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Response of Some Sunflower Hybrids (*Helianthus annuus* l.) to Different Nitrogen Fertilizer Rates and Plant Densities

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***Abstract*—** *In order to improve sunflower productivity, this investigation aimed to study the performance of some genotypes to different doses of nitrogen and plant population density on seed yield and yield components. Two field Experiments carried out on the Experimental Farm of the Sakha Agriculture Research Station during 2015 and 2016 seasons. The objective of this study aimed to investigate the performance of some sunflower hybrids to different nitrogen fertilizer rates and plant population densities to growth, yield components, seed yield and its quality.The results indicated that tallest plants, highest leaves number/plant, number of achenes/head and highest values of head diameter were obtained from MS.sirena F1 genotype. Biest Brima genotype recorded the highest values of leaf area. The highest weight of 1000 seed and seed yield/ha were recorded from Nsovak genotype.The increases in nitrogen fertilizer rates to 168 Kg N/ha produced tallest plants,thick stems (cm), the highest leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) in both seasons. It could observed that increasing nitrogen fertilizer from 72 to 168 Kg N/ha significantly increased seed yield by 12.0 and 11.6 % in the first and second seasons, respectively. Increasing hill spacing from 15, 20 and 25 cm produced thickness stem, highest number of leaves/plant, highest values of leaf area, maximum number of achenes/head, head diameter and weight of 1000 achene. The tallest plants and highest and achene yield were produced from 20cm hill spacing. It could concluded that increasing nitrogen fertilizer from 72 to 168 Kg N/ha and sown Nsovak genotype at dense hill spacing of 15 cm between plants maximized seed yield per unite area.*

***Keywords*— *Sunflower cultivars, nitrogen fertilizer rates, Plant population density*.**

I. INTRODUCTION

Sunflower (Helianthus annuus L.) plants the greatest significant oilseeds and occupies the fourth next to the soybean, palm oil and canola as anoil source.The cultivated area in Egypt is limited to old soils of Nile Valley and the Delta because its cultivation in it competes with other important summercrops like rice.Therefore, it could be cultivated on newlyreclaimed soils in the desert area, for minimizing this existing gap between production and import of edible oil; we should grow sunflower crops preferably. For increasing sunflower productivity, oil content and tothe oilyield to this area are the major target ofresearch programs.The hybrid S-278 erected out supreme for head diameters,seed numbers/head, weight of 1000-seed, seed yield. Maximum seed and oil percentageobtained from S-278 hybrid**(Ali et al., 2012).** The hybrid S-278 gave a higher seed yield/ha than Hysun-33 hybrid**(Ali et al., 2014)**.The great seed yield (2.06 t/ha) produced from sown sunflower hybrid PSH 569, excelling SH 332' by 3.5% and PSFH 118 by 13.8 % **(Parvender et al., 2014).**The highest seed yield/ha, thousand seed weight and head diameters obtained from Isera cultivar; the highoil content, oil yield/ha and plant height observed from C-70165, Isera and Teknosol cultivars **(Gul and Kara, 2015).**The highest percentages of seed oil recorded in Hysun-33, SMH-0917 and SMH-0907. Overall Hysun-33, SMH-0917 and SMH-0907 hybrids achieved improved for plant height, head diameters, seed numbers/head and seed yield/ha **(Iqrasanet al., 2017)**. Sunflower Hysun38 hybrids excelled the other two hybrids in seed yield/ha and oil percentage **(Nasim et al., 2017).**

Nitrogen fertilizerconsidered as one of the realelements that supplement the metabolic developmentsfounded on protein, reproducedupsurge on vegetative, generative growth stage and seed production. Different varieties need different plant densities and nitrogen requirements forproducing high seed and oil yields/ha.In this respect,

nitrogen fertilizer rates muchexaggerated on seed numbers/head, yield to seed/head, weight of 1000–seeds, seed and oil yields/ha. Maximum seed and oil yields/ha produced from about 60 kg N/ha fertilization **(Killi, 2004)**.Fertilization of nitrogen decidedlyincreased the growth and seed yields, but occasionedreduced seed oil content. Application of 200 kg nitrogen/ha recorded the highest seed yield/ha, becauseapplication of 150 kg nitrogen/ha produced the higher oil yield/ha**(Al-Thabet, 2006).**Fertilization of nitrogen at levels of 150 kg/ha produced the highestyield/ha of achenewhich followed with nitrogen fertilization at a level of 125 kg N/ha while the lowest seed yield/haobtainedfrom fertilization of nitrogen at the rate of 100 kg N/ha **(Jahangir et al., 2006).** The greatest seed yield/ha was gottenfrom nitrogen fertilization ata rate of 50 kg N/ha for DW-2 cultivar and nitrogen fertilization at a rate of 80 kg N/ha for DW-2 and Trakya-80 cultivars. **(Süzer, 2010).**Seed yield and its attributes significantly increased, but decreased oil percentage with increasing nitrogen fertilizer rates**(Naseem et al. 2011).** Theincreases in rates of nitrogen had a significant effect and recorded the tallest plants, the highest biological and seed yields/haas well as seed oil percentage.Increasing nitrogen fertilizer rates of 225 kg/ha nitrogen were recorded the most of study traits **(Mollashahi et al., 2013).** Each nitrogen increase improves seed yield and its attributes, science oil percentage were enviably affected **(Awais et al., 2015).**

Plant density is among the factors affecting sunflower yield and seed oil percentages.Maximum yields to achenes obtained from an increasing sunflower population ofa certain level. Optimum population depends on cultural, environmental and field management factors **(Weiss, 2000).**Sunflower hybrids, plant height reduced retortedimproved to high plant populations than the standard and tall hybrids did **(Johnson, 2002).**The widerof hill spacing improvesto stem and head diameters, and weight of the seed/head,butthe narrow hill spacing significantly increased plant height, seed and oil yields/fed**(Allam et al., 2003)**.With the increase in plant populations per unit area significantly decreased head diameters, number and seed weight/head and a higher plant density of a boundaryinsignificantly effect of yield of achene/ha **(Majiri and Arzani, 2003).**The less plant population density produced the more head diameter, the higher seed number/head and seed yield/head as well as the heaviest of 1000–seed weight while, the more plant population densities produced the higher oil percentage, seed and oil yields/ha**(Killi, 2004).** Hill spacing influenced moststudiedtraits, except oil content. Sown at 25 cm hills spacing was the suitable hill spacing, butthe higher or the lower hill spacing had anundesirableresult of seed and oil yields/ha. Application of nitrogen fertilizerevidentlyimproved both growth and seed yield, neverthelesscaused decreases in the percentage of oil **(Al-Thabet, 2006).** Maximum yield toachenesyield and itsattributes as well as oil percentageproduced from the optimum with 60 x 20 cm. The lowestseed and oil yields/ha logged with planting decoration of 45 x 10cm **(Asghar et al., 2007).**Seed oil yieldsreduced with increasing plant population densities, while higher plant populations **(Ishfaq et al., 2009)** did not exaggerate the percentage of oil in the seed**.** Increasing plant population densities significantly reduced weight of 1000-seed and head diameters.The greatest seed yield in both studied hybrids produced from hill spacing of 15 × 70 cm **(Süzer, 2010).**Sow sunflower plants at hill spacing of 22.5cm recorded themost suitable planting population density, which recode the greatest of achene yield/ha, whilethe lossof hill spacing (17.5cm and 20cm) caused reducesof seed yield/ha(**Ali et al., 2011)**. Plant population density significantly differedfrom plant height, the diameters of the stem and head, the weight of achenes,weight of 100-seed and seed yield ha. The highest of seed yield/ha obtained by plant density of 48000 plants/ha in studying seasons (**Radwan et al., 2013)**.

In order to get the greatest seed and oil yield/ha, it can conclude that confection (Inegöl) and oilseed, sunflower should sow in high populations with nitrogen fertilization with60 kg N/ha **(Killi, 2004).**The hill spacing of 25 cm and nitrogen fertilization at a rate of 150-200 kg N/harecorded highest seed and oil yields/ha**(Al-Thabet, 2006).**It could noticed that hill spacing at 10 cm and fertilization of nitrogen at a rate of 60 kg N/fed maximized seed and oil yields/fed **(Osman and Awed, 2010).**Under studied hybrids, increasing plant population densities significantly reduced weight of 1000-seed and diameter of the heads.Nitrogen and plant populationinfluenced seed yield and itsattributes of different hybrids **(Süzer, 2010).**In view of the superiority, over 22.5cm hills spacing for both Hysun-38 hybrid recorded the high productivity. FH-331 hybrid recorded the lowest in seed yield compared to with hysun-38 hybrid**(Ali et al., 2011)**.Higher seed yield/ha recorded from sownat 20 cm hill spacing and 125 kg N/ha nitrogen fertilizer application **(Ali et al., 2012)**. Maximum seed yield produced with increases of plant population and the highest rate of nitrogen fertilization **(Ali et al., 2013).**Highest plant density increased seed oilspercentagewith sunflower. Similar results recorded with increasing nitrogen application phonological duration and achene yield/ha were increased, but the seed oil percentage reduced**(Ali et al., 2014)**.Nitrogen fertilization at a rate of 150 kg N/ha in 83,333 plants/ha plant population was the better treatment to extreme seed yield **(Awais et al., 2015). Nasim et al. (2017)**

summarized that Hysun-38 hybrid maximized seed yield/ha by fertilization of nitrogen at a rate of 180 kg N/ha. Therefore, the purposes of this study evaluating the outcome of plant population density of some sunflower hybrids at different application of nitrogen fertilizer rates on growth, seed yield, yield components, its seed quality, and the interaction effects among population densitiesof some hybrids at different nitrogen fertilization rates on seed yield and seed quality.

II. MATERIALS AND METHODS

2.1. Research time and location:

Two field Experiments carried out on the Experimental Farm of the Sakha Agriculture ResearchStation, ARC Egypt during the two consecutive summer seasons (2015 and 2016). A split-split plot of RCBD with four replication used.The main plots assigned to the three sunflower cultivars (Nsovak, MS.Sirena F1, BiestBrima), while the three nitrogen fertilizer rates (72, 120 and 168 Kg N/ha) which arranged in the sub-plot and the three hills spacing (15, 20 and 25 cm apart) were assigned to the sub-sub plot.Each experimental unit contained of five ridges with 3 m in length and 60 cm between hills. The size of each sub-plot was $12m^2$. The middle two rows used for determining seed yield and its components.Seeds of the studied sunflower cultivars obtained from the Field Crops Research Institute, A.R.C. Giza Egypt. The preceding crop was wheat.Analyses of chemical and physical properties of the experimental soil (0 to 30 cm depth) carried out according to the methods reported by Page et al. (1982). The soil was loamy clay in texture, the pH was 7.6, 7.8, organic matter was 4.9, 5.1%, 7.9, 7.6, E.C. dS/m^{-1} available nitrogen was 15.9 and 16.8 ppm and available phosphorus was 40.6 and 39.8 ppm of both seasons, respectively. After plotting and before the planting, sulfate of potassium (48 % K_2O) at a rate of 120 kg/ha and 240 kg/ha as calcium super-phosphate (15.5 % P_2O_5) supplied to experimental plots. Nitrogen at above rates of the form of ammonium nitrate (33.5 % N) added in two equal portions before the first and third irrigations.

2.2. Studied Characters:

Ten guarded plants occupied at harvest time from the 2^{nd} and 3^{th} ridges in each sub-plot to estimate plant height (cm),stem diameters (cm), number of leaves/plant, leaf area per plant (cm2), achene diameter (cm), achene weight (g), weight of 1000 seed (g), seed yields/head and per hectare. Leaf area per plant (cm2)It was determined according to the equation of **Schneiter (1978):** LA=[(LxW) x 0.6683] – 2.45

Where L = Maximum length of the leaf, W = Maximum width of the leaf.

2.3. Experimental analysis:

The analysis of data collected done, statistically by the analysis of variance technique using the MSTAT–C statistical package programmed as described by a procedure of Gomez and Gomez (1991).Lest significant differences test (LSD) at 5 and 1 % level of probability used to compare between treatment means according toSnedecor and Cochran (1980).

III. RESULTS AND DISCUSSIONS

3.1. Performance of cultivars:

Average of plant height (cm), leaves number/plant and leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) significantly differed in studied sunflower cultivars in both seasons as presented in Tables 1 and 2. However, steam diameter (cm) insignificantly affected in both seasons.

It could state that tallest plants (136.6, 138.4 cm), highest leaves number/plant (21.7, 21.7), number of achenes /head (869.7, 881.0 achenes /head) and highest values of head diameter (17.1, 16.86 cm) were obtained from MS.sirena F1 genotype in the first and second seasons, respectively. Meanwhile, Biest Brima genotype recorded the highest values of leaf area (178.8, 177.8 cm^2)in the first and second seasons, respectively. However, Nsovak genotype recorded the lowest values of plant height (cm), leaves number/plant and leaf area (cm^2), number of achenes/head and head diameter in both seasons. Whereas, the highest weight of 1000 seed (56.31, 56.40 g) and highest seed yield per hectare (3397.8, 3402.4 kg/ha) were recorded from Nsovak genotype in the first and second seasons, respectively. The results clearly indicated that Biest Brima genotyperecorded the lowest seed yield/ha and MS.sirena F1 genotype the lowest of 1000 achene weight in both seasons. The differences between studying genotypes in seed yields may attributed to the genotype genetics.The highest percentages of seed oil recorded in Hysun-33, SMH-0917 and SMH-0907. Overall Hysun-33, SMH-0917 and SMH-0907 hybrids achieved improved for plant height, head diameters, achene numbers/head and achenes yield/ha **(Iqrasan et al., 2017)**. The variances in sunflower hybrids seed yield and its components may be due to the genetic factors.These results in linewith those reported by**Ergen and Saglam (2005) and Smiderle et al. (2007).**Many investigators such as **Ali et al. (2012), Parvender et al. (2014), Gul and Kara (2015) and Nasim et al. (2017),** reported similar observations.

3.2. Effect of nitrogen fertilizer rates:

Average of plant height (cm), stem diameter (cm), leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) as affected by nitrogen fertilizer rates

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significantly affected as presented in Tables 1 and 2. Increasing nitrogen fertilizer rates from 72, 120 and 168 Kg N/ha significantly increased plant height (cm), stem diameter (cm), leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) in both seasons. Increasing nitrogen fertilizer rates up to 168 Kg N/ha produced the tallest plants (136.8, 137.5 cm), thickness stem (1.83, 1.98 cm), highest number of leaves/plant (22.2, 22.5), highest values of leaf area (191.7, 186.1 cm^2), maximum number of achenes/head (845.5, 860.4), head diameter (17.68, 17.97 cm), weight of 1000 achene (55.04, 55.93 g) and achene yield (3537.9, 3530.7 Kg/ha) Increasing nitrogen fertilizer rates up to 168 Kg N/ha in the first and second seasons, respectively. It could observed that increasing nitrogen fertilizer from 72 to 168 Kg N/ha significantly increased seed yield by 12.0 and 11.6 % in both seasons, respectively. Studied trials increased due to increases of nitrogen fertilization levels, this increase could be the effect of nitrogen encouraging the growth, seed yield and its attributes. Nitrogen fertilization significantly affected growth, physiological and metabolic procedures of sunflower **(Massignam et al., 2009)**. Growth trails, seed yield and its attributes increased with increases in nitrogen fertilizer rates due to the role of nitrogen in motivating development. Nitrogen fertilizer is an essential of the proteins and nucleotides that are vital to the metabolic purpose of sunflower **(Salisbury and Ross, 1994).** Nevertheless, increasing nitrogen fertilizer rates was reduced the oil percentage **(Nasim et al., 2012).** A reduction in growth and less translocation of photo-assimilates from source to sink organs of the sunflower crop due to deficiency of nitrogen fertilizer **(Nasim et al., 2017).** Dry matter, seed yield and its attributes improved due to increases in nitrogen fertilizer levels, but oil percentage was **decreased (Hussain et al., 2011 and Naseem et al., 2011).** A significant effect on plant height, biological and seed yields/ha and seed oil percentage with increasing nitrogen fertilizer rates. Increasing nitrogen fertilizer rates of 225 kg/ha nitrogen recorded the most of study traits **(Mollashahi et al., 2013).** Others **Osman and Awed (2010), Süzer (2010),** reported similar results. **Ali et al. (2011), (2012), (2013) and (2014) as well as Awais et al. (2015).**

Table.1: Average of plant height (cm), steam diameter (cm), leaves number/plant and leaf area (cm^2) as affected by sunflower cultivars, nitrogen fertilizer rates and hill spaces in both seasons.

Characters / Treatments	Plant height (cm)		Stem diameter (cm)		Leaves number/plant		Leaf area (cm^2)	
	2014	2015	2014	2015	2014	2015	2014	2015
A-Sunflower Cultivars:								
Nsovak	129.4	129.1	1.77	1.69	19.6	20.1	160.4	160.0
MS.sirena F1	136.6	138.4	1.75	1.81	21.7	21.7	169.4	165.4
Biest Brima	133.5	135.2	1.81	1.89	21.4	21.7	178.8	177.8
F. test	*	*	N.S	N.S	*	*	*	*
LSD at 5%	0.5	0.7	--	--	0.7	0.6	3.0	3.1
B-Nitrogen fertilizer rates:								
72 kg N/ha	127.9	129.0	1.53	1.66	19.4	19.8	146.5	149.1
120 kg N/ha	134.9	135.8	1.80	1.81	21.2	21.3	171.2	168.1
168 kg N/ha	136.8	137.5	1.83	1.98	22.2	22.5	191.7	186.1
F. test	*	*	*	*	*	*	*	*
LSD at 5%	0.5	0.7	0.07	0.05	0.7	0.6	3.0	3.1
C-Hill spacing:								
15 cm apart	141.5	142.2	1.40	1.54	20.8	20.9	149.4	150.2
20 cm apart	133.9	125.3	1.77	1.83	20.9	21.2	167.2	165.7
25 cm apart	124.2	124.8	2.00	2.07	21.0	21.6	191.9	187.3
F. test	*	*	*	*	*	N.S	*	*
LSD at 5%	0.8	0.7	0.07	0.06	0.6	--	4.3	2.7
D-Interaction F-Test:								
A x B	*	*	N.S	N.S	N.S	N.S	*	*
A x C	*	*	N.S	N.S	*	*	*	*
B x C	*	*	N.S	N.S	N.S	N.S	*	*
A x B x C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

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3.3. Effect of hill spacing:

Means of plant height (cm), stem diameter (cm), leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) as affected by nitrogen fertilizer rates significantly affected as presented in Tables 1 and 2 in both seasons except leaves number/plant was significantly affected only in the first season. Increasing hill spacing from 15, 20 and 25 cm significantly increased stem diameter (cm), leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm) and 1000 achene weight (gm), but, decreased plant height and achene yield (Kg/ha) in both seasons. Increasing hill spacing from 15, 20 and 25 cm produced thickness stem (2.00, 2.07 cm), highest number of leaves/plant (21.0, 21.6), highest values of leaf area (191.9, 187.3 cm^2), maximum number of achenes/head (894.1, 907.8), head diameter 18.30, 18.31 cm) and weight of 1000 achene (57.69, 57.88 g). However the lowest stem diameter (cm), leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm) and 1000 achene weight (gm) were produced from less hill space (20 cm). The tallest plants (141.5, 142.2 cm) and highest and achene yield (3629.6, 3649.6 Kg/ha) were produced from 20cm hill spacing.

Table.2: Average of number of achenes/head, head diameter (cm), 1000 achene weight(gm) and achene yield (Kg/ha) as affected by sunflower cultivars nitrogen fertilizer rates and hill spaces in both seasons.

Characters / Treatments	Number of achenes/head		Head diameter (cm)		1000 achene weight		Achene yield/ kg/ha	
	2014	2015	2014	2015	2014	2015	2014	2015
A-Sunflower Cultivars:								
Nsovak	751.3	774.5	15.33	15.46	56.31	56.40	3397.8	3402.4
MS.sirena F1	869.7	881.0	17.10	16.86	48.89	49.21	3359.5	3288.9
Biest Brima	806.9	812.7	17.00	17.26	52.31	53.40	3293.4	3297.9
F. test	*	*	*	*	*	*	*	*
LSD at 5%	15.0	12.9	0.25	0.07	0.65	0.95	28.3	25.90
B-Nitrogen fertilizer rates:								
72 kg N/ha	768.4	792.4	15.31	15.39	48.91	48.86	3113.2	3122.1
120 kg N/ha	814.1	815.4	16.43	16.24	53.58	54.22	3399.6	3336.5
168 kg N/ha	845.5	860.4	17.68	17.96	55.04	55.93	3537.9	3530.7
F. test	*	*	*	*	*	*	*	*
LSD at 5%	15.0	13.0	0.25	0.07	0.65	0.95	28.3	25.9
C-Hill spacing:								
15 cm apart	732.3	741.1	14.64	14.64	47.07	47.80	3629.6	3649.6
20 cm apart	801.5	819.3	16.64	16.65	52.74	53.33	3330.2	3330.5
25 cm apart	894.1	907.8	18.30	18.31	57.69	57.88	3029.5	3070.7
F. test	*	*	*	*	*	*	*	*
LSD at 5%	15.7	13.2	0.32	0.11	1.01	1.02	34.2	23.5
D-Interaction F-Test								
A x B	N.S	N.S	*	*	N.S	N.S	*	*
A x C	*	*	*	*	*	*	*	*
B x C	*	*	*	*	N.S	N.S	*	*
A x B x C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

The shortest plants and lowest achene yield kg/ha was obtained from wide space (25 cm). The increases of these characters may be due to the sufficiency of environmental conditions reflected less competition between plants in wide spacing due to increases in light penetration within sunflower canopies that improved assimilation rate and oil creation. Plant population density significantly differed from plant height, the diameters of the stem and head, the weight of achenes, weight of 100-seed and seed yield ha. The highest of seed yield/ha obtained by plant density of 48000 plants/ha in studying seasons (**Radwan et al., 2013)**. The wider plant spacing of 25 cm seems to a good compromise between the highest seed yield/fad and good acid composition of the oil (**Abd El-Satar et al., 2017).** Similarly, others reported accordance results such as **Osman and Awed (2010), Süzer (2010), Ali et al. (2011), (2012), (2013), (2014) and Nasim et al. (2017).**

3.4. Interaction Effects:

3.4.1. Interaction between cultivars and nitrogen fertilizer rates:

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Cultivars and nitrogen fertilizer rates interaction significantly affected plant height (cm), leaf area (cm^2), head diameter (cm) and achene yield (kg/ha), however, insignificantly affectedsteam diameter (cm), leaves number/plant, number of achenes/head and 1000 achene weight (gm) in both seasons as presented in Tables 1 and 2. The results graphically illustrated in Figs. 1 the effect of the interaction between genotype sand nitrogen fertilization rates on plant height, the results clearly showed that sown MS.sirena F1 genotype and addition of nitrogen fertilizer at168 kg N/ha recorded the tallest plants (140.2, 141.5 cm). The highest values of leaf area (217.62, 209.88cm^2) and the thick heads (18.53, 18.98 cm) were obtained from sown Biest Brima genotype when fertilized with 168 kg N/ha in both seasons, respectively as graphically demonstrated in Figs 2 and 3. The highest achene yield (3588.8, 3608.5 kg/ha)was obtained from sown Nsovak genotype at higher nitrogen rates 168 N/ha as graphically illustrated in Fig 4 in both seasons, respectively.While, the lowermost values from plant height (cm), leaf area (cm^2), head diameter (cm) and achene yield (kg/ha) were recorded from sown Nsovak genotype when fertilized with the lowest nitrogen fertilizer (72 kg/ha) in both seasons. Highest seed yield/ha produced from sown Hysun-38 by nitrogen fertilizer supply at the rate of 180 kg N/ha **(Nasim et al., 2017)**

3.4.2. Interaction between cultivars and hill spacing:

The interaction between cultivars and hill spacing significantly affected plant height (cm), leaf area (cm^2), achene numbers/head, diameter of head (cm), 1000-achene weight (g) and achene yield (Kg/ha), except, stem diameter (cm) and leaves number/plant, in both seasons as presented in Tables 1 and 2. The results graphically illustrated in Fig. 5 indicated that the effect of the interaction cultivars and hill spacing on plant height, the tallest plants was produce from sown MS.sirena F1 genotype at hill spacing of 15 cm (145.1, 147.0 cm) in both seasons. The shortest plant was obtained from sownNsovak genotype at wider hill spacing (25.0 cm).

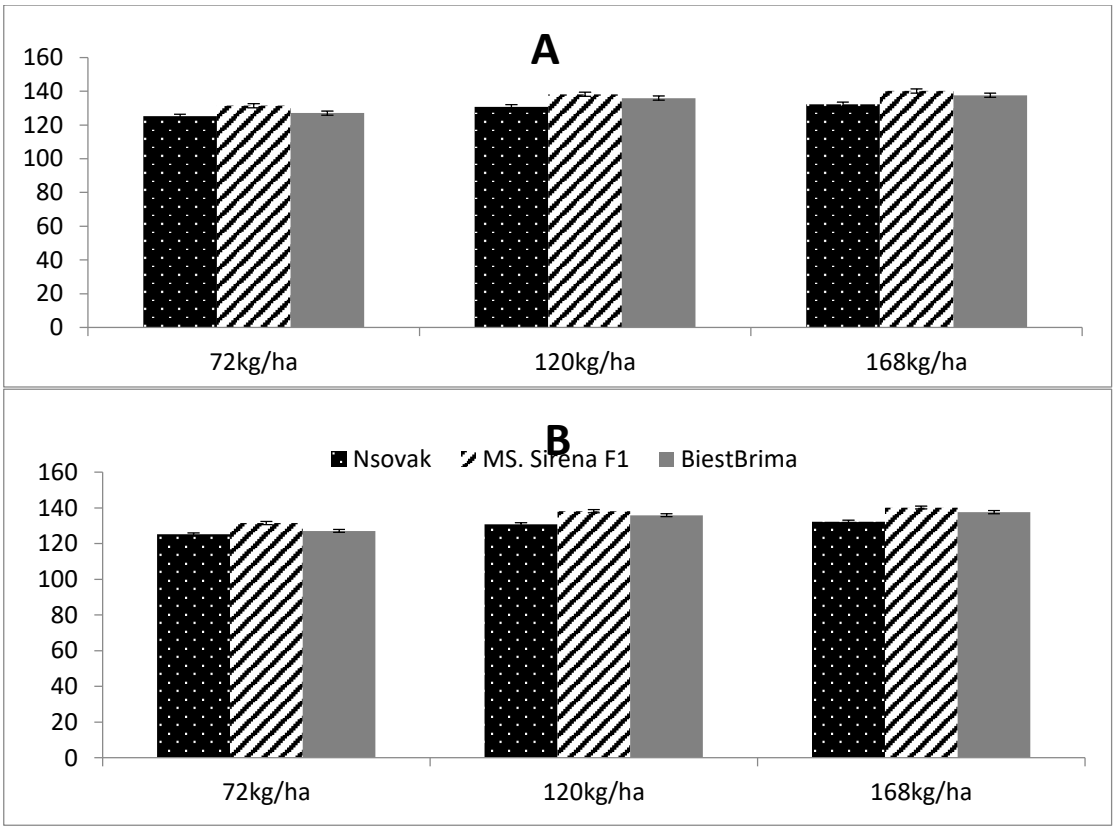

Fig. 1: Average of plant height (cm) as affected by interaction between sunflower cultivars and nitrogen fertilization during two season (A) 2014 and (B) 2015.

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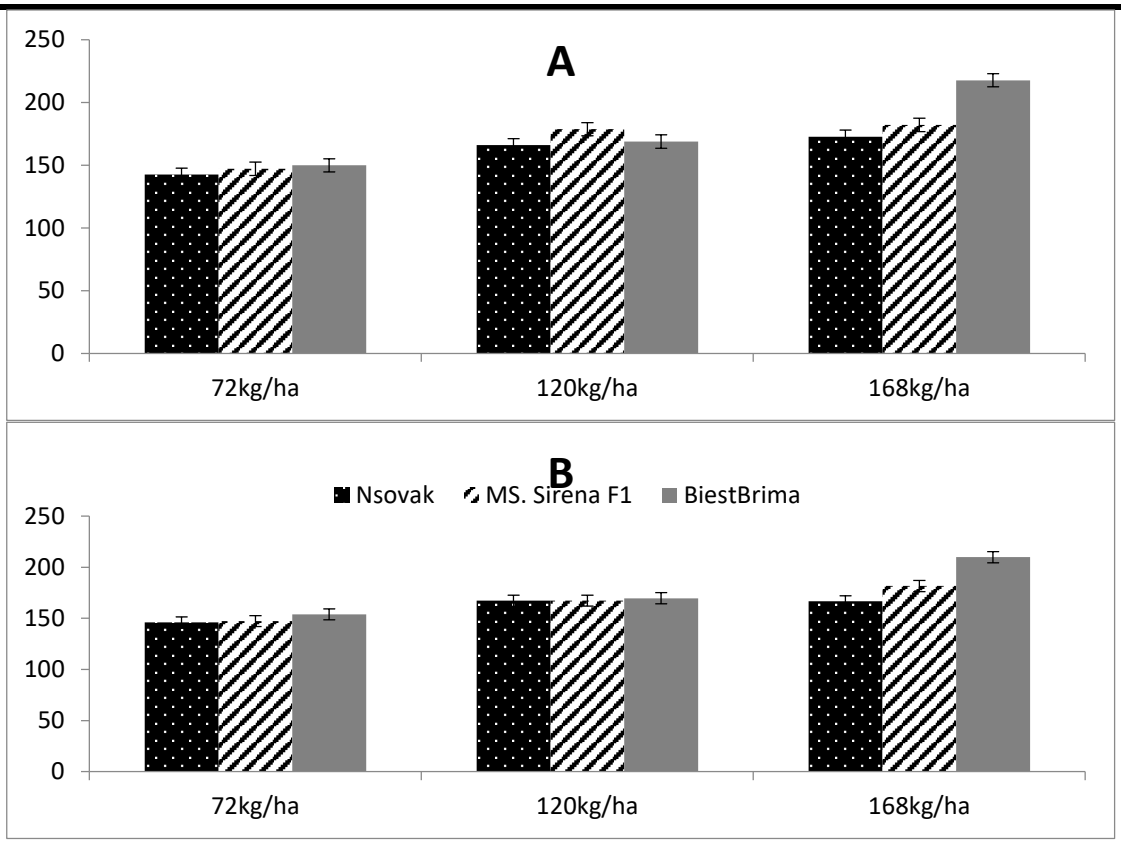

Fig.2: Average of leaf area (cm^2) as affected by interaction between sunflower cultivars and nitrogen fertilization during two season (A) 2014 and (B) 2015.

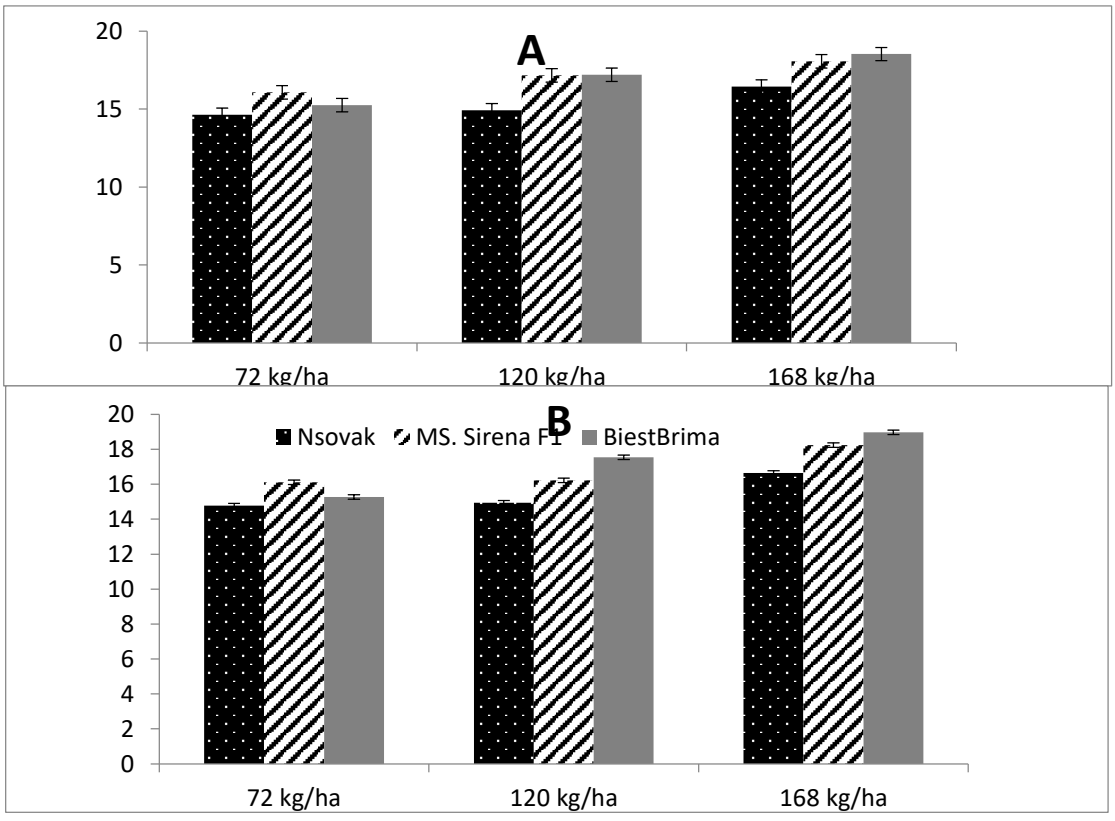

Fig. 3: Average of head diameter (cm) as affected by interaction between sunflower cultivars and nitrogen fertilization during two season (A) 2014 and (B) 2015.

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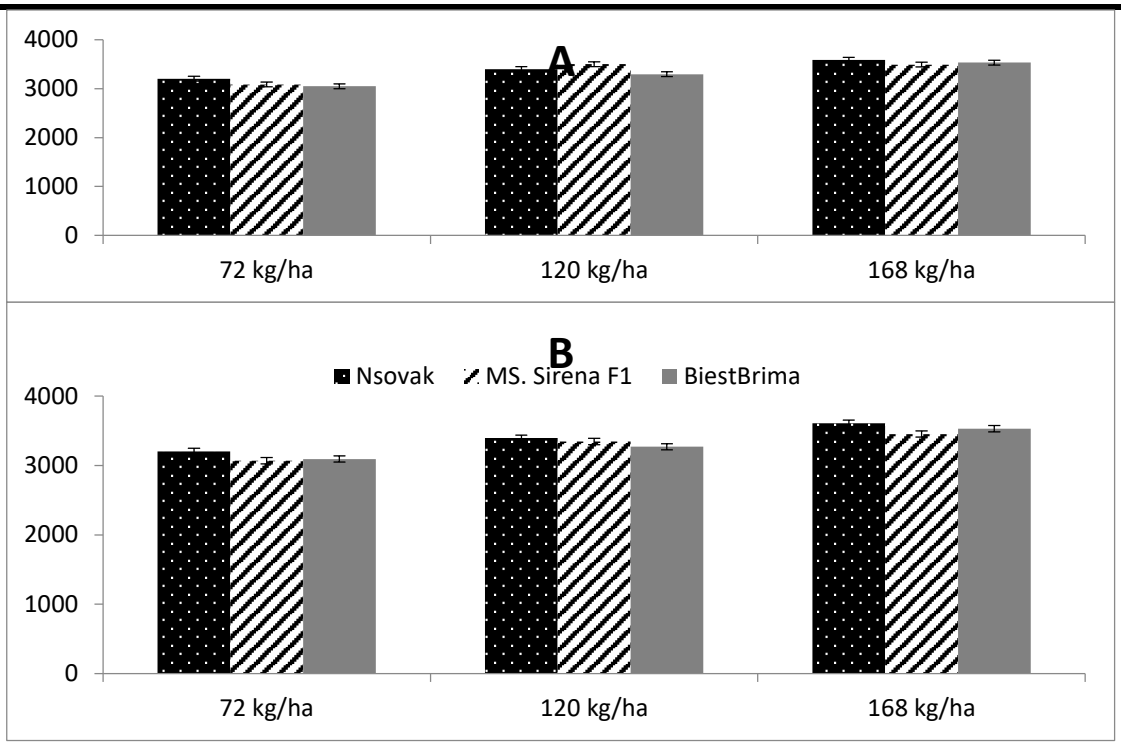

Fig. 4: Average of Achene yield/ ha (kg) as affected by interaction between sunflower cultivars genotypes and nitrogen fertilization during two season (A) 2014 and (B) 2015.

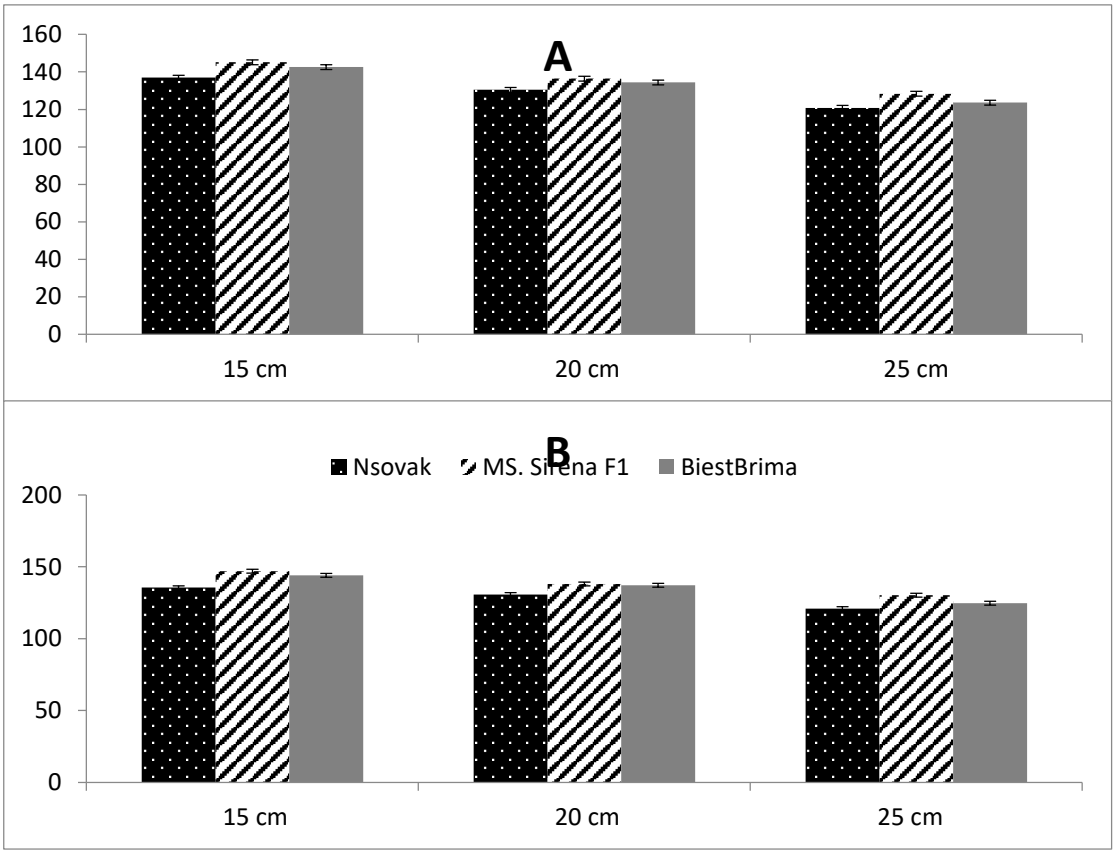

Fig. 5: Average of plant height (cm) as affected by interaction between sunflower cultivars genotypes and hill spacing during two season (A) 2014 and (B) 2015.

Data presented in Figs. 6, 7 and 8 showed the interaction between cultivars and hill spacing effects on leaf area and number of achenes/head. In both seasons. The results indicated that the highest values of leaf area (209.31,

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196.61 cm^2),number of achenes/head (1042.7, 1054.8), head diameter (19.33, 18.96 cm) were recorded from sown MS.sirena F1 at wider hill spacing (25 cm) in both seasons, respectively.In addition, the highest weight of 1000 achenes (60.7, 61.2 g)from sown Nsovak genotype graphically illustrated in Fig. 9. However, the lowest values of plant height (cm), leaf area (cm^2), achene numbers/head, diameter of head (cm), 1000-achene weight (g) were produced from sown Nsovak genotype at wider hills (25 cm). Results demonstrated in Fig. 10 clearly indicated that maximum achene yield (1558.7, 1520.9 kg/ha) produced from sown Nsovak genotype at dense hills (15 cm) in both seasons, respectively. The less yield obtained from sown Biest Brima genotypeat wider hills (25 cm). In view of the superiority, over 22.5 cm hills spacing for both Hysun-38 hybrid recorded the high productivity. FH-331 hybrid recorded the lowest in seed yield compared to with hysun-38 hybrid **(Ali et al., 2011)**.

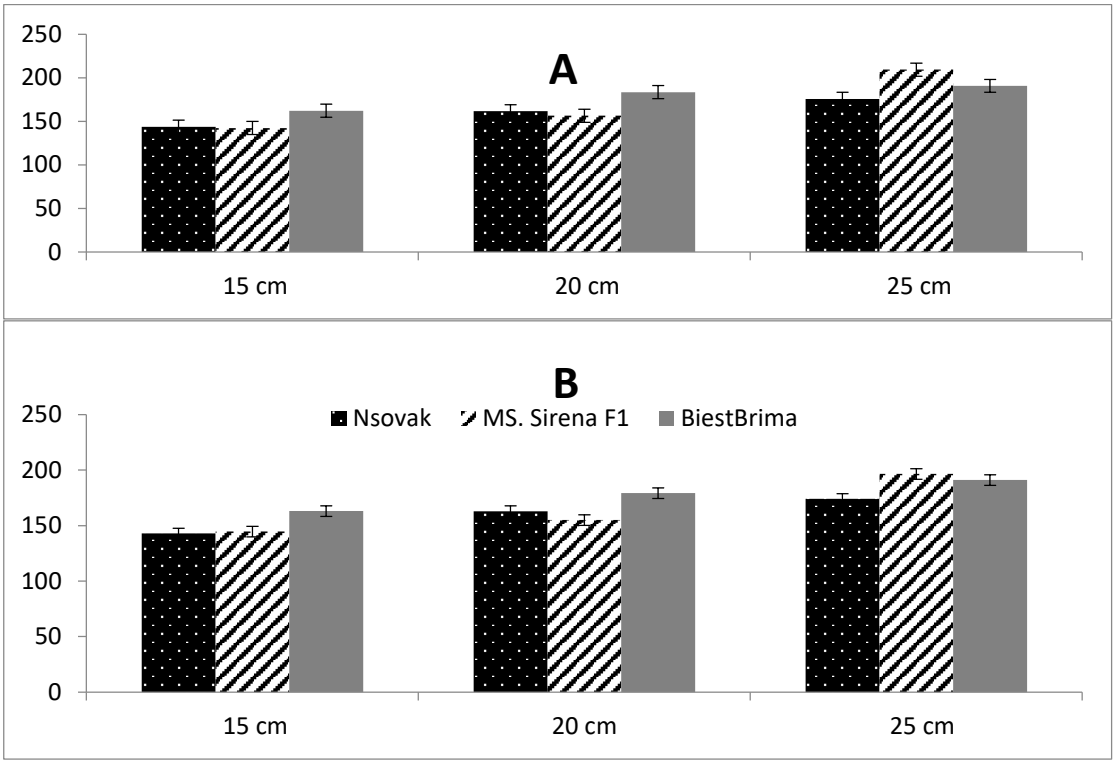

Fig. 6: Average of leaf area (cm^2) as affected by interaction between sunflower cultivars genotype and hill spacing during two season (A) 2014 and (B) 2015.

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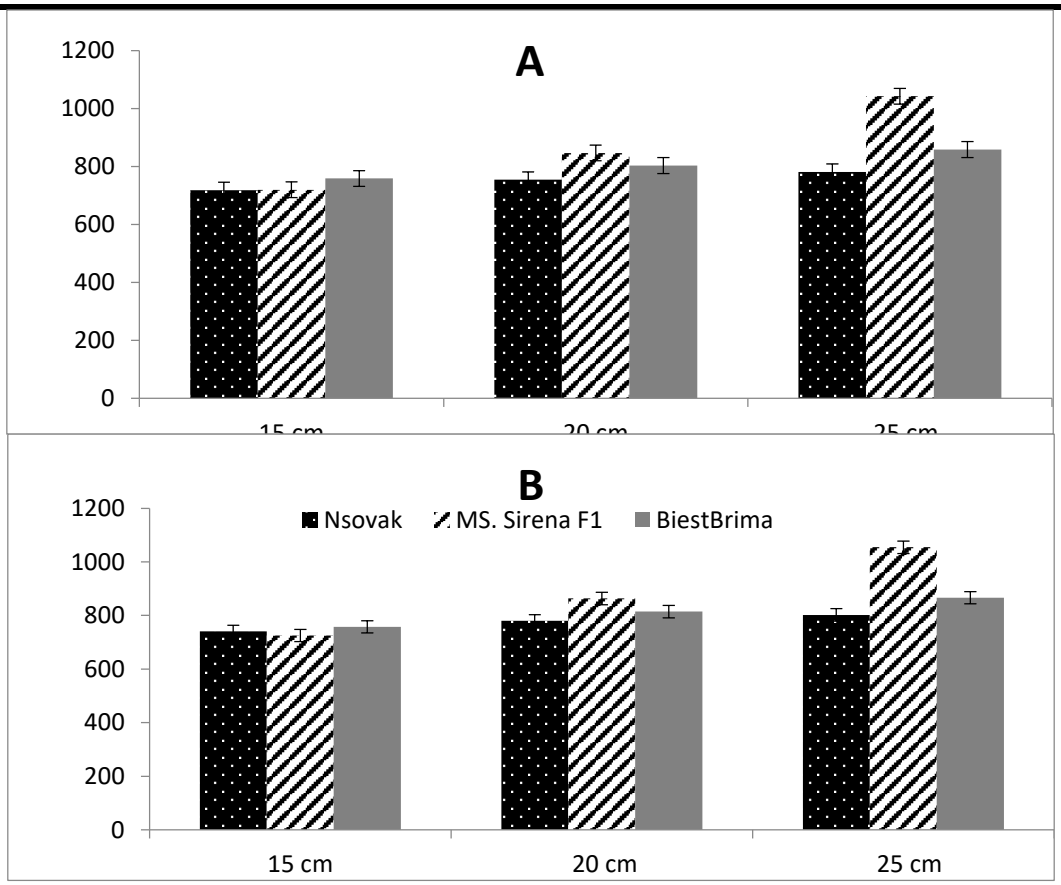

Fig. 7: Average of number of achenes /head as affected by interaction between sunflower cultivars and hill spacing during two season (A) 2014 and (B) 2015.

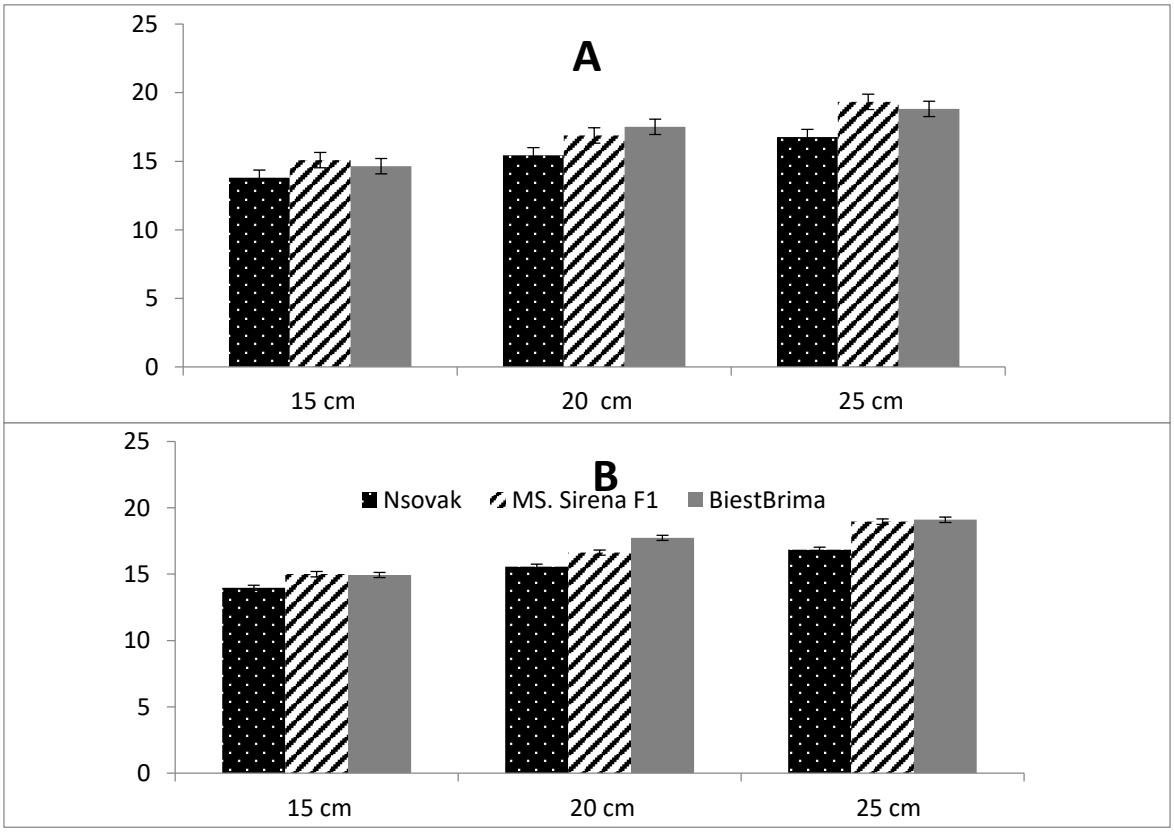

Fig. 8: Average of head diameter (cm) as affected by interaction between sunflower cultivars and hill spacing during two season (A) 2014 and (B) 2015.

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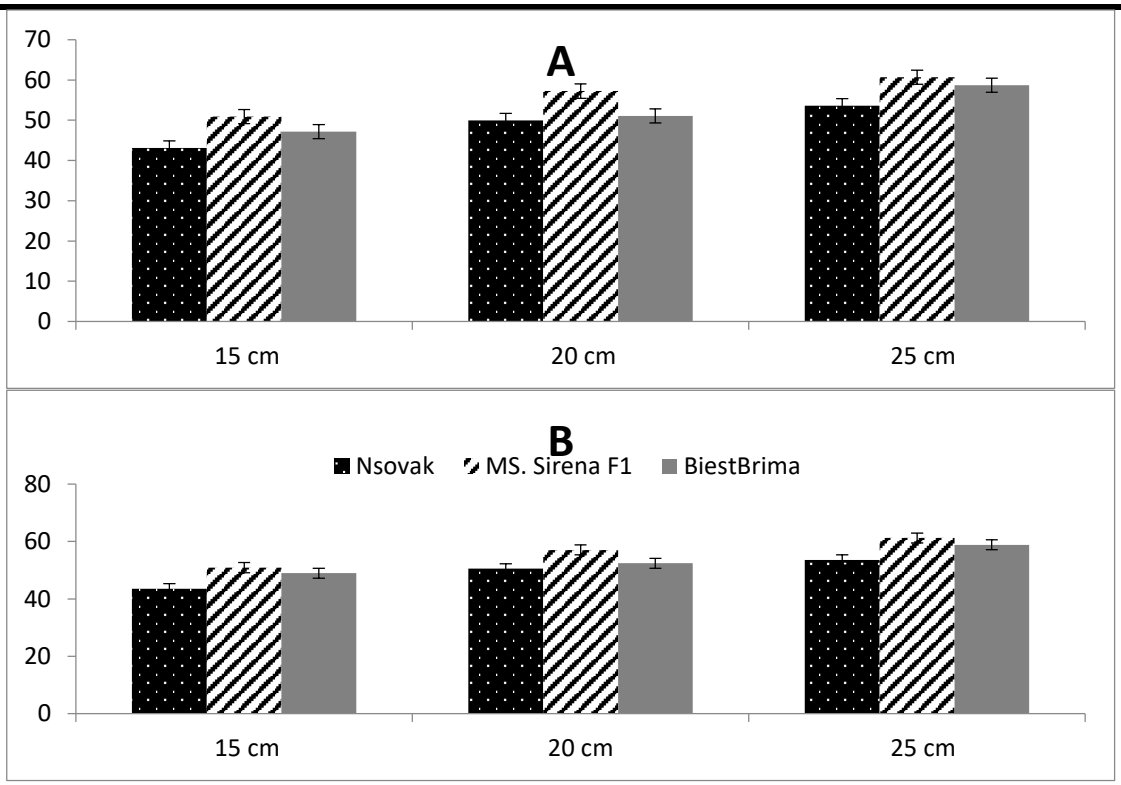

Fig. 9: Average of thousand achenes weight (g) as affected by interaction between sunflower cultivars and hill spacing during two season (A) 2014 and (B) 2015.

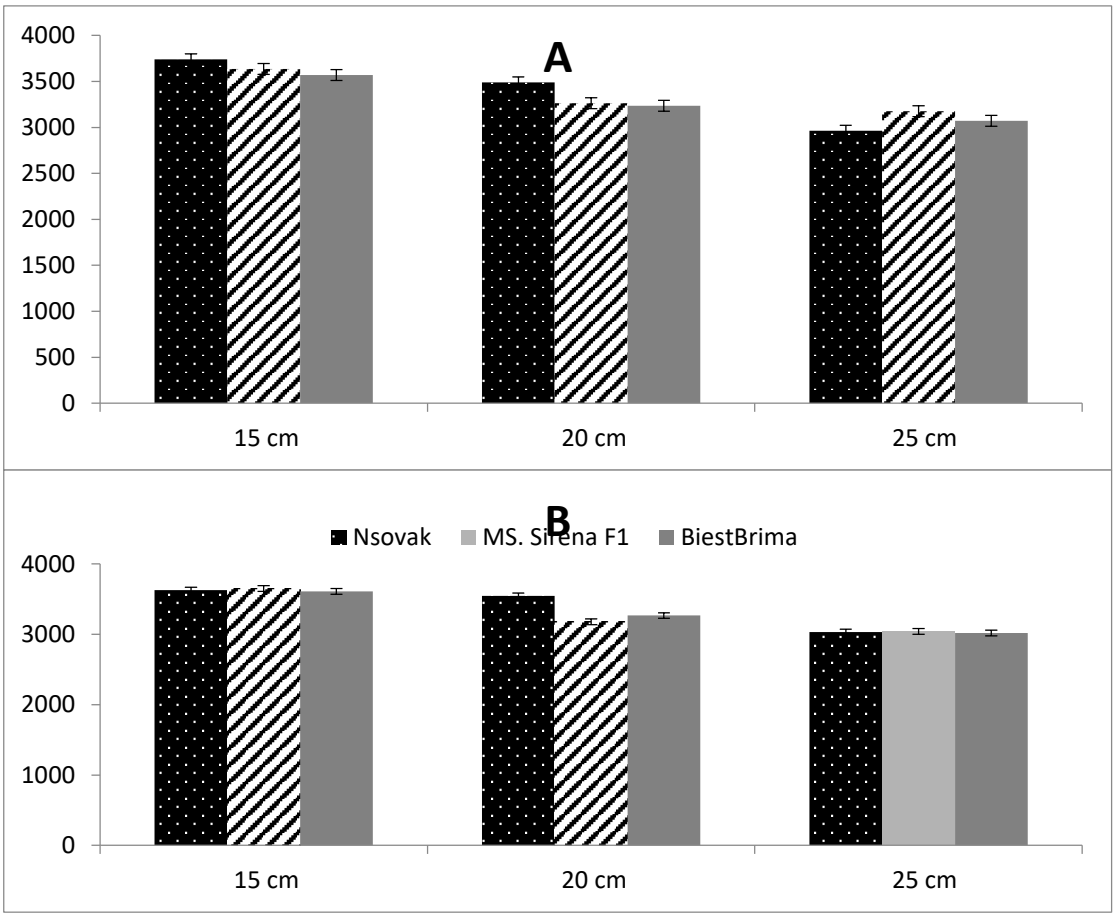

Fig. 10: Average of achene yield/ ha (kg) as affected by interaction between sunflower cultivars and hill spacing during two season (A) 2014 and (B 2015

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3.4.3. Interaction between nitrogen fertilizer rates and hill spacing:

The interaction between nitrogen fertilizer rates and hill spacing significantly affected plant height (cm),leaf area (cm^2), achene numbers/head, head diameter (cm), and achene yield (kg/ha), except, and stem diameter (cm), leaves number/plant and 1000 achene weight (g) in both seasons as presented in Tables 1 and 2. The results graphically illustrated in Fig. 11 indicated the interaction between nitrogen fertilizer rates and hill spacing effects on plant height, the tallest plants was produce from sown increasing nitrogen fertilizer up to168 kg N/haat dense hill spacing of 15 cm (144.7, 145.9 cm) in the first and second seasons, respectively. The results graphically demonstrated in Fig 12, 13 and14 showed that thehighest values of leaf area/plant (217.0, 209.5 cm^2), number of achenes/head (936.8, 952.5) head diameter and (19.2, 19.6 cm)were obtained from nitrogen fertilizer up to 168 kg N/ha and increasing hill spacing to 25 cm in both seasons, respectively. However, the lowest values of leaf area/plant (cm^2), number of achenes/head and head diameter were produced from reducing fertilizer to 72 kg N/ha at dense hill spacing of 15 cm in both seasons. In addition, the results in Fig. 15 showed that the highest achene yield (3903.4,3914.4 kg/ha) produced from increasing nitrogen fertilizer up to 168 kg N/ha and decreasing hill spacing to 15 cm between plants in both seasons, respectively. Sown sunflower plants at25 cm hill spacing and fertilization of nitrogen at a rate of 150-200 kg N/ha had maximized seed and oil yields/ha **(Al-Thabet, 2006).** Seed yield in addition, its attributes significantly affected by nitrogen fertilizer and plant population densities on of different-height sunflower hybrids **(Süzer, 2010).** Hill spacing at 10 cm and fertilization of nitrogen at a rate of 60 kg N/fed maximized seed and oil yields/fed **(Osman and Awed, 2010).** Higher seed yield/ha recorded from sown at 20 cm hill spacing and nitrogen fertilizer at a rate of 125 kg N/ha addition **(Ali et al., 2012)**. Seed yield and photosynthesis active increase radiation observation when nitrogen fertilization rates and plant density increased. Maximum seed yield recorded from increasing plant population densitywith highest nitrogen fertilizer levels **(Ali et al., 2013).**Plant spacing, nitrogen fertilization levels and genotypes as well as interactions in both seasons and their combined analysis significantly influenced yield and quality traits **(Abd El-Satar et al., 2017).**

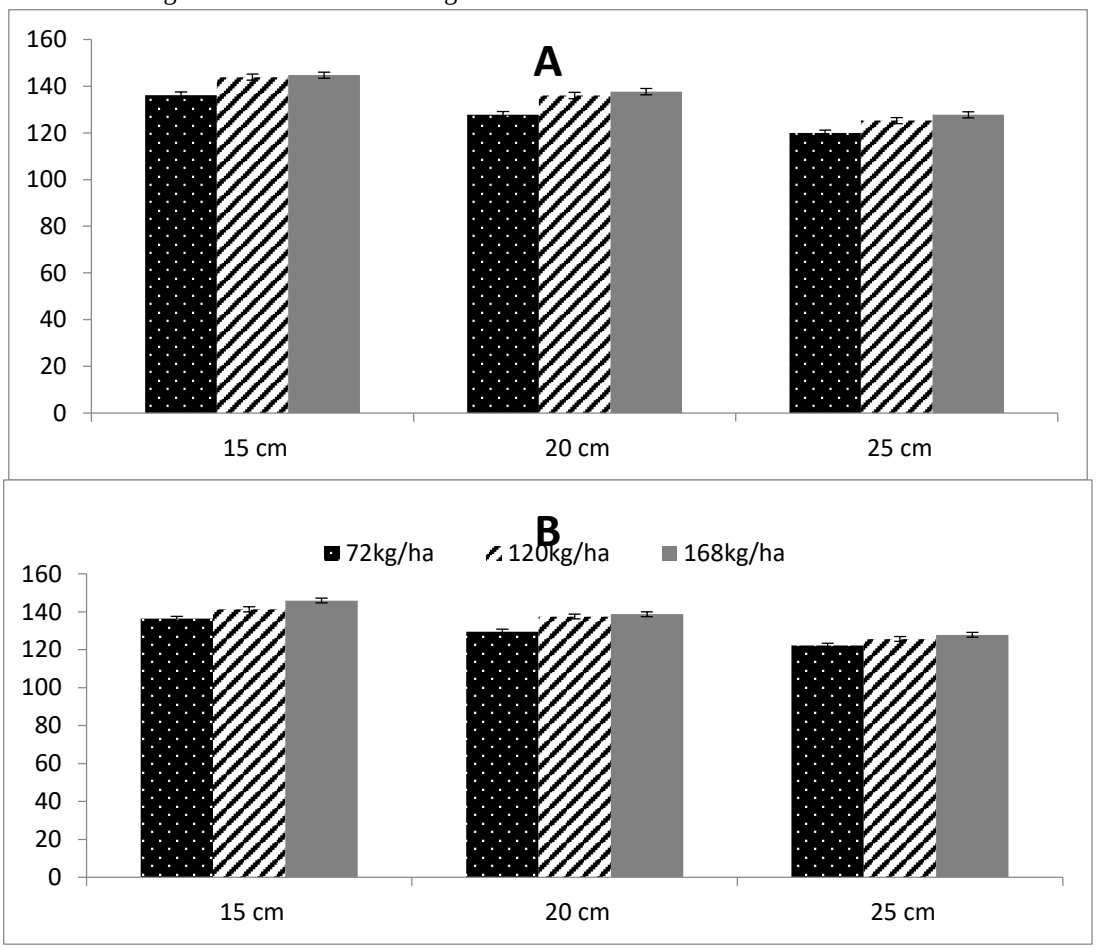

Fig. 11: Average of plant height (cm) as affected by interaction between nitrogen fertilizer rates and hill spacing during two season (A) 2014 and (B) 2015.

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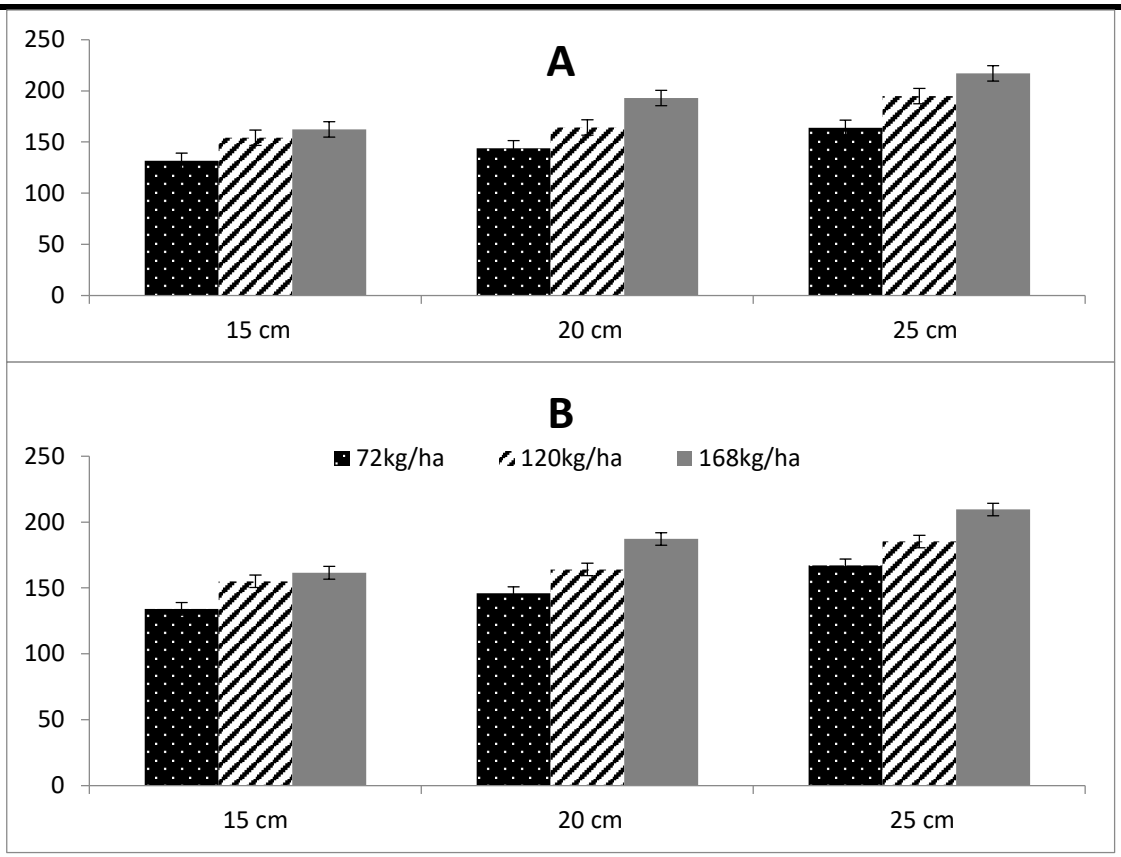

Fig. 12: Average of Leaf area (cm^2) as affected by interaction between nitrogen fertilization and plant density during two season (A) 2014 and (B) 2015.

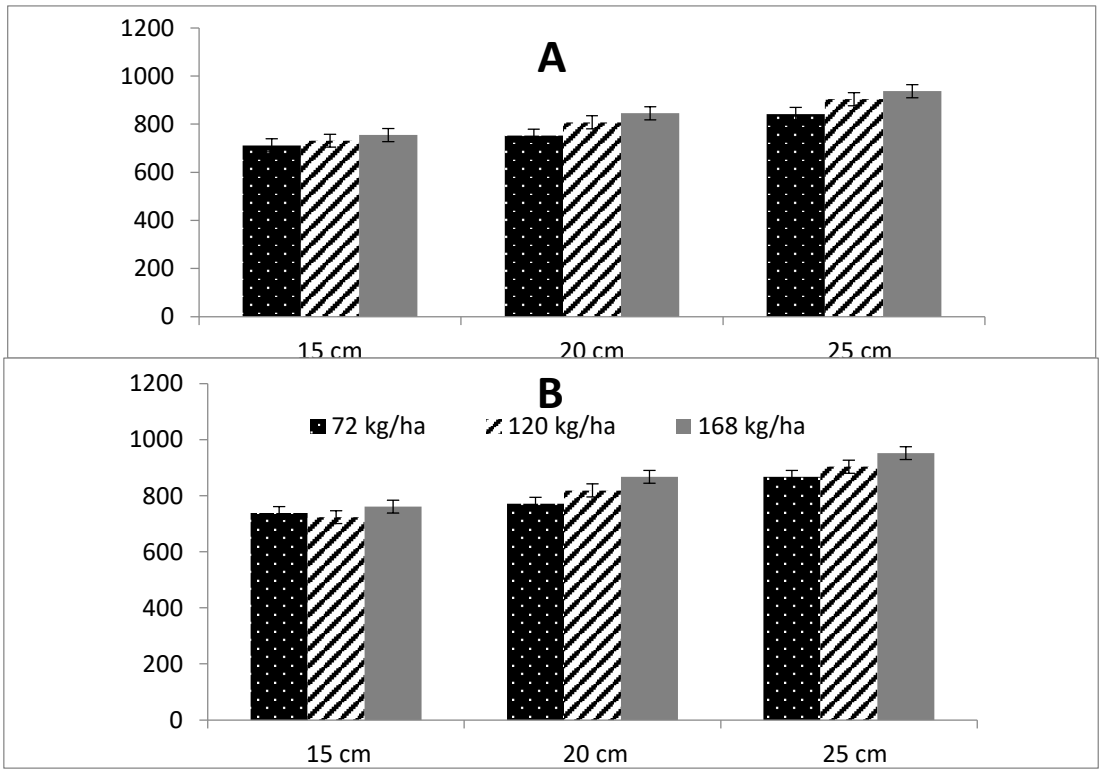

Fig.13: Average of number of achenes/head as affected by interaction between nitrogen fertilization and hill spacing during two season (A) 2014 and (B) 2015.

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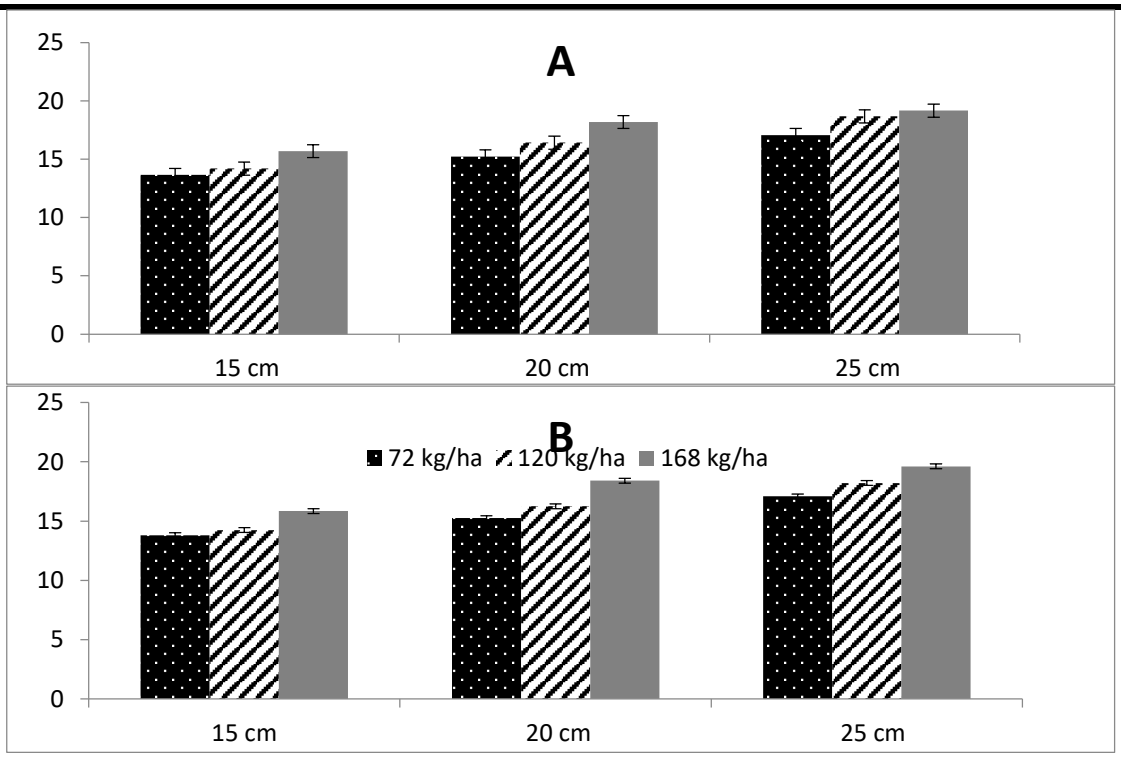

Fig.14: Average of head diameter (cm) as affected by interaction between nitrogen fertilization and plant density during two season (A) 2014 and (B) 2015.

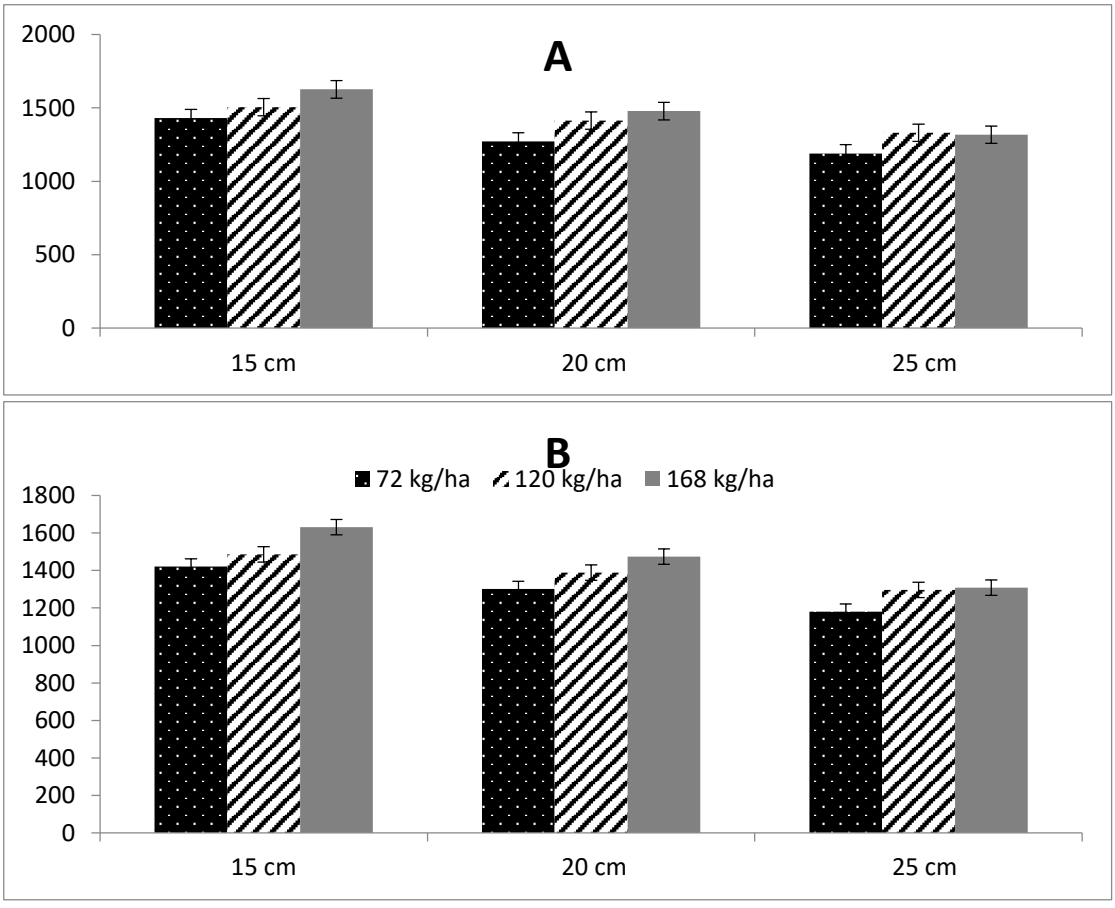

Fig.15: Average of Achene yield/ fed (kg) as affected by interaction between nitrogen fertilization and hill spacing during two season (A) 2014 and (B)2015.

3.4.4. Interaction between cultivars, nitrogen fertilizer rates, and hill spacing:

The interaction between cultivars, nitrogen fertilizer rates, and hill spacing plant height (cm), stem diameter (cm), leaves number/plant, leaf area (cm^2), number of achenes/head, head diameter (cm), 1000 achene weight (gm) and achene yield (Kg/ha) insignificantly affected as presented in Tables 1 and 2 in both seasons.

IV. CONCLUSION

It could concluded that the increases in nitrogen fertilizer rates from 72 to 168 Kg N/ha and sown Nsovak genotype at dense hill spacing of 15 cm between plants maximized seed yield per unite area under the environmental conditions of Egypt.

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