weight g	-0.25	0.75**	0.82**	0.92**	0.76**	0.81**	0.64**	0.88**	0.52*		
Bio. yield kg ha^{-1}	1.00**	-0.49*	0.04	-0.06	0.19	-0.09	-0.01	0.05	0.15	-0.25	
HI %	0.88**	-0.39	-0.10	0.03	0.09	-0.06	-0.07	0.04	0. 32	-0.26	0.88**

4.CONCULSION

To sum up, the Animax cultivar performed significantly differ in most of the studied characteristics such as primary and secondary branches, leaf area index, chlorophyll content, number of capita per plant, number of seed per capita, seed index, seed yield, biological yield in the autumn season.

Spacing 45 cm per rows produced maximum number of seed yield and biological yield. Spraying 700 mg L^{-1} humic acid application caused increase in most of the growth and yield parameters. The treatment combination of ($C_3xG_2xHA_2$) produced the highest values of number of primary and secondary branchs, leaf area, leaf area index, number of capita $plant^{-1}$ and weight of 1000 seed for Autumn season.

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