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Maize Yield and the Associated Weeds as Affected by Plant Population Density and Weed Control Treatments

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Abstract

Two field experiments were carried out in the Farm of Agricultural Research and the Experimental Center of Faculty of Agriculture at Moshtohor, (Toukh Directorate, Qalyubia Governorate) Benha Univ. Egypt, during 2017 and 2018 seasons to investigate the effect of five plant population densities, *i.e.* 18, 21, 24, 27 and 30 thousand maize plants/feddan (fed) {one fed = 4200 m^2} and five weed control treatments, *i.e.* pendimethalin 682.5 g a.i./fed (stomp extra 45.5 % CS), acetochlor 840 g a.i./fed (harness 84 % EC), nicosulfuron 24 g a.i./fed (active 6 % SC), hand hoeing twice and the unweeded check (the control) on yield, some of its components and associated weeds in maize (single cross hybrid 2036 for Misr Hytech Seed Int.). Increasing plant population density from 18 to 30 thousand maize plants/fed reduced weed biomass at 50 days after sowing as well as significantly increased mean values of silking date, leaf area index at 80 days after sowing, plant height, ear height, No. of barren plants/fed, No. of ears/fed and stover yield/fed in both seasons. On the other hand, mean values of area of topmost ear leaf at 80 days after sowing, leaf area/plant at 80 days after sowing, stem diameter, No. of plants carried two ears/fed, ear length, No. of kernels/ear, weight of kernels/ear, shelling %, 100-kernel weight and harvest index were significantly decreased in the two seasons. Maize planted at 24000 plants/fed produced the highest mean values of grain and biological yields/fed in both seasons. Weed control by hand hoeing twice or using nicosulfuron herbicide surpassed the other weed control treatments in depressing mean values of fresh and dry weights of broad-leaved, grassy and total annual weeds at 50 days after sowing maize, as well as gave the best mean values of all maize traits without significant difference between them. Maize planted at 30000 plants/fed under mechanical weed control (hand hoeing twice) or using nicosulfuron herbicide gave the lowest mean values of all weed measurements at 50 days after sowing as well as gave the greatest mean values of leaf area index, plant height, ear height, No. of ears/fed and stover yield/fed in both seasons. The greatest mean values of area of topmost ear leaf, leaf area/plant, No. of kernels/ear, weight of kernels/ear and 100-kernel weight were obtained from planting 18000 maize plants/fed with hand hoeing twice. Maize planted at 24000 plants/fed and hand hoeing twice produced the greatest mean values of biological yield/fed in both seasons. The maximum mean values of grain yield/fed were obtained by maize planted at 24000 and 21000 plants/fed and hand hoeing twice the first and second seasons, respectively. Planting maize by 21000 plants/fed with hand hoeing twice gave the highest mean values of nitrogen uptake/fed and protein yield/fed in both seasons.

Keywords: Maize, plant density, weed control, Pendimethalin, Acetochlor, nicosulfuron and hand hoeing

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in the world and ranks the third of the most important cereal crops in the world which surpassed by wheat and rice. In Egypt, Maize is essential for livestocks and human consumption as an available source of carbohydrate, oil and slightly for protein. World average cultivated area of maize in 2017 year (www.fao.org) reached 469.49 million fed, the total production was 1134.75 million tonnes and an average productivity of 2416.97 kg grain/fed. The growing area of maize in Egypt was about 2.192 million fed with a total grain yield of 7.10 million tonnes by average grain yield was about 3239.19 kg/fed. The total production supplies 40-50 % of the require consumption with a reduction gap of 50-60 % which has to be filled via importation.

As maize does not have tillering capacity to adjust to variation in plant stand, optimum plant population for grain production is important. Thus to increase grain yield, maize must be planted at proper population density. Fresh and dry weights of broad-leaved, grassy and total annual weeds in maize fields were significantly decreased with increasing maize plant population density **(Acciares and Zuluaga 2006; Abouziena *et al*. 2008; El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; Teymoori *et al*. 2013; Amiri *et al*. 2014; El-Sobky and El-Naggar 2016 and Simić *et al*. 2017)**. Increasing maize plant population density significantly increased mean values of silking date, leaf area index, plant height, ear height, No. of barren plants/fed, No. of ears/fed, stover yield/fed. Vice-versa, significantly decreased mean values of area of topmost ear leaf, leaf area/plant, stem diameter, No. of plants carried two ears/fed, No. of ears/fed, ear length, No. of kernels/ear, weight of kernels/ear, kernels shelling %, 100-kernel weight, harvest index, kernels nitrogen content and kernels crude protein content were significantly decreased. While, mean values of grain yield/fed, biological yield/fed, nitrogen uptake/fed

and protein yield/fed were increased by increasing plant population density from lower plant density to optimum plant density then decreased **(Abouziena *et al*. 2008; EL-Metwally *et al*. 2012; El-Gedwy *et al*. 2012; Teymoori *et al*. 2013; Amiri *et al*. 2014; Marin and Weiner 2014; Gobeze *et al*. 2016; El-Sobky and El-Naggar 2016; Mandić *et al*. 2016; Rahman *et al*. 2016; Sharanabasappa *et al*. 2017; Simić *et al*. 2017; Eyasu *et al*. 2018; Zeleke *et al*. 2018; El-Hosary *et al*. 2019; Ramesh Babu and Senthivel 2019; Sidi *et al*. 2019).**

Excluding environmental variables, yield losses in corn are caused mainly by inter-specific competition with weeds. Weed interference is a severe problem in corn, especially in the early part of the growing season, due to slow early growth rate and wide row spacing. Weeds compete with the corn plants for resources such as light, nutrients, space, and moisture that influence the morphology and phenology of crop, reduce the yield, make harvesting difficult, and mar the quality of grains. Furthermore, high weed infestation increases the cost of cultivation, lowers value of land, and reduces the returns of corn producers. In order to realize the yield potential of corn, weed management becomes indispensable. A number of weed species compete with corn plant and have been observed to reduce yield as much as 46 % with delay in weed control **(El-Gedwy *et al*. 2012)**. Weed competition among the major constrains to crop production. Estimates of the worldwide loss potential in due to weeds, pathogens and animal pests in maize totaled by 40.3, 9.4 and 16.0 %, respectively **(Oerke, 2006).** However, other researchers reported that losses in maize grain yield due to weed competition ranged between 74-90 % **(El-Gedwy *et al*. 2012 and Ramesh Babu & Senthivel 2019).** The allowing weeds to grow for whole growing season in maize significantly decreased all mean values of maize growth traits, yield components, yield and kernels properties compared with weed control by using hand hoeing or herbicides, vice versa, total fresh and dry weights of weeds were significantly increased **(El-Gedwy *et al*. 2012; Pacanoski *et al*. 2015; Tyagi *et al*. 2017; Simić *et al*. 2017 and Ramesh Babu & Senthivel 2019)**. Several investigators showed that weed control by pendimethalin herbicides **(Tahir *et al*. 2009; Pacanoski *et al*. 2015; Shaban *et al*. 2015 and Shaban *et al*. 2016),** acetochlor herbicides **(Ahmed *et al*. 2008; EL-Metwally *et al*. 2012; Shaban *et al*. 2015; El-Sobky & El-Naggar 2016; Shaban *et al*. 2016 and Tyagi *et al*. 2017),** nicosulfuron herbicides **(Knezevic *et al*. 2003; Rastgordani *et al*. 2013; Teymoori *et al*. 2013; Tesfay *et al*. 2014; Amare *et al*. 2015; Nogueira & Correia 2016 and Simić *et al*. 2017)** and hand hoeing (**Abouziena *et al*. 2008; Ahmed *et al*. 2008; Tahir *et al*. 2009; El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; Rastgordani *et al*. 2013; Teymoori *et al*. 2013; Tesfay *et al*. 2014; Amare *et al*. 2015; Shaban *et al*. 2015; El-Sobky & El-Naggar 2016; Shaban *et al*. 2016 and Ramesh Babu & Senthivel 2019**) were significantly depressed fresh and dry weights of weeds compared to the unweeded check as well as increased all mean values of maize.

Our objective in establishing this study was to determine the effects of different plant population density and weed control treatment on the associated weeds, growth traits, yield components, yield and kernels chemical properties of maize (single cross hybrid 2036 for Misr Hytech Seed Int.).

Materials and Methods

Two field experiments were carried out at the Farm of Agricultural Research and the Experimental Center of Faculty of Agriculture at Moshtohor, (Toukh Directorate, Qalyoubia Governorate) Benha Univ. Egypt, during the two summer successive growing seasons of 2017 and 2018 to investigate five plant population densities and five weed control treatments on the growth traits, yield components, yield and kernels chemical properties of maize (single cross hybrid 2036 for Misr Hytech Seed Int.) as well as associated weeds.

Soil texture of the experimental site was clay soil with a pH value of 8.12, 8.16 and 2.23 %, 2.27 % organic matter content during 2017 and 2018 seasons, respectively. The chemical and mechanical properties analysis of the experimental soil were determined according to the standard procedures described by **Black** and **Evans (1965)** and represented in Table 1 in each of the two growing seasons.

Table 1. Chemical and mechanical properties of the experimental soil units at planting maize during 2017 and 2018 seasons.

Properties	Seasons	
	2017	2018
Chemical analysis		
E.C.	2.26	2.23
pH (1 :2.5)	8.12	8.16
$CaCo_3$ %	3.25	3.18
O.M %	2.23	2.27
N % (total)	0.21	0.23
N (ppm) (available)	65.11	67.02
P % (total)	0.132	0.128
P (ppm) (available)	25.75	23.43
K % (total)	0.66	0.67
K (ppm) (available)	897.06	925.98
Particle size distribution (mechanical analysis)		
Course sand %	5.86	6.17
Find sand %	28.25	27.84
Silt %	14.62	13.26
Clay %	51.27	52.73
Texture grade	Clay	Clay

Factors under study were as follows:

A. Plant population densities were as follows:

Five plant densities are tested. They are 18000, 21000, 24000, 27000 and 30000 maize plants/fed. Maize was grown in ridges 70 cm. apart. The five densities were carried out as shown in Table 2.

Table 2. Plant density (plants/fed), No. of hills/4 m long of ridge and hills distance (cm).

Plant density (plants/fed)	No. of hills/4 m long of ridge	Hills distance (cm)
18000	12	33.33
21000	14	28.57
24000	16	25.00
27000	18	22.22
30000	20	20.00

B. Weed control treatment were as follows:

1. Pendimethalin (Stomp Extra 45.5 % CS): N - (1 - ethylpropyl) - 3,4 - dimethyl - 2,6 - dinitrobenzenamine, applied as pre-emergence at the rate 682.5 g a.i./fed (one fed = 4200 m^2).
2. Acetochlor (harness 84 % EC): 2 - chloro - N - (ethoxymethyl) - N - (2 - ethyl - 6 - methylphenyl) acetamide, applied as pre-emergence at the rate 840 g a.i./fed.
3. Nicosulfuron (Active 6 % SC): 2- [[[[(4,6 - dimethoxy - 2 - pyrimidinyl) amino] carbonyl] amino] sulfonyl] - N,N - dimethyl - 3 - pyridinecarboxamide, applied as post-emergence at the rate 24 g a.i./fed.
4. Hand hoeing twice: at 15 and 30 days after sowing.
5. Unweeded check (the control).

All herbicides were sprayed using a knapsack sprayer equipped with one nozzle boom was used with spray volume of 200 liters/fed.

The preceding winter crop in the two seasons was wheat. The experimental design was laid out using randomized complete block design (RCBD) using split plot design in three replications. Each of the five plant densities were distributed in the main plots and the five treatments of weed control were assigned at random in sub plots. The sub plot area was 14.00 m^2 and contained five ridges of 4.00 m long and 70 cm apart. Phosphorous fertilizer was applied in form of Calcium super phosphate (12.5 % P_2O_5) at a rate of 100 kg/fed during soil preparation in each season. Experiments were planted on May 12th and 15th of in the first season (2017) and the second season (2018), respectively. Maize plants were thinned before the first irrigation to one plant/hill. Nitrogen fertilizer was applied at a rate of 150 kg N/fed as urea (46 % N), and divided into two equal parts and applied side dressed before the first and second irrigations in each season. The first irrigation was applied after 21 days from sowing and the following irrigations were applied at 10-15 days intervals during the growing seasons. Maize plants were harvested on 10th and 14th of September in the first and the second seasons, respectively. The other agricultural practices were kept the same as normally practiced in maize fields according to the recommendations of Ministry of Agriculture and Land Reclamation, except for the factors under study.

Data recorded:

A. Weeds survey:-

Annual weeds were manually pulled in a central area of square one meter area randomly placed from each sub plot after 50 days from sowing maize in each season and were identified and classified into annual broad-leaved and annual grassy weeds to estimate: fresh weight of broad-leaved weeds (g), fresh weight of grassy weeds (g) and total fresh weight of weeds (g). Then dried on an air forced drying oven at 70 ^{0} c for 72 hours to estimate: dry weight of broad-leaved weeds (g), dry weight of grassy weeds (g) and total dry weight of weeds (g).

B. Maize traits:

I- Growth traits:

Ten plants were chosen from the three center ridges at random from each sub plots to determine area of topmost ear leaf (cm^2) by **Stickler 1964**, leaf area/plant (cm^2), leaf area index [at 80 days after planting], plant height (cm), ear height (cm) and stem diameter (cm) [at maize harvest]. Whereas, the silking date [No. of days from planting to 50 % silking], No. of plants carried two ears/fed and No. of barren plants/fed [at maize harvest] were estimated from the whole plants in the sub plot.

II- Yield and yield components:

Ten ears were chosen from the three center ridges at random from each sub plots during maize harvest to determine ear length (cm), No. of kernels/ear, weight of kernels/ear (g), kernels shelling (%) and 100-kernel weight (g). Whereas, No. of ears/fed, stover yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg) and harvest index (%) were estimated from the whole plants in the sub plots.

C. Chemical analysis

Maize kernels samples were taken after harvest at random from all kernels of ten ears to determine: nitrogen uptake/fed (kg) = grain yield (kg) X kernels nitrogen % (modified micro Kjeldahl method, **A. O. A. C., 1990)**) and protein yield/fed (kg) = nitrogen uptake/fed (kg) X 6.25.

Statistical analysis:

The analysis of variance was carried out according to the procedure described by **Gomez and Gomez (1984).** Data were statistically analyzed according to using the MSTAT-C Statistical Software Package (**Michigan State University, 1983).** Where the F-test showed significant differences among

means L. S. D. test at 0.05 level was used to compare between means.

Results and Discussion:

A- Weed survey :-

The most dominant annual weeds in the experimental plots during the two seasons were represented by annual broad-leaved weeds as mexican fireplant (*Euphorbia geniculata* Ortega.), common purslane (*Portulaca oleracea* L.), jew's mallow (*Corchorus olitorius* L.), redroot pigweed (*Amaranthus retroflexus* L.), cocklebur (*Xanthium strumarium* L.), venice mallow (*Hibiscus trionum* L.) and prickly sida (*Sida alba* L.) as well as the annual grassy weeds as jungle rice {*Echinochloa colonum* (L.) Link.}, viper grass {*Dinebra retroflexa* (Vahl.) Panz.}, barnyard grass {*Echinochloa crus-galli* (L.) Beauv.} and grain foxtail {*Setaria viridis* (L.) Beauv.}.

1- Effect of plant population density:-

Fresh and dry weights of broad-leaved, grassy and total annual weeds at 50 days after sowing maize were significantly reduced with every increase in plant population density up to 30000 plants/fed in both seasons (Table 3). No significance difference was shown among 18000 and 21000, 21000 and 24000 as well as 24000 and 27000 plants/fed on all weed measurements under study during both seasons. Results show that, the more denser maize plants, the more reduction in fresh and dry weights of broad-leaved, grassy and total annual weeds at 50 days after sowing. The lowest mean values of fresh weight of broad-leaved weeds (335.88 and 293.54 g/m^2), fresh weight of grassy weeds (141.12 and 130.78 g/m^2), total fresh weight of weeds (477.00 and 424.32 g/m^2), dry weight of broad-leaved weeds (45.28 and 39.69 g/m^2), dry weight of grassy weeds (23.91 and 22.16 g/m^2) and total dry weight of weeds (69.19 and 61.85 g/m^2) which obtained from planting 30000 maize plants/fed in the 2017 and 2018 seasons, respectively. As well as, recorded the greatest mean values of control effect for annual broad-leaved weeds (16.27 and 19.79 %), annual grassy weeds (18.42 and 23.85 %) and total annual weeds (17.04 and 21.29 %) as compared with 18000 plants/fed in both seasons, respectively. Whereas, the highest mean values of fresh weight of broad-leaved weeds (401.28 and 365.80 g/m^2), fresh weight of grassy weeds (173.46 and 170.22 g/m^2), total fresh weight of weeds (574.74 and 536.02 g/m^2), dry weight of broad-leaved weeds (54.08 and 49.48 g/m^2), dry weight of grassy weeds (29.31 and 29.10 g/m^2) as well as total dry weight of weeds (83.40 and 78.58 g/m^2) was obtained with growing 18000 maize plants/fed in the first and second season, respectively. The greatest reduction in weed biomass was achieved by sowing 30000 plants/fed during the two experimental seasons, where it decreased dry weight of annual broad-leaved weeds by 16.27 % and 19.79 % also dry weight of annual grassy weeds by 18.42 % and 23.85 % as well as total dry weight of annual weeds by 17.04 % and 21.29 % when compared with 18000 plants/fed in the first and second seasons, respectively. The gradual depression in weed biomass as plant population density of maize increased up to 30000 plants/fed may be due to inter and intra-specific competitions between maize plants and weeds plants for environmental factors (light, nutrient minerals, growth place and water). These results are in agreement with those reported by **Acciares and Zuluaga 2006; Abouziena *et al.* 2008; El-Gedwy *et al.* 2012; EL-Metwally *et al.* 2012; Teymoori *et al.* 2013; Amiri *et al.* 2014; El-Sobky and El-Naggar 2016 and Simić *et al.* 2017.**

2- Effect of weed control treatments:-

Results in Table 3 indicate that, hand hoeing twice and all herbicides treatments significantly depressed fresh and dry weights of weeds at 50 days after sowing compared to the unweeded check. No significantly difference was shown between nicosulfuron herbicide and hand hoeing twice on all weeds measurements under study during both seasons, as well as among pendimethalin and acetochlor herbicides on total fresh and dry weights of annual weeds in both seasons. Hand hoeing twice was the best treatment over all on depressed fresh and dry weights of weeds at 50 days after sowing during the two experimental seasons, where it gave the lowest mean values of fresh weight of broad-leaved weeds (12.42 and 13.60 g/m^2), fresh weight of grassy weeds (8.18 and 11.08 g/m^2), total fresh weight of weeds (20.60 and 24.68 g/m^2), dry weight of broad-leaved weeds (1.70 and 1.84 g/m^2), dry weight of grassy weeds (1.41 and 1.91 g/m^2) as well as total dry weight of weeds (3.12 and 3.74 g/m^2) in 2017 and 2018 seasons, respectively. As well as, gave the maximum mean values of control effect for annual broad-leaved weeds (99.13 and 98.87 %), annual grassy weeds (98.66 and 97.93 %) and total annual weeds (98.96 and 98.53 %) as compared with unweeded control in both seasons, respectively. The next effective treatment against weeds biomass was nicosulfuron herbicide, where it decreased dry weight of annual broad-leaved weeds by 99.00 % and 98.72 % and dry weight of annual grassy weeds by 98.50 % and 97.68 % as well as total dry weight of annual weeds by 98.82 % and 98.34 % compared with unweeded check at 50 days after sowing in 2017 and 2018 seasons, respectively. Fresh and dry weights of annual broad-leaved weeds as well as total weeds markedly reduced with using weed control treatments in a descending order; hand hoeing twice, nicosulfuron, acetochlor and pendimethalin herbicide. Meanwhile, fresh and dry weights of

annual grassy weeds were significantly decreased with using control treatments in a descending order; hand hoeing twice, nicosulfuron, pendimethalin and acetochlor herbicide. Similar results were obtained by **Knezevic *et al*. 2003; Abouziena *et al*. 2008; Ahmed *et al*. 2008; Tahir *et al*. 2009; El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; Rastgordani *et al*. 2013; Teymoori *et al*. 2013; Tesfay *et al*. 2014; Amare *et al*. 2015; Pacanoski *et al*. 2015; Shaban *et al*. 2015; El-Sobky & El-Naggar 2016; Nogueira & Correia 2016; Shaban *et al*. 2016; Simić *et al*. 2017; Tyagi *et al*. 2017 as well as Ramesh Babu & Senthivel 2019.**

3- Interaction effect between plant population density and weed control treatments:-

Results in Table 4 show a significant interaction effect between plant population densities and weed control treatments on fresh and dry weights of broad-leaved, grassy and total annual weeds in 2017 and 2018 seasons at 50 days after sowing maize. Results indicated that planting maize at a population density of 30000 plants/fed gave the greatest depression in all mean values of weed biomass with all weed control treatments. On the other hand, plant population density of 18000 plants/fed gave the lowest depression in all mean values under all weed control treatments in both growing seasons. Also, weed control by hand hoeing twice or using nicosulfuron herbicide gave the greatest depression in all mean values of weed biomass under all plant population densities in the first and second seasons. The lowest mean values of fresh weight of broad-leaved weeds (10.2 and 9.5 g/m^2), fresh weight of grassy weeds (5.7 and 8.6 g/m^2), total fresh weight of weeds (15.9 and 18.1 g/m^2), dry weight of broad-leaved weeds (1.38 and 1.28 g/m^2), dry weight of grassy weeds (1.01 and 1.46 g/m^2) as well as total dry weight of weeds (2.39 and 2.74 g/m^2) in 2017 and 2018 seasons, respectively which obtained from plots under weed control by hand hoeing twice with maize planted at higher plant density (30000 plants/fed). These results are in agreement with those obtained by **Acciares and Zuluaga 2006; Abouziena *et al*. 2008; El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; Teymoori *et al*. 2013; Amiri *et al*. 2014; El-Sobky and El-Naggar 2016 and Simić *et al*. 2017.**

B- Maize traits:

I- Growth traits:

1- Effect of plant population density:-

Mean values of all maize growth traits under study as affected by plant population densities in 2017 and 2018 seasons, are presented in Table 5. Results indicated that increasing plant population densities from 18000 up to 30000 plants/fed caused remarkable increments in mean values of No. of days from sowing to 50 %silking, leaf area index, plant height (cm), ear height (cm) and No. of barren plants/fed during 2017 and 2018 seasons. On the other hand, mean values of area of topmost ear leaf (cm^2), leaf area/plant (cm^2), stem diameter (cm) and No. of plants carried two ears/fed were significantly decreased by increasing maize plant population density in both seasons. Data revealed that planting maize at lowest plant density (18000 plants/fed) gave the greatest mean values of area of topmost ear leaf (769.36 and 786.26 cm^2), leaf area/plant (9609.57 and 9971.02 cm^2), stem diameter (3.94 and 4.05 cm) and No. of plants carried two ears/fed (2820 and 2760 plants) as well as recorded the lowest mean values of No. of days to 50 % silking (64.90 and 65.45 days), leaf area index (4.12 and 4.27), plant height (291.45 and 299.85 cm), ear height (137.30 and 140.80 cm) and No. of barren plants/fed (300 and 360 plants) in the first and second seasons, respectively. While, the greatest mean values of No. of days to 50 % silking (67.00 and 68.95 days), leaf area index (5.08 and 5.01), plant height (326.10 and 336.70 cm), ear height (160.20 and 165.40 cm) and No. of barren plants/fed (3120 and 3060 plants) as well as the lowest mean values of area of topmost ear leaf (569.39 and 554.80 cm^2), leaf area/plant (7114.46 and 7017.93 cm^2), stem diameter (2.92 and 3.00 cm) and No. of plants carried two ears/fed (zero) in the first and second seasons, respectively were obtained from maize planted at highest plant density (30000 plants/fed). Increasing population density from 18 to 21, 24, 27 and 30 thousand plants/fed significantly increased plant height by 2.01, 4.25, 7.72 and 11.89 % respectively, in the first season. The corresponding increases were 3.15, 5.62, 7.74 and 12.29 % in the second season for the respective densities. The increases in plant height by increasing plant densities is mainly due to the increased intra-specific competition among maize plants for light and decrease in light penetration, interception and photosynthetic efficiency at higher densities as well as higher dense of plants excessive shade exist which help to produce more content of gibberellin in tissues and consequently higher plants formed. These results are in harmony with those reported by **Abouziena *et al*. 2008; El-Gedwy *et al*. 2012; Amiri *et al*. 2014; Gobeze *et al*. 2016; Mandić *et al*. 2016; Simić *et al*. 2017; Eyasu *et al*. 2018; Zeleke *et al*. 2018 and Sidi *et al*. 2019.**

Table 3. Effect of plant population density and weed control treatments on mean values of fresh and dry weights of annual weeds (g/m^2) at 50 days from sowing maize in 2017 and 2018 seasons.

Weed characters	Fresh weight (g/m^2)			Dry weight (g/m^2)					
	Broad-leaved weeds	Grassy weeds	Total weeds	Broad-leaved weeds	Control effect %	Grassy weeds	Control effect %	Total weeds	Control effect %
Plant population density									
				2017 season					
18000 plants/fed	401.28	173.46	574.74	54.08	--	29.31	--	83.40	--
21000 plants/fed	384.32	166.94	551.26	51.48	4.81	28.14	3.99	79.62	4.53
24000 plants/fed	370.72	161.14	531.86	50.15	7.27	27.14	7.40	77.29	7.33
27000 plants/fed	358.26	155.08	513.34	48.36	10.58	26.40	9.93	74.76	10.36
30000 plants/fed	335.88	141.12	477.00	45.28	16.27	23.91	18.42	69.19	17.04
L.S.D at 5%	20.65	11.75	30.44	2.99	--	1.73	--	4.52	--
				2018 season					
18000 plants/fed	365.80	170.22	536.02	49.48	--	29.10	--	78.58	--
21000 plants/fed	359.94	155.96	515.90	48.64	1.70	26.56	8.73	75.20	4.30
24000 plants/fed	349.52	149.58	499.10	47.20	4.61	25.39	12.75	72.58	7.64
27000 plants/fed	338.22	142.98	481.20	45.61	7.82	24.32	16.43	69.93	11.01
30000 plants/fed	293.54	130.78	424.32	39.69	19.79	22.16	23.85	61.85	21.29
L.S.D at 5%	16.23	14.75	30.52	2.25	--	2.06	--	4.88	--
Weed control treatments									
				2017 season					
Pendimethalin	260.64	53.52	314.16	35.18	81.99	9.15	91.30	44.33	85.25
Acetochlor	111.58	103.44	215.02	15.20	92.22	17.59	83.28	32.79	89.09
Nicosulfuron	14.34	9.18	23.52	1.96	99.00	1.58	98.50	3.54	98.82
Hand hoeing twice	12.42	8.18	20.60	1.70	99.13	1.41	98.66	3.12	98.96
Unweeded check	1451.48	623.42	2074.90	195.30	--	105.18	--	300.48	--
L.S.D at 5%	71.56	32.51	118.25	10.25	--	5.43	--	18.29	--
				2018 season					
Pendimethalin	336.98	59.04	396.02	45.54	71.97	10.07	89.07	55.61	78.16
Acetochlor	138.52	124.98	263.50	18.68	88.50	21.30	76.87	39.98	84.30
Nicosulfuron	15.36	12.56	27.92	2.08	98.72	2.14	97.68	4.22	98.34
Hand hoeing twice	13.60	11.08	24.68	1.84	98.87	1.91	97.93	3.74	98.53
Unweeded check	1202.56	541.86	1744.42	162.49	--	92.09	--	254.58	--
L.S.D at 5%	64.54	36.56	105.72	9.04	--	6.22	--	16.39	--

Table 4. Effect of interaction between plant population density and weed control treatments on mean values of fresh and dry weights of annual weeds (g/m^2) at 50 days from sowing maize during 2017 and 2018 seasons.

Weed characters		Fresh weight (g/m^2)			Dry weight(g/m^2)		
		Broad-leaved weeds	Grassy weeds	Total weeds	Broad-leaved weeds	Grassy weeds	Total weeds
		2017 season					
18000 plants/fed	Pendimethalin	279.5	66.8	346.3	37.75	11.36	49.11
	Acetochlor	125.4	120.4	245.8	17.59	20.45	38.04
	Nicosulfuron	17.6	11.4	29.0	2.41	1.95	4.36
	Hand hoeing twice	15.4	11.2	26.6	2.11	1.92	4.03
	Unweeded check	1568.5	657.5	2226.0	210.56	110.88	321.44
21000 plants/fed	Pendimethalin	271.5	59.8	331.3	36.55	10.24	46.79
	Acetochlor	120.4	115.4	235.8	16.25	19.65	35.90
	Nicosulfuron	15.4	10.2	25.6	2.11	1.75	3.86
	Hand hoeing twice	13.1	8.9	22.0	1.87	1.53	3.40
	Unweeded check	1501.2	640.4	2141.6	200.61	107.55	308.16
24000 plants/fed	Pendimethalin	265.3	51.7	317.0	35.88	8.79	44.67
	Acetochlor	110.7	100.5	211.2	14.95	17.05	32.00
	Nicosulfuron	12.7	9.4	22.1	1.71	1.62	3.33
	Hand hoeing twice	12.5	8.4	20.9	1.69	1.45	3.14
	Unweeded check	1452.4	635.7	2088.1	196.50	106.80	303.30
27000 plants/fed	Pendimethalin	251.4	46.8	298.2	33.95	8.11	42.06
	Acetochlor	105.7	92.4	198.1	14.25	15.75	30.00
	Nicosulfuron	13.5	8.4	21.9	1.87	1.45	3.32
	Hand hoeing twice	10.9	6.7	17.6	1.47	1.15	2.62
	Unweeded check	1409.8	621.1	2030.9	190.25	105.55	295.80
30000 plants/fed	Pendimethalin	235.5	42.5	278.0	31.79	7.25	39.04
	Acetochlor	95.7	88.5	184.2	12.95	15.05	28.00
	Nicosulfuron	12.5	6.5	19.0	1.69	1.15	2.84
	Hand hoeing twice	10.2	5.7	15.9	1.38	1.01	2.39
	Unweeded check	1325.5	562.4	1887.9	178.57	95.11	273.68
L.S.D at 5%		160.02	72.70	264.42	22.92	12.14	40.90
		2018 season					
18000 plants/fed	Pendimethalin	356.4	76.8	433.2	48.25	13.23	61.48
	Acetochlor	145.6	142.5	288.1	19.55	24.51	44.06
	Nicosulfuron	19.8	15.9	35.7	2.67	2.76	5.43
	Hand hoeing twice	17.5	14.5	32.0	2.36	2.45	4.81
	Unweeded check	1289.7	601.4	1891.1	174.59	102.55	277.14
21000 plants/fed	Pendimethalin	346.8	66.8	413.6	46.51	11.36	57.87
	Acetochlor	143.5	135.4	278.9	19.37	23.02	42.39
	Nicosulfuron	17.4	15.4	32.8	2.35	2.63	4.98
	Hand hoeing twice	15.5	12.4	27.9	2.08	2.21	4.29
	Unweeded check	1276.5	549.8	1826.3	172.88	93.57	266.45
24000 plants/fed	Pendimethalin	339.8	60.5	400.3	45.87	10.29	56.16
	Acetochlor	140.5	120.7	261.2	18.96	20.52	39.48
	Nicosulfuron	16.5	10.5	27.0	2.22	1.79	4.01
	Hand hoeing twice	15.4	10.4	25.8	2.08	1.78	3.86
	Unweeded check	1235.4	545.8	1781.2	166.86	92.55	259.41
27000 plants/fed	Pendimethalin	330.4	54.6	385.0	44.51	9.28	53.79
	Acetochlor	132.5	115.8	248.3	17.87	19.68	37.55
	Nicosulfuron	12.7	10.5	23.2	1.72	1.75	3.47
	Hand hoeing twice	10.1	9.5	19.6	1.39	1.63	3.02
	Unweeded check	1205.4	524.5	1729.9	162.55	89.25	251.80
30000 plants/fed	Pendimethalin	311.5	36.5	348.0	42.55	6.21	48.76
	Acetochlor	130.5	110.5	241.0	17.65	18.79	36.44
	Nicosulfuron	10.4	10.5	20.9	1.42	1.79	3.21
	Hand hoeing twice	9.5	8.6	18.1	1.28	1.46	2.74
	Unweeded check	1005.8	487.8	1493.6	135.55	82.55	218.10
L.S.D at 5%		144.32	81.75	236.40	20.21	13.91	36.65

2- Effect of weed control treatments:-

Results presented in Table 5 showed that mean values of area of topmost ear leaf (cm^2), leaf area/plant (cm^2), leaf area index, plant height (cm), ear height (cm), stem diameter (cm) and No. of plants carried two ears/fed were significant increased by using hand hoeing twice and all herbicides treatments compared to unweeded check except, mean values of No. of days from sowing to 50 % silking and No. of barren plants/fed were significantly decreased during 2017 and 2018 seasons. But, No significantly difference was shown among pendimethalin, acetochlor, nicosulfuron and hand hoeing twice on No. of days from sowing to 50 % silking, plant height, ear height and stem diameter during 2017 and 2018 seasons. Results show that weed control by hand hoeing twice recorded the maximum mean values of area of topmost ear leaf (715.61 and 736.00 cm^2), leaf area/plant (9481.83 and 10119.95 cm^2), leaf area index (5.31 and 5.64), plant height (330.10 and 342.05 cm), ear height (157.30 and 162.95cm), stem diameter (3.79 and 3.86 cm) and No. of plants carried two ears/fed (1680 and 1620 plants) as well as recorded the shortest period from planting to 50 % silking (64.95 and 66.15 days) and gave lowest mean values of No. of barren plants/fed (600 and 660 plants) in the first and second seasons, respectively. The higher increases in mean values of plant leaf area were obtained with hand hoeing twice (63.80 and 78.48 %), nicosulfuron (56.79 and 66.65 %), acetochlor (53.95 and 55.01 %) followed by pendimethalin (48.58 and52.53 %) in 2017 and 2018 seasons, respectively over unweeded check. The increases in maize growth traits may be due to the good role of hand hoeing twice and herbicides treatments in depressed fresh and dry weights of weeds and decreased inter-specific competition among maize plants and weed plants. These results are in harmony with those reported by **Knezevic *et al*. 2003; Rastgordani *et al*. 2013; Teymoori *et al*. 2013; Tesfay *et al*. 2014; Amare *et al*. 2015; Nogueira & Correia 2016 and Simić *et al*. 2017**, who found that mean values of maize growth traits were increased as a result of using hand hoeing twice or some herbicidal treatments as nicosulfuron.

3- Interaction effect between plant population density and weed control treatments:-

Results in Table 6 show that the significant effect of the interaction among the five plant population densities, *i.e.* 18, 21, 24, 27 and 30 thousand maize plants/fed and the five weed control treatments (pendimethalin, acetochlor, nicosulfuron, hand hoeing twice and unweeded check) were obtained for mean values of area of topmost ear leaf (cm^2), leaf area/plant (cm^2), leaf area index, plant height (cm) and ear height (cm). Meanwhile, mean values of No. of days from sowing to 50 % silking, stem diameter (cm), No. of plants carried two ears/fed and No. of barren plants/fed were not significantly affected by the interaction between plant population densities and weed control treatments during 2017 and 2018 seasons. Results indicated that planting maize at a population density of 18000 plants/fed gave the greatest mean values of area of topmost ear leaf and leaf area/plant as well as recorded the lowest mean values of leaf area index, plant height and ear height under all weed control treatments. Also, weed control by hand hoeing twice or using nicosulfuron herbicide gave the highest mean values of area of topmost ear leaf, leaf area/plant, leaf area index, plant height and ear height under all plant population densities in the first and second seasons. Results revealed that maize planted at higher plant density (30000 plants/fed) under weed control by hand hoeing twice recorded significantly the maximum values of leaf area index (5.78 and 5.90), plant height (351.25 and 365.75 cm) and ear height (172.25 and 179.25 cm) during 2017 and 2018 seasons, respectively. Meanwhile, the greatest mean values of area of topmost ear leaf (825.75 and 875.24 cm^2) and leaf area/plant (10941.19 and 12034.55 cm^2) which were obtained from planting lower plant density (18000 plants/fed) under mechanical weed control by hand hoeing twice. Similar results were also reported by **Abouziena *et al*. 2008; El-Gedwy *et al*. 2012; Amiri *et al*. 2014 and Simić *et al*. 2017.**

II- Yield and yield components:

1- Effect of plant population density:-

Results presented in Table 7 revealed that the differences between the studied five plant population densities, *i.e.* 18, 21, 24, 27 and 30 thousand maize plants/fed were significant on all mean values of yield components and yield during 2017 and 2018 seasons. But, there were no significant differences between planting 18000 and 21000 plants fed on mean values of shelling % and 100-kernels weight in both seasons and harvest index in the second season. Also, there was no significant difference between planting 21000 and 24000 plants/fed on mean values of 100-kernel weight and grain yield/fed. As well as, no significant difference among planting 27000 and 30000 plants/fed on mean values of biological yield/fed. Data revealed that planting 18000 maize plants/fed gave the greatest mean values of ear length (18.75 and 19.88 cm), No. of kernels/ear (482.44 and 513.86 kernels), weight of kernels/ear (156.53 and 177.92 g), kernels shelling (77.23 and 78.93 %), 100-kernel weight (31.66 and 33.78 g) and harvest index (36.70 and 37.49 %) in the first and second seasons, respectively. In the 2017 season, planting maize at plant density of 18000 plants/fed increased No. of kernels/ear by 11.25, 28.16, 49.71 and 82.58 % also increased weight of kernels/ear by 13.63, 36.40, 70.81 and 125.78 % compared with the growing maize at plant densities of 21000, 24000, 27000 and 30000 plants/fed respectively, the respective

corresponding in the second season, were 8.14, 25.03, 39.15 and 73.76 % for No. of kernels/ear and by 12.72, 34.48, 60.48 and 114.98 % for weight of kernels/ear. This trend could be explained on the fact that in case of low population density produced by increasing hill spacing resulted in low intra-specific competition between it for nutrient elements, soil moisture and sun light, plants would have better opportunity to produce more metabolite contents and positive effect on plant growth and productivity as well as increased translocation and consequently accumulation of metabolites through kernels and gave the maximum values of plant traits and yield components. The greatest mean values of No. of ears/fed (26880 and 26940 ears) and stover yield/fed (5173 and 5370 kg) which were obtained from planting 30000 maize plants/fed in the first and second seasons, respectively. Increasing population density from 18 to 21, 24, 27 and 30 thousand plants/fed significantly increased stover yield/fed by 18.14, 28.69, 35.86 and 45.57 % respectively, in the first season. The corresponding increases were 15.08, 25.40, 34.92 and 42.06 % in the second season for the respective densities. Such increase in stover yield/fed could be due to the increases in plant height, leaf area index and No. of plants/fed. Results showed that the optimum plant population density (24000 plants/fed) produced the highest mean values of grain yield/fed (2949.68 and 3219.89 kg) and biological yield/fed (8445 and 8880 kg) in the first and second seasons, respectively compared to the higher plant population (27000 and 30000 plants/fed) or the lower plants population (21000 and 18000 plants/ fed) in both seasons. These results reflect the important role of intra-specific competition between maize plants as plant density increased to reduce the yield till the optimum plant density is reached. On the other hand, the highest plant density (30000 plants/fed) produced the lowest grain yield/fed which were 1702.13 and 2008.95 kg in the first and second season, respectively. Meanwhile, the lowest plant density (18000 plants/fed) produced the lowest biological yield/fed which were 6870 and 7305 kg in the first and second season, respectively These results are in harmony with those reported by **Acciares and Zuluaga 2006; El-Gedwy *et al.* 2012; Teymoori *et al.* 2013; Marin and Weiner 2014; El-Sobky and El-Naggar 2016; Rahman *et al.* 2016; Sharanabasappa *et al.* 2017 as well as Ramesh Babu and Senthivel 2019.**

2- Effect of weed control treatments:-

Results presented in Table 7 showed that mean values of yield and yield components traits of maize significant increased when using hand hoeing twice or all herbicides treatments compared to unweeded check in the two growing seasons. Results may reveal the superiority of hand hoeing twice in mean values of No. of ears/fed (25080 and 24960 ears), ear length (17.48 and 19.01 cm), No. of kernels/ear (441.50 and 486.71 kernels), weight of kernels/ear (141.85 and 165.37 g), kernels shelling (77.76 and 79.58 %), 100-kernel weight (31.66 and 33.51 g), stover yield/fed (4920 and 5100 kg), grain yield/fed (3008.39 and 3339.63 kg), biological yield/fed (8775 and 9285 kg) and harvest index (34.33 and 36.04 %) during 2017 and 2018 seasons, respectively. Mean values of maize yield and its components increased under weed control treatments in ascending order; pendimethalin, acetochlor nicosulfuron and hand hoeing twice. But, there were no significant differences between nicosulfuron and hand hoeing twice and between pendimethalin and acetochlor as well as among acetochlor and nicosulfuron on mean values of allmost maize yield and yield components traits in the two growing seasons. The higher increases were obtained with hand hoeing twice (193.26 and 200.32 %), nicosulfuron (179.76 and 192.00 %), acetochlor (167.43 and 180.08 %) and followed by pendimethalin (159.82 and 167.63 %) in 2017 and 2018 seasons, respectively over the unweeded check (the control). The severe reduction in maize yield and its components when allowing weeds to compete maize plants could be attributed to inter-specific competition with the crop for light, water, nutrients and space which affected negatively the vegetative growth of plants particularly plant leaf area as well as dry matter accumulation. Moreover, some weeds shade the crop plants and then decrease the radiation that would fall on foliage of the crop. Consequently, this well affects negatively the photosynthesis efficiency and translocation of synthates to be stored in grain. As well as, may be due to the decrease in No. of ears/fed, ear length, No. of kernels/ear, weight of kernels/ear, shelling, 100-kernel weight and harvest index. The increases in seed yield/fed may be due to the good role of weed control by hand hoeing twice or using herbicides in improving and increasing yield attributes, *i.e.* No. of ears/fed, ear length, No. of kernels/ear, weight of kernels/ear, shelling, 100-kernel weight and harvest index. These results are in harmony with those reported by **Knezevic *et al.* 2003; Rastgordani *et al.* 2013; Teymoori *et al.* 2013; Tesfay *et al.* 2014; Amare *et al.* 2015; Nogueira & Correia 2016 and Simić *et al.* 2017**, who found that mean values of yield components traits and yield of maize were increased as a result of using hand hoeing twice or some herbicidal treatments as nicosulfuron.

Table 5. Mean values of silking date, area of topmost ear leaf (cm^2), leaf area/plant (cm^2), leaf area index, plant height (cm), ear height (cm), stem diameter (cm), No. of plants carried two ears/fed and No. of barren plants/fed of maize as affected by plant population density and weed control treatments during 2017 and 2018 seasons.

Trait	Silking date		Area of topmost ear leaf (cm^2)		Leaf area/plant (cm^2)		Leaf area index		Plant height (cm)		Ear height (cm)		Stem diameter (cm)		No. of plants carried two ears/fed		No. of barren plants/fed	
Seasons	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Plant population density (plants/fed)																		
18000	64.90	65.45	769.36	786.26	9609.57	9971.02	4.12	4.27	291.45	299.85	137.30	140.80	3.94	4.05	2820	2760	300	360
21000	65.25	65.85	735.99	751.81	9195.87	9522.33	4.60	4.76	297.30	309.30	139.80	145.35	3.83	3.90	1860	1920	480	420
24000	65.80	67.00	669.26	666.69	8356.91	8445.29	4.78	4.83	303.85	316.70	142.95	149.10	3.65	3.71	1020	1140	900	960
27000	66.25	68.00	608.69	610.40	7581.88	7720.08	4.87	4.96	313.95	323.05	150.75	155.10	3.39	3.41	120	240	1680	1680
30000	67.00	68.95	569.39	554.80	7114.46	7017.93	5.08	5.01	326.10	336.70	160.20	165.40	2.92	3.00	0	0	3120	3060
L.S.D at 5%	0.82	0.89	26.54	38.51	342.11	481.55	0.12	0.17	6.72	8.12	4.12	4.98	0.10	0.11	54	48	61	52
Weed control treatments																		
Pendimethalin	65.90	67.00	674.56	678.33	8600.69	8648.66	4.82	4.83	323.50	333.15	154.05	158.70	3.64	3.76	1260	1380	1200	1080
Acetochlor	65.50	66.70	685.51	689.33	8911.60	8789.01	4.99	4.91	326.10	334.05	155.40	159.10	3.69	3.79	1380	1500	960	900
Nicosulfuron	65.05	66.30	698.16	713.13	9076.03	9449.03	5.09	5.27	328.30	339.30	156.40	161.65	3.73	3.81	1500	1560	780	780
Hand hoeing twice	64.95	66.15	715.61	736.00	9481.83	10119.95	5.31	5.64	330.10	342.05	157.30	162.95	3.79	3.86	1680	1620	600	660
Unweeded check	67.80	69.10	578.85	553.17	5788.54	5670.01	3.25	3.18	224.65	237.05	107.85	113.35	2.88	2.86	0	0	2940	3060
L.S.D at 5%	0.96	0.98	29.23	39.54	401.23	498.33	0.21	0.28	11.25	13.41	6.52	7.84	0.16	0.18	65	57	83	75

Table 6. Mean values of silking date, area of topmost ear leaf (cm^2), leaf area/plant (cm^2), leaf area index, plant height (cm), ear height (cm), stem diameter (cm), No. of plants carried two ears/fed and No. of barren plants/fed of maize as affected by interaction between plant population density and weed control treatments during 2017 and 2018 seasons.

Trait		Silking date		area of topmost ear leaf (cm^2)		leaf area/plant (cm^2)		leaf area index		Plant height (cm)		Ear height (cm)		Stem diameter (cm)		No. of plants carried two ears/fed		No. of barren plants/fed	
Season		**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
18000 plants/fed	**Pendimethalin**	64.75	65.25	776.85	793.25	9904.84	10113.94	4.24	4.33	308.75	312.25	145.00	146.75	4.11	4.25	3300	3300	0	0
	Acetochlor	64.50	64.75	786.36	804.75	10222.68	10260.56	4.38	4.40	310.25	315.25	146.00	148.25	4.15	4.29	3300	3300	0	0
	Nicosulfuron	64.25	64.50	800.25	833.57	10403.25	11044.80	4.46	4.73	312.25	320.75	146.75	150.75	4.23	4.32	3600	3600	0	0
	Hand hoeing twice	64.00	64.50	825.75	875.24	10941.19	12034.55	4.69	5.16	315.75	325.50	148.50	153.00	4.25	4.39	3900	3600	0	0
	Unweeded check	67.00	68.25	657.59	624.51	6575.90	6401.23	2.82	2.74	210.25	225.50	100.25	105.25	2.98	3.02	0	0	1500	1800
21000 plants/fed	**Pendimethalin**	65.00	65.50	744.23	751.24	9488.93	9578.31	4.74	4.79	316.25	326.50	148.75	153.50	4.02	4.11	2100	2400	300	0
	Acetochlor	64.75	65.25	756.91	768.72	9839.83	9801.18	4.92	4.90	318.25	327.75	149.75	154.00	4.03	4.12	2400	2400	0	0
	Nicosulfuron	64.50	64.75	765.81	799.82	9955.53	10597.62	4.98	5.30	319.00	330.00	150.00	155.00	4.07	4.13	2100	2400	0	0
	Hand hoeing twice	64.50	64.75	789.25	823.50	10457.56	11323.13	5.23	5.66	319.25	330.75	150.00	155.50	4.10	4.20	2700	2400	0	0
	Unweeded check	67.50	69.00	623.75	615.75	6237.50	6311.44	3.12	3.16	213.75	231.50	100.50	108.75	2.95	2.94	0	0	2100	2100
24000 plants/fed	**Pendimethalin**	66.25	67.00	667.24	671.25	8507.31	8558.44	4.86	4.89	320.75	333.25	150.75	156.75	3.75	3.88	900	1200	600	600
	Acetochlor	65.50	66.25	689.78	678.25	8967.14	8647.69	5.12	4.94	323.50	336.75	152.00	158.25	3.82	3.91	1200	1500	600	300
	Nicosulfuron	64.50	66.50	700.69	715.47	9108.97	9479.98	5.21	5.42	325.25	337.50	152.75	158.75	3.85	3.92	1500	1500	300	300
	Hand hoeing twice	64.75	66.25	712.35	725.24	9438.64	9972.05	5.39	5.70	326.50	338.75	153.50	159.25	3.91	3.95	1500	1500	0	300
	Unweeded check	68.00	69.00	576.25	543.25	5762.50	5568.31	3.29	3.18	223.25	237.25	105.75	112.50	2.92	2.90	0	0	3000	3300
27000 plants/fed	**Pendimethalin**	66.50	68.25	610.25	615.75	7780.69	7850.81	5.00	5.05	329.25	340.50	158.00	163.50	3.45	3.50	0	0	1500	1500
	Acetochlor	66.00	68.25	613.24	625.24	7972.12	7971.81	5.12	5.12	332.75	334.75	159.75	160.75	3.49	3.53	0	300	1200	1500
	Nicosulfuron	65.50	67.25	625.46	640.00	8130.98	8480.00	5.23	5.45	335.50	346.75	161.25	166.50	3.51	3.55	300	300	1200	900
	Hand hoeing twice	65.25	66.75	640.25	655.75	8483.31	9016.56	5.45	5.80	337.75	349.50	162.25	167.75	3.65	3.64	300	600	900	600
	Unweeded check	68.00	69.50	554.23	515.24	5542.30	5281.21	3.56	3.40	234.50	243.75	112.50	117.00	2.86	2.81	0	0	3600	3900
30000 plants/fed	**Pendimethalin**	67.00	69.00	574.25	560.14	7321.69	7141.79	5.23	5.10	342.50	353.25	167.75	173.00	2.89	3.05	0	0	3600	3300
	Acetochlor	66.75	69.00	581.25	569.71	7556.25	7263.80	5.40	5.19	345.75	355.75	169.50	174.25	2.95	3.08	0	0	3000	2700
	Nicosulfuron	66.50	68.50	598.57	576.81	7781.41	7642.73	5.56	5.46	349.50	361.50	171.25	177.25	3.00	3.11	0	0	2400	2700
	Hand hoeing twice	66.25	68.50	610.45	600.25	8088.46	8253.44	5.78	5.90	351.25	365.75	172.25	179.25	3.05	3.11	0	0	2100	2400
	Unweeded check	68.50	69.75	482.45	467.11	4824.50	4787.88	3.45	3.42	241.50	247.25	120.25	123.25	2.71	2.63	0	0	4500	4200
L.S.D at 5%		N.S.	N.S.	65.36	88.41	897.18	1114.30	0.47	0.63	25.16	29.99	14.58	17.53	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 7. Mean values of No. ears/fed, ear length (cm), No. of kernels/ear, weight of kernels/ear(g), shelling %, 100-kernel weight (g), stover yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg) and harvest index (%) as affected by plant population density and weed control treatments during 2017 and 2018 seasons.

Trait	No. of ears/fed		ear length (cm)		No. of kernels/ear		Weight of kernels/ear (g)		Shelling %		100-kernel weight (g)		Stover yield/fed (kg)		Grain yield/fed (kg)		Biological yield/fed (kg)		Harvest index %	
Seasons	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Plant population density (plants/fed)																				
18000	20520	20400	18.75	19.88	482.44	513.86	156.53	177.92	77.23	78.93	31.66	33.78	3555	3780	2617.35	2845.03	6870	7305	36.70	37.49
21000	22380	22500	17.11	18.39	433.66	475.16	137.75	157.84	76.62	78.24	31.08	32.49	4200	4350	2838.49	3184.97	7830	8340	35.12	36.96
24000	24120	24180	15.92	17.18	376.45	411.00	114.76	132.30	74.71	76.21	29.81	31.48	4575	4740	2949.68	3219.89	8445	8880	33.92	35.15
27000	25440	25560	14.24	15.48	322.24	369.28	91.64	110.87	73.25	74.50	27.81	29.34	4830	5100	2205.11	2530.52	7785	8430	27.49	29.10
30000	26880	26940	12.76	14.37	264.23	295.73	69.33	82.76	70.53	72.11	25.87	27.46	5175	5370	1702.13	2008.95	7560	8115	22.14	24.19
L.S.D at 5%	112	120	0.85	0.76	26.51	20.15	10.25	8.87	1.23	0.98	1.43	1.32	216	198	156.98	142.72	356	312	0.98	0.75
Weed control treatments																				
Pendimethalin	24060	24300	16.03	17.56	384.97	421.67	119.50	136.73	76.77	78.30	30.57	31.95	4620	4845	2665.31	2976.10	8070	8625	33.01	34.48
Acetochlor	24420	24600	16.47	17.95	399.12	443.34	123.92	145.07	77.04	78.60	30.51	32.27	4740	4905	2743.34	3114.51	8280	8850	33.08	35.22
Nicosulfuron	24720	24780	16.85	18.41	414.49	458.54	130.44	153.16	77.43	79.04	30.98	32.97	4845	5040	2869.89	3247.12	8535	9135	33.63	35.57
Hand hoeing twice	25080	24960	17.48	19.01	441.50	486.71	141.85	165.37	77.76	79.58	31.66	33.51	4920	5100	3008.39	3339.63	8775	9285	34.33	36.04
Unweeded check	21060	20940	11.96	12.36	238.92	254.76	54.30	61.35	63.35	64.46	22.52	23.83	3210	3450	1025.83	1112.01	4830	5175	21.32	21.59
L.S.D at 5%	132	142	1.11	1.04	31.25	28.41	13.26	11.74	1.41	1.13	1.54	1.39	236	213	186.54	172.76	436	398	1.12	1.02

3- Interaction effect between plant population density and weed control treatments:-

Results in Table 8 clear that mean values of No. of ears/fed, No. of kernels/ear, weight of kernels/ear, 100-kernel weight, stover yield/fed, grain yield/fed and biological yield/fed were significantly affected by the interaction between plant population densities and weed control treatments. While, mean values of ear length, shelling % and harvest index were not significantly affected by the interaction during 2017 and 2018 seasons. Results showed that maize planed at lower plant density (18000 plants/fed) under mechanical weed control (hand hoeing twice) gave the maximum mean values of No. of kernels/ear (574.20 and 619.08 kernels), weight of kernels/ear (198.21 and 229.37 g), 100-kernel weight (34.52 and 37.05 g) in the first and second seasons, respectively. The maximum mean values of No. of ears/fed (27900 and 27600 ears) and stover yield/fed (5700 and 5775 kg) in the first and second seasons, respectively which were obtained from higher plant density (30000 plants/fed) with hand hoeing twice for weed control. Maize planted at 24000 plants/fed under weed control by hand hoeing twice produced the greatest mean values of biological yield/fed (9375 and 9975 kg) in the first and second season. The maximum mean values of grain yield/fed (3458.14 and 3798.12 kg) were obtained from maize planted at 24000 and 21000 plants/fed under hand hoeing twice for weed control the first and second seasons, respectively. These results agree with those reported by **Acciares and Zuluaga 2006; El-Gedwy *et al*. 2012; Teymoori *et al*. 2013 as well as El-Sobky and El-Naggar 2016.**

C- Chemical analysis:

1- Effect of plant population density:-

Results in Table 9 show that plant density significantly affected mean values of nitrogen uptake/fed (kg) and protein yield/fed (kg). While, mean values of kernels nitrogen content (%) and kernels crude protein content (%) were not significantly affected by maize plant density in 2017 and 2018 seasons. In the first season, the highest mean values of nitrogen uptake/fed (56.61 kg) and protein yield/fed (353.82 kg) were detected with maize planting by 24000 plants/ fed. While, in the second season, maize planting at 21000 plants/fed gave the greatest mean values of nitrogen uptake/fed (61.25 kg) and protein yield/fed (382.84 kg). However, the highest plant density (30000 plants/fed) gave the lowest nitrogen uptake/fed (30.03 and 34.95 kg) and protein yield/fed (187.71 and 218.47 kg) in the first and second seasons, respectively. No significant difference was found between planting 21000 and 24000 plants/fed on mean values of nitrogen uptake/fed (kg) and protein yield/fed (kg). This result may be due to the increase in grain yield/fed. The results agree with those reported by **El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; El-Sobky and El-Naggar 2016 and El-Hosary *et al*. 2019.**

2- Effect of weed control treatments:-

Results in Table 9 showed that mean values of nitrogen uptake/fed (kg) and protein yield/fed (kg) were significantly influenced by weed control treatments. But, mean values of kernels nitrogen content (%) and kernels crude protein content (%) were not significantly affected by weed control treatments in the first and second season. Planting maize with weeds controlling by hand hoeing twice recoded maximum mean values of nitrogen uptake/fed (59.15 and 63.57 kg) and protein yield/fed (369.70 and 397.29 kg) in the first and second seasons, respectively. On the other hand, the minimum mean values of nitrogen uptake/fed (16.73 and 18.33 kg) as well as protein yield/fed (104.55 and 114.58 kg) were obtained when planting maize under unweeded control in the first and second seasons, respectively. The differences among nicosulfuron and hand hoeing twice and between pendimethalin and acetochlor as well as among acetochlor and nicosulfuron were not significant on mean values of nitrogen uptake/fed (kg) and protein yield/fed (kg). This result may be due to the increase in grain yield/fed. The results agree with those reported by **El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012; El-Sobky & El-Naggar 2016 and Shaban *et al*. 2016.**

3- Interaction effect between plant population density and weed control treatments:-

Results in Table 9 showed that mean values of nitrogen uptake/fed (kg) and protein yield/fed (kg) were significantly affected by the interaction between plant population density and weed control treatments in maize. But, mean values of kernels nitrogen content (%) and kernels crude protein content (%) were not significantly affected by the interaction during 2017 and 2018 seasons. It is clear that planting maize by 21000 plants/fed under mechanical weed control (hand hoeing twice) gave the highest mean values of nitrogen uptake/fed (69.75 and 74.82 kg) and protein yield/fed (435.94 and 467.64 kg) in the first and second seasons, respectively. Whereas, the minimum mean values of nitrogen uptake/fed (14.88 and 15.87 kg) and protein yield/fed (92.97 and 99.16 kg) in the first and second season, respectively were obtained from planting maize by 30000 plants/fed without weed control. These results are in agreement with those obtained by **El-Gedwy *et al*. 2012; EL-Metwally *et al*. 2012 as well as El-Sobky and El-Naggar 2016.**

Table 8. Mean values of No. ears/fed, ear length (cm), No. of kernels/ear, weight of kernels/ear(g), shelling %, 100-kernel weight (g), stover yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg) and harvest index (%) as affected by interaction between plant population density and weed control treatments during 2017 and 2018 seasons.

Trait		No. of ears/fed		ear length (cm)		No. of kernels/ear		Weight of kernels/ear (g)		Shelling (%)		100-kernel weight (g)		Stover yield/fed (kg)		Grain yield/fed (kg)		Biological yield/fed (kg)		Harvest index (%)	
Season		**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
18000 plants/fed	**Pendimethalin**	21300	21300	19.25	20.25	492.80	522.45	162.87	182.23	79.85	81.56	33.05	34.88	3450	3825	2934.49	3180.84	7125	7725	41.19	41.18
	Acetochlor	21300	21300	19.88	21.02	514.71	551.51	170.63	193.14	80.02	81.77	33.15	35.02	3675	3900	3000.75	3250.36	7425	7875	40.41	41.27
	Nicosulfuron	21600	21600	20.57	21.89	543.40	573.78	181.60	206.27	80.24	82.16	33.42	35.95	3900	4200	3069.18	3327.48	7725	8250	39.73	40.33
	Hand hoeing twice	21900	21600	21.52	23.11	574.20	619.08	198.21	229.37	80.87	82.57	34.52	37.05	4050	4200	3153.93	3467.94	7950	8400	39.67	41.29
	Unweeded check	16500	16200	12.55	13.11	287.10	302.50	69.33	78.59	65.15	66.57	24.15	25.98	2700	2775	928.39	998.55	4125	4275	22.51	23.36
21000 plants/fed	**Pendimethalin**	22800	23400	17.77	19.25	454.40	496.65	146.63	166.92	79.31	80.91	32.27	33.61	4350	4500	3152.57	3519.59	8325	8850	37.87	39.77
	Acetochlor	23400	23400	18.09	19.77	466.98	517.45	151.91	175.88	79.48	81.00	32.53	33.99	4500	4575	3218.94	3645.00	8550	9075	37.65	40.17
	Nicosulfuron	23100	23400	18.24	20.04	474.50	525.31	156.92	182.49	79.67	81.29	33.07	34.74	4575	4650	3286.39	3719.02	8700	9225	37.77	40.31
	Hand hoeing twice	23700	23400	19.02	20.15	502.92	542.70	168.58	190.32	79.98	81.68	33.52	35.07	4650	4725	3419.15	3798.12	8925	9375	38.31	40.51
	Unweeded check	18900	18900	12.45	12.74	269.50	293.70	64.73	73.57	64.66	66.30	24.02	25.05	2925	3300	1115.39	1243.13	4650	5175	23.99	24.02
24000 plants/fed	**Pendimethalin**	24300	24600	16.05	17.77	387.45	424.08	122.12	138.97	77.25	78.81	31.52	32.77	4800	4875	3302.44	3605.56	9075	9450	36.39	38.15
	Acetochlor	24600	25200	16.55	18.02	405.48	443.52	128.13	146.49	77.57	79.02	31.60	33.03	4875	4950	3374.30	3674.43	9225	9600	36.58	38.28
	Nicosulfuron	25200	25200	17.25	18.53	415.00	454.86	131.22	151.47	78.01	79.25	31.62	33.30	4950	5100	3393.44	3744.56	9300	9825	36.49	38.11
	Hand hoeing twice	25500	25200	17.75	19.00	435.61	485.04	138.79	163.94	78.15	79.99	31.86	33.80	4950	5250	3458.14	3779.53	9375	9975	36.89	37.89
	Unweeded check	21000	20700	12.01	12.57	238.70	247.50	53.54	60.64	62.57	63.97	22.43	24.50	3300	3525	1220.12	1295.39	5250	5550	23.24	23.34
27000 plants/fed	**Pendimethalin**	25500	25500	14.22	16.00	324.72	383.16	94.23	115.91	75.42	76.48	29.02	30.25	5100	5325	2262.60	2638.56	8100	8775	27.93	30.07
	Acetochlor	25800	25800	14.77	16.04	333.56	396.90	97.10	122.13	75.68	77.24	29.11	30.77	5100	5400	2383.92	2838.57	8250	9075	28.90	31.28
	Nicosulfuron	26100	26400	15.09	16.57	358.75	413.28	106.01	129.11	76.24	77.67	29.55	31.24	5175	5475	2630.28	3087.38	8625	9450	30.50	32.67
	Hand hoeing twice	26400	27000	15.55	17.02	387.35	430.86	117.13	136.88	76.55	78.22	30.24	31.77	5250	5550	2813.21	3050.58	8925	9450	31.52	32.28
	Unweeded check	23400	23100	11.55	11.76	206.80	222.20	43.74	50.33	62.37	62.88	21.15	22.65	3525	3750	935.55	1037.52	5025	5400	18.62	19.21
30000 plants/fed	**Pendimethalin**	26400	26700	12.88	14.55	265.50	282.03	71.66	79.62	72.02	73.75	26.99	28.23	5400	5700	1674.47	1935.94	7725	8325	21.68	23.25
	Acetochlor	27000	27300	13.04	14.88	274.89	307.34	71.86	87.71	72.45	73.99	26.14	28.54	5550	5700	1738.80	2164.21	7950	8625	21.87	25.09
	Nicosulfuron	27600	27300	13.09	15.04	280.80	325.49	76.43	96.48	72.97	74.83	27.22	29.64	5625	5775	1970.19	2357.15	8325	8925	23.67	26.41
	Hand hoeing twice	27900	27600	13.57	15.77	307.44	355.88	86.54	106.34	73.25	75.42	28.15	29.88	5700	5775	2197.50	2601.99	8700	9225	25.26	28.21
	Unweeded check	25500	25800	11.23	11.62	192.50	207.90	40.17	43.64	61.98	62.57	20.87	20.99	3600	3900	929.70	985.48	5100	5475	18.23	18.00
L.S.D at 5%		295	318	N.S.	N.S.	69.88	63.53	29.65	26.25	N.S.	N.S.	3.44	3.11	528	476	417.12	386.30	975	890	N.S.	N.S.

Table 9. Mean values of kernels nitrogen content (%), kernels crude protein content (%), nitrogen uptake/fed (kg) and protein yield/fed (kg) as affected by plant population density, weed control treatments and their interaction during 2017 and 2018 seasons.

Trait		Kernels nitrogen content (%)		Kernels crude protein content (%)		Nitrogen uptake/fed (kg)		Protein yield/fed (kg)	
		2017	2018	2017	2018	2017	2018	2017	2018
Plant population density (plants/fed)									
18000		1.95	1.89	12.16	11.84	52.16	54.85	325.99	342.82
21000		1.94	1.89	12.10	11.80	56.21	61.25	351.30	382.84
24000		1.88	1.83	11.76	11.45	56.61	59.87	353.82	374.20
27000		1.82	1.79	11.39	11.18	40.88	45.85	255.50	286.59
30000		1.75	1.72	10.91	10.78	30.03	34.95	187.71	218.47
L.S.D at 5%		N.S.	N.S.	N.S.	N.S.	2.44	2.12	15.23	13.25
Weed control treatments									
Pendimethalin		1.89	1.85	11.84	11.55	50.96	55.39	318.47	346.20
Acetochlor		1.91	1.86	11.96	11.63	52.95	58.27	330.93	364.21
Nicosulfuron		1.94	1.88	12.13	11.73	56.11	61.22	350.68	382.62
Hand hoeing twice		1.95	1.89	12.21	11.84	59.15	63.57	369.70	397.29
Unweeded check		1.63	1.65	10.19	10.30	16.73	18.33	104.55	114.58
L.S.D at 5%		N.S.	N.S.	N.S.	N.S.	3.48	2.98	21.75	18.65
Plant density X Weed control									
18000 plants/fed	**Pendimethalin**	1.98	1.92	12.38	12.00	58.10	61.07	363.14	381.70
	Acetochlor	2.00	1.92	12.50	12.00	60.02	62.41	375.09	390.04
	Nicosulfuron	2.04	1.95	12.75	12.19	62.61	64.89	391.32	405.54
	Hand hoeing twice	2.05	1.99	12.81	12.44	64.66	69.01	404.10	431.33
	Unweeded check	1.66	1.69	10.38	10.56	15.41	16.88	96.32	105.47
21000 plants/fed	**Pendimethalin**	1.97	1.92	12.31	12.00	62.11	67.58	388.16	422.35
	Acetochlor	1.98	1.94	12.38	12.13	63.74	70.71	398.34	441.96
	Nicosulfuron	2.04	1.95	12.75	12.19	67.04	72.52	419.01	453.26
	Hand hoeing twice	2.04	1.97	12.75	12.31	69.75	74.82	435.94	467.64
	Unweeded check	1.65	1.66	10.31	10.38	18.40	20.64	115.02	128.97
24000 plants/fed	**Pendimethalin**	1.92	1.86	12.00	11.63	63.41	67.06	396.29	419.15
	Acetochlor	1.94	1.87	12.13	11.69	65.46	68.71	409.13	429.45
	Nicosulfuron	1.95	1.88	12.19	11.75	66.17	70.40	413.57	439.99
	Hand hoeing twice	1.97	1.90	12.31	11.88	68.13	71.81	425.78	448.82
	Unweeded check	1.63	1.65	10.19	10.31	19.89	21.37	124.30	133.59
27000 plants/fed	**Pendimethalin**	1.85	1.81	11.56	11.31	41.86	47.76	261.61	298.49
	Acetochlor	1.87	1.82	11.69	11.38	44.58	51.66	278.62	322.89
	Nicosulfuron	1.88	1.84	11.75	11.50	49.45	56.81	309.06	355.05
	Hand hoeing twice	1.90	1.84	11.88	11.50	53.45	56.13	334.07	350.82
	Unweeded check	1.61	1.63	10.06	10.19	15.06	16.91	94.14	105.70
30000 plants/fed	**Pendimethalin**	1.75	1.73	10.94	10.81	29.30	33.49	183.14	209.32
	Acetochlor	1.78	1.75	11.13	10.94	30.95	37.87	193.44	236.71
	Nicosulfuron	1.79	1.76	11.19	11.00	35.27	41.49	220.42	259.29
	Hand hoeing twice	1.81	1.77	11.31	11.06	39.77	46.06	248.59	287.85
	Unweeded check	1.60	1.61	10.00	10.06	14.88	15.87	92.97	99.16
L.S.D at 5%		N.S.	N.S.	N.S.	N.S.	7.78	6.66	48.63	41.70

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تأثير الكثافة النباتية ومعاملات مقاومة الحشائش على محصول الذرة الشامية والحشائش المصاحبة

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أجريت تجربتان حقليتان في مزرعة مركز البحوث و التجارب الزراعية بكلية الزراعة بمشتهر جامعة بنها (مركز طوخ ـ محافظة القليوبية ـ مصر) خلال الموسمين 2017 و 2018 م لدراسة تأثير خمسة كثافات نباتية للذرة الشامية (18، 21، 24، 27 و 30 ألف نبات/فدان) مع خمسة معاملات لمقاومة الحشائش تشمل كل من بينديميثالين 682,5 جم مادة فعالة/فدان (ستومب 45.5 % CS)، أسيتوكلور 840 جم مادة فعالة/فدان (هارنس 84 % EC)، نيكوسلفرون 24 جم مادة فعالة/فدان (أكتيف 6 % SC)، العزيق اليدوي مرتين و عدم المقاومة (للمقارنة) على محصول الذرة الشامية (هجين فردي أبيض 2036 شركة مصر هاي تك الدولية للبذور) والحشائش المصاحبة. ويمكن تلخيص أهم النتائج فيما يلي:-

أدت زيادة الكثافة النباتية من 18 إلى 30 ألف نبات/فدان إلى تقليل الوزن الغض و الجاف للحشائش الحولية المختلفة مع حدوث زيادة معنوية في متوسط قيم صفات عدد الأيام من الزراعة حتى ظهور 50 % من النورات المؤنثة، دليل مساحة الأوراق عند 80 يوم من الزراعة، إرتفاع النبات، إرتفاع الكوز، عدد النباتات المذكرة/فدان، عدد الكيزان/فدان و محصول الحطب/فدان بينما إنخفضت معنوياً متوسط قيم صفات مساحة ورقة الكوز، مساحة أوراق النبات عند 80 يوم من الزراعة، سمك الساق، عدد النباتات الحاملة لكوزين/فدان، طول الكوز، عدد حبوب الكوز، وزن حبوب الكوز، النسبة المئوية للتفريط، وزن 100 حبة و دليل الحصاد خلال موسمي الدراسة. زراعة 24 ألف نبات ذرة شامية/فدان حقق أفضل متوسط قيم لصفات محصول الحبوب/فدان و المحصول البيولوجي/فدان خلال موسمي الدراسة.

مقاومة الحشائش بإجراء العزيق اليدوي مرتين أو إستخدام مبيد نيكوسلفرون تفوقا على باقي معاملات مقاومة الحشائش الأخرى في تقليل الوزن الغض والجاف للحشائش الحولية المختلفة المنتشرة في حقول الذرة الشامية وكذلك أعطا معنوياً أفضل القيم في كل الصفات المدروسة للذرة الشامية مع عدم وجود فروق معنوية بينهما خلال موسمي التجربة.

أشارت النتائج أن أفضل تأثير في تقليل الوزن الغض و الجاف للحشائش الحولية المختلفة تحقق من زراعة الذرة الشامية بأعلى كثافة نباتية (30 ألف نبات/فدان) مع إجراء العزيق اليدوي مرتين أو إستخدام مبيد نيكوسلفرون وكلتا المعاملاتان أعطت أفضل متوسط لقيم صفات دليل مساحة الأوراق عند 80 يوم من الزراعة، إرتفاع النبات، إرتفاع الكوز، عدد الكيزان/فدان و محصول الحطب/فدان خلال موسمي التجربة. بينما أفضل متوسط قيم لصفات مساحة ورقة الكوز، مساحة أوراق النبات عند 80 يوم من الزراعة، عدد حبوب الكوز، وزن حبوب الكوز ووزن 100 حبة تم الحصول عليها من زراعة الذرة الشامية بأقل كثافة نباتية (18 ألف نبات/فدان) مع إجراء العزيق مرتين أو إستخدام مبيد نيكوسلفرون خلال موسمي التجربية. زراعة 21 ألف نبات ذرة شامية/فدان مع مقاومة الحشائش ميكانيكاً (العزيق مرتين) حقق أفضل متوسط قيم لصفات النيتروجين الممتص/فدان ومحصول البروتين/فدان خلال موسمي الدراسة. أفضل محصول حبوب تم الحصول علية من زراعة 24 ألف نبات/فدان في الموسم الأول وزراعة 21 ألف نبات/فدان في الموسم الثاني مع مقاومة الحشائش بإجراء العزيق مرتين.

توصي النتائج بزراعة الذرة الشامية (هجين فردي أبيض 2036 شركة مصر هاي تك الدولية للبذور) بمعدل 21 أو 24 ألف نبات/فدان مع إجراء العزيق اليدوي مرتين أو إستخدام مبيد نيكوسلفرون 24 جم مادة فعالة/فدان (أكتيف 6 % SC) حيث أدى إلى تقليل الوزن الغض و الجاف للحشائش الحولية المختلفة وزاد محصول الحبوب/فدان.