Journal of Plant Production

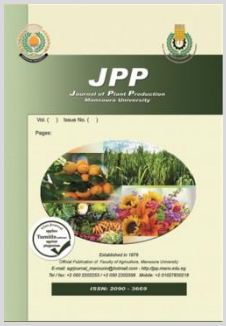
Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Yield, Quality and Economic Evaluation for Onion grown at Different Densities under Weed Control Treatments

Marey, R. A.[1*]; L.S.M. Geries [1] and A. M. Abd-El-Kareem[2]

[1]Onion Res. Depart., Field Crops Res. Inst., Agric, Res. Center, Giza, Egypt.
[2]Weed Res. Central Lab., Agric, Res. Center, Giza, Egypt.

Cross Mark



ABSTRACT

Two field experiments were conducted during 2015/2016 and 2016/2017 seasons at Shandaweel Agriculture Research Station, Sohag Governorate, to study the effect of onion density and weed control treatments on vegetative growth, yield and quality of onion. Split plot design with three replicates was used. Onion plant density (240 000, 300 000, and 400 000 plant/ fed.) occupied the main plots, whereas weed control treatments (hand hoeing (twice), Goal + Select (once), Goal + Select (twice), Ecopart + Select (once), Ecopart + Select (twice) and control) occupied the sub plots. Onion plants grown under the highest density (400 000 plants/fed.) attained the highest values of plant height and number of leaves/plant, while the lowest density (240 000 plants/fed.) attained the lowest values, in both seasons. Total yield/fed. for onion grown under high density were higher than those under other densities. Planting onion at low density recorded the highest values of single bulbs%, and double bulbs%, while planting at high density recorded the lowest values, in both seasons. The highest values of number of leaves/plant and bulb weight were obtained by application of Goal + Select (twice), in both seasons. Average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. were significantly decreased under weed control treatment, in both seasons. From this investigation, it could be concluded that using of the highest plant density (400 000 plant/fed.) and application of Goal + Select (twice) could be recommended for the highest values of gross income, net benefit and the percentage of benefit/cost ratio.

Keywords: Onion, density; Goal; Select super and Ecopart.

INTRODUCTION

Onion is one of the most important commercial vegetable crops grown all over the world. Also, it is one of the most important field and vegetable crops for both local or export market in Egypt (Ghalwash *et al.* 2008). In Egypt, onion production was approximately 2.96 million tons produced from the harvested area of 81 517 ha, in 2018 (FAOSTAT,2020). Egyptian onion are characterized by high specifications that make it occupy an advanced rank globally, where it is characterized by the early availability of crop for foreign markets as well as its higher quality compared to other onions due to its high pungency and long shelf-storage period. The Egyptian onions exports in 2018 reached 526 000 ton (Agricultural Export council-Egypt).

Plant spacing is a vulnerable way of controlling bulb size, shape and yield in onion. Higher yield and better control over bulb size could be obtained if plants are grown at optimum density (Jilani *et al.*, 2009). It is important to adjust onion plants density in order to optimize light interception, photosynthesis and dry matter accumulation to onion bulbs. In addition, optimum density must be permit for the onion plants to use all growth factors in efficient way. Spacing affects the plant growth, size of bulb, yield as well as the quality of the produce (Purewal and Dargan, 1962; Badaruddin and Haque, 1977; and Rahim *et al.* 1983). The control of plant spacing is one of the cultural practices to control bulb size, shape and yield (Awas *et al.*, 2010). The higher yield and better control of over or under bulb size could be obtained if plants are grown at optimum density. Bulb neck diameter, mean bulb weight and plant height decreased as population density increased (Kahsay *et al.*, 2013). Optimum plant population is one of the important factors for optimum utilization of solar energy and soil nutrients to increase the yield per hectare of onion crop, where only single underground bulb is produced per plant (Ali *et al.*, 2020).

Crop weed competition has long been recognized as one of major constraints for low production in onion. Weeds cause reduction in bulb yield to an extent of 40-80 per cent (Patel *et al.*, 1983). Weeds are one of the main plant protection problems in onion fields. Due to their slow growth, small stature, shallow roots, and lack of dense foliage, onions cannot withstand the ill effects of weeds (Ware and McCollum, 1975). Research has documented that onions are poor competitors (Jones and Mann, 1963). Many researchers have reported that onion plants are poor competitors (Ghosheh, 2004; Carlson and Kirby, 2005). In addition to this, frequent irrigation water and fertilizer application allows for successive flushes of weeds in onion (Kalhapure *et al.* 2013). Weed compete with onion for light, nutrient, water, space and also act as host plant of several harmful insects and pathogens and considerably reduce the yield, quality and value of the crop through increased production and harvesting costs (Uygur *et al.*, 2010). Weeds in onion are a global problem and loss due to weeds was as high as 70-75% (Mani and Gautam, 1976).

* **Corresponding author.**
E-mail address: refatdoh@yahoo.com
DOI: 10.21608/jpp.2020.149797

Pyraflufen-ethyl was a potent protoporphyrinogen IX oxidase (Protox, EC 1.3.3.4) inhibitor and its selective effect on wheat (*Triticum aestivum L.*) and cleavers was due to differences of foliar deposition and absorption, and the rate of metabolic detoxification (Murata *et al.*, 2002). Clethodim is registered in cotton, peanut (*Arachis hypogaea* L.), soybean, and various other broadleaf crops (Anonymous 2005). Clethodim is generally applied with an adjuvant, crop oil concentrate (COC), alone or in combination with a nitrogen source (e.g., ammonium sulfate [AMS]), for maximum efficacy (Anonymous 2005). Weedy plots resulted in the lowest marketable onion yield (Vanhala and Tiilikkala 1999). Weed crop competition caused 71% and 76% reduction in the marketable bulb yield during the first and second year (Khokhar, 2006), respectively. Weed management is one of the most important agricultural production practices. A number of weed management practices have been reported, including use of cultural, mechanical, herbicidal and the use of organic and inorganic mulches (Pushpa and Choudhary, 2019). Several herbicides used as early post-emergence treatments for annual weed control in onions must be applied only at certain stages of growth to avoid injury to the crop (Ashton and Monaco, 1991). Oxyfluorfen, pendimethalin and metribuzin significantly reduced the weed population and increased onion yield to levels comparable to yields of weeded control in a relay cabbage–onion cropping system (Sanjeev *et al.*, 2003). Cultivation and hand-weeding are physical weed control methods in onion. However, because of an easily damaged, shallow root system, the potential injury to onion by cultivation may outweigh the benefit for overall yield (Melander and Hartvig 1997). Also only application of weedicide does not give the effective weed control. (Panse *et al.*, 2014). The use of selective herbicides together with mechanical methods for weed control in onion has been recommended (Rapparini, 1994).

MATERIALS AND METHODS

This investigation was conducted at the Experimental Farm of Shandawel Agricultural Research Station, Agricultural Research Center (ARC), during the two winter seasons of 2015/2016 and 2016/2017 to study the effect of row spacing and weed control treatments on vegetative growth, yield and quality of onion (*Allium cepa*, L.). The preceding summer crop was maize (*Zea maize* L.) in both seasons.

The soil of the experiment area was clay loam in texture. The mechanical and chemical analyses for the soil of the experimental sites (Table 1) were done according to the procedures described by Piper (1950) and Jackson (1967) at the Soil and Water Lab. of Agricultural Research Center (ARC).

Table 1. Mechanical and chemical analysis of the experimental site soil at the depth of 30 cm in 2015/2016 and 2016/2017 seasons.

Season	Soil pH	Sand	Silt	Clay	Texture classes	Organ. matter	N	P	K
		%					ppm		
2015/16	7.8	29.07	40.53	30.40	Clay loam	1.53	18.2	9.6	273
2016/17	7.7	26.94	41.00	32.06	Clay loam	1.60	20.0	9.0	257

The seeds in this experiment were sown in the nursery on 20 and 25 th August in the first and second seasons respectively, Nursery bed was prepared and planted with onion seeds cv. Giza 6 mohassan, while transplanting took place on 25 th October in both seasons of the experiment. All the cultural operations for nursery were carried out as recommended. The experimental plot size was 10.5 m^2 (3.5 m length and 3 m in width), planting rows were 15, 20 or 25 cm in width, and 3,5 m in length. The distance between onion plants at the same row was 7 cm. During soil preparation, all phosphorus requirement fertilizer was added at the rate of 60 P_2O_5 kg $fed.^{-1}$ mixed with potassium sulphate (48%) requirement at the rate of 50 K_20 unites $fed.^{-1}$. The nitrogen fertilizer at rate of 120 kg $fed.^{-1}$ as ammonium nitrate (33.5%) was side dressed at two equal doses, at 30 and 60 days from transplanting. The experimental design was a split-plot design with three replications. The main plots were randomly assigned with the three spacing, whereas weed control treatments were randomly distributed in sub plots. All the cultural operations like nursery raising, main field preparation, transplanting, fertilization, irrigation; weeding, plant protection etc. were carried out as recommended. Herbicides were sprayed by CP3 knapsack sprayers with 200 litter of water/fed. Trade, common and chemical names of the used herbicides were presented in Table 2. The investigation includes the following treatments:

Main plots: Plant density:

1- 240 000 plant/fed. (25 cm between rows and 7 cm between plants).
2- 300 000 plant/ fed. (20 cm between rows and 7 cm between plants).
3- 400 000 plant/ fed. (15 cm between rows and 7 cm between plants).

Sub plots: weed control treatments:

1- Hand hoeing twice after 30 and 45 days from transplanting.
2- Goal 24% EC at rate of 750 cm^3/fed. after 21 days from transplanting + Select super 12.5% EC at rate of 500 cm^3/fed. after 25 days from transplanting (once).
3- Goal 24% EC at rate of 750 cm^3/fed. after 21 and 40 days from transplanting + Select super 12.5% EC at rate of 500 cm^3/fed. after 25 and 45 days from transplanting (twice).
4- Ecopart 2% SC at rate of 200 cm^3/fed. after 21 days from transplanting + Select super 12.5% EC at rate of 500 cm^3/fed. after 25 days from transplanting (once).
5-Ecopart 2% SC at rate of 200 cm^3/fed. after 21 and 40 days from transplanting + Select super 12.5% EC at rate of 500 cm^3/fed. after 25 and 45 days from transplanting (twice).
6- Control (Un-weeded).

Table 2. Trade, common and chemical names of the used herbicides:

Trade name	Common name	Chemical name	Mode of action
Goal 24% EC	Oxyfluorofen	2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluorom ethyl) benzene.	Cell membranes disrupters
Select super 12.5% EC	Clethodim	2-[(E)-1-[(E)-3-chloroallyloxyimino]propyl]-5-[2-(ethylthio)propyl]-3- hydroxycyclohex-2-enone	Lipid synthesis inhibitors
Ecopart 2% SC	Pyraflufen ethyl	ethyl 2-[2-chloro-5-[4-chloro-5-(difluoromethoxy)-1-methylpyrazol-3-yl]-4-fluorophenoxy]acetate	Cell membranes disrupters

Data recorded:

1- Weeds:

Weed were hand pulled from square meter randomly of each plot after 75 days after sowing, then identified into species and classified into the following two groups and total annual weeds:

1-Annual grassy weeds: Wild oat (*Avena spp*.) and canary grass (*Phalaris spp*).

2-Annual broad-leaved weeds: lampsquarters (*Chenopodum albam* L.), spiny emex (*Emex spinosus* L.), sheep sorrel (*6Rumex dentatus* L.), common bishop (*Ammi majus* L.), kabar mustard (*Brassica nigra* L.), annual sowthistle (*Sonchus oleraceus* L.), sweet clover (*Melilotus indica* L.) and toothed medik (*Medicago polymorpha* L.).

3-Total weight of annual weeds: combined of grassy weeds and broad -leaved weeds.

Weeds were air dried for 3 days and dried on oven at 70 C° until constant weight and weighed. After that, the dry weight of weeds was recorded in g/m^2.

2- Vegetative growth:

After 120 days from transplanting, 10 randomly selected plants were taken from each plot to measure plant height (cm), number of leaves/plant, fresh bulb weight (g), bulb diameter (cm), neck diameter (cm) and bulbing ratio. Bulbing ratio = neck diameter (cm)/bulb diameter (cm), according to Mann (1952).

3- Bulb yield and its components:

At harvest time, all plants in the experimental plot were uprooted and the following data were recorded:

a- Average bulb weight (g): It was calculated by dividing weight of single bulbs by its number.

b- Marketable yield (ton/fed): It was determined as the weight of single bulb yield for each experimental plot.

c- Culls yield (ton/fed): It includes bulbs of less than 3 cm diameter, doubles, bolters, off-color and scallions.

d- Total yield (ton/fed): It was calculated on basis of yield for the experimental plot in tons/fed.

4- Onion bulb quality:

After harvest, the following characteristics were determined:

a- Single bulbs%: It was estimated by dividing number of single bulbs by the total number of bulbs x 100 for each experimental plot.

b- Double bulbs%: It was estimated by dividing number of double bulbs by the total number of bulbs x 100 for each experimental plot.

c- Bolters%: It was estimated by dividing number of bolter bulbs by the total number of bulbs x 100 for each experimental plot.

d- Small bulbs%: It was estimated by dividing number of single bulbs (smaller than 3 cm in diameter) by the total number of bulbs x 100 for each experimental plot.

e- Bulb diameter (cm): It was measured by a caliper at the maximum swollen part of the bulb, as a mean for 10 randomly selected bulbs.

f- Total soluble solids percentage (TSS %): It was determined immediately after harvest by a hand refractometer in the same representative sample of the ten bulbs according to A.O.A.C. (1975).

5- Economic feasibility study:

Economic feasibility evaluation due to experiment treatments was calculated according to (Cimmyt, 1988) as follows:

1. Total costs of onion production (L.E./ fad): as affected by different treatments.

2- Gross income (L.E/fed.) = Yield (ton/fed.) x Price (L.E/ton).

3- Gross margin = Gross income – Total cost.

4- Benefit / cost ratio (B/C) = Gross income / Total cost.

Net return was calculated by expressing the cost and yield of the unit area in monetary. The retail price used in computing cash returns was (200) Egyptian pounds for onion/ton for both seasons. The costs were negated from the overall cash returns as the resulted cash was considered to be the net return.

Statistical analysis:

The collected data were statistically analyzed and treatment effects were compared using least significant difference test (LSD, P <0.05) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Weeds:

The results in Table 3 indicated that the dry weight of grassy, broad-leaved and total weeds/m^2 were significantly decreased by increasing onion density in both seasons. It was found that moderate onion density (300 000 plants/fed.) decreased dry weight of grassy leaved (g/m^2) by 12.82 and 17.12%, decreased dry weight of broad leaved (g/m^2) by 8.16 and 9.24; and decreased dry weight of total weeds (g/m^2) by 10.14 and 12.80%; as compared to low onion density (240 000 plant/fed.) in the first and second seasons, respectively. While, high onion density (400 000 plant/fed.) decreased dry weight of grassy leaved/m^2 by 23.52 and 20.14%, decreased dry weight of broad leaves (g/m^2) by 17.22 and 16.23%; and decreased dry weight of total weeds (g/m^2) by 19.89% and17.10; as compared to low onion density (240 000 plant/fed.); in the first and second seasons, respectively.

Results in Table 3 revealed to a significant differences in dry weight of grassy, broad-leaved and total weeds/m^2 due to weed control treatments. Application of Hand hoeing twice, Goal + Select (once), Goal + Select (twice), Ecopart + Select (once) and Ecopart + Select (twice) decreased dry weight of grassy leaved weeds/m^2 by

84.56, 66.64, 88.93, 54.95 and 68.71%; dry weight of broad leaved weeds/m^2 by 90.39, 83.88, 92.76, 81.12 and 87.11%; and dry weight of total weeds/m^2 by 88.46, 78.18, 91.49, 72.47 and 81.03% in the first season, respectively as compared to un-weeded check treatment. In the second season, the application of Hand hoeing (twice), Goal + Select (once), Goal + Select (twice), Ecopart + Select (once) and Ecopart + Select (twice) decreased dry weight of grassy leaved weeds/m^2 by 87.79, 63.80, 88.05, 57.52 and 69.9%; dry weight of broad leaved weeds/m^2 by 86.80, 80.93, 88.02, 77.75 and 84.76%; and dry weight of total weeds/m^2 by 87.18, 74.41, 88.03, 70.04 and 79.10%, respectively as compared to un-weeded check treatment. These results deducted that the using of the above five control treatments were good measures for controlling weeds during early growth period of onion crop. These treatments were efficiency in control of weeds. These results are in harmony with those obtained by several researchers, such as Uygur *et al.* (2010), Ramalingam *et al.* (2013) and Panse *et al.* (2014).

Table 3. Response of dry weeds weight in onion crop to plant density and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016			2016/2017		
		Grassy leaved dry weig. (g/m^2)	Broad leaved dry weig.(g/m^2)	Total weeds dry weig. (g/m^2)	Grassy leaved dry weig.(g/m^2)	Broad leaved dry weig.(g/m^2)	Total weeds dry weig.(g/m^2)
Plant density (A):							
240 000 plant/ fed.		194.68	264.22	458.91	222.61	270.06	492.67
300 000 plant/ fed.		169.72	242.67	412.39	184.50	245.11	429.61
400 000 plant/ fed.		148.89	218.72	367.61	177.778	226.22	404.00
L.S.D at 5%:		8.59	11.35	10.88	15.68	17.13	23.78
Weed control treatments (B):							
Hand hoeing (twice)		67.09	84.67	151.76	61.33	107.67	169.00
Goal + Select (once)		145.00	142.00	287.00	181.78	155.56	337.33
Goal + Select (twice)		48.11	63.78	111.89	60.00	97.78	157.78
Ecopart + Select (once)		195.78	166.33	362.11	213.33	181.56	394.89
Ecopart + Select (twice)		136.00	113.56	249.56	151.11	124.33	275.44
Control		434.61	880.89	1315.50	502.22	815.89	1318.11
L.S.D at 5%		24.78	24.14	38.72	21.60	20.23	30.88
Interaction (A x B):							
240 000 plant/ fed.	Hand hoeing (twice)	69.60	88.67	158.27	70.00	96.33	166.33
	Goal + Select (once)	162.00	156.33	318.33	200.67	169.00	369.67
	Goal + Select (twice)	69.33	72.67	142.00	88.00	101.67	189.67
	Ecopart + Select (once)	217.33	182.00	399.33	242.00	194.67	436.67
	Ecopart + Select (twice)	150.00	125.33	275.33	170.33	139.00	309.33
	Control	499.83	960.33	1460.17	564.67	919.67	1484.33
300 000 plant/ fed.	Hand hoeing (twice)	74.67	85.33	160.00	67.00	88.00	155
	Goal + Select (once)	147.67	143.33	291.00	186.33	161.00	347.33
	Goal + Select (twice)	50.33	62.67	113.00	59.00	99.33	158.33
	Ecopart + Select (once)	193.33	163.67	357.00	205.00	186.33	391.33
	Ecopart + Select (twice)	141.67	118.33	260.00	152.33	127.00	279.33
	Control	410.67	882.67	1293.33	437.33	809.00	1246.33
400 000 plant/ fed.	Hand hoeing (twice)	57.00	80.00	137.00	47.00	138.67	185.67
	Goal + Select (once)	125.33	126.33	251.67	158.33	136.67	295.00
	Goal + Select (twice)	24.67	56.00	80.67	33.00	92.33	125.33
	Ecopart + Select (once)	176.67	153.33	330.00	193.00	163.67	356.67
	Ecopart + Select (twice)	116.33	97.00	213.33	130.67	107.00	237.67
	Control	393.33	799.67	1193.00	504.67	719.00	1223.67
L.S.D at 5%:		N.S	41.81	67.07	37.42	35.04	53.48

Dry weight of grassy, broad-leaved and total weeds/m^2 were significantly affected by this interaction between plant density and weed control treatments in both seasons. The highest values of dry weight of grassy leaved/m^2 (499.83 and 564.67 g), dry weight of broad leaved/m^2 (960.33 and 919.67g) and dry weight of total weeds/m^2 (1460.17 and 1448.33 g) were obtained by planting onion at low density (240 000 plant/fed) under control treatments, in the first and second seasons, respectively. While, The lowest values of dry weight of grassy leaved/m^2 (24.67 and 33.00g), dry weight of broad leaved/m^2 (56.00 and 92.33 g) and dry weight of total weeds/m^2 (80.67 and 125.33 g) were obtained by planting onion at high density (400 000 plant/fed) when using Goal + Select (twice) treatment**,** in the first and second seasons, respectively.

B- Vegetative growth:

Results in table 4 revealed that plant height, number of leaves/plant and fresh bulb weight were significantly affected by plant density in both seasons, except for bulb weight in the second season. It was noticed that onion plants grown under the highest density (400 0000 plants/fed.) attained the highest values of plant height and number of leaves/plant, while the lowest density (240 000 plants/fed.) attained the lowest values, in both seasons. The tallest onion plants under high density might be due to the more competition between onion plants for light which caused an increase in elongation of plants. These results

was in agreement with that found by Harun-or-Rashid (1998), who obtained taller plant from closer spacing.

Fresh bulb weight appeared adverse trend under plant density effect, as the lowest density appeared the highest values, while the highest density appeared the lowest ones. The high values of bulb weight under low density were probably due to less interplant competition for water, nutrients and light. These results are in agreement with the results of Rashid and Rashid (1976), Kumar *et al.* (1998), Khushk *et al.* (1990); Rizk *et al.* (1991), Sikder *et al.* (2010) and Geries, L. S. M. and Azza E. Khaffagy (2018).

These results also showed that plant height, number of leaves per plant and bulb weight was significantly affected by weed control treatments in both seasons. Control treatment gave the highest values of plant height in both seasons, while application of Ecopart + Select (once) and Ecopart + Select (twice) gave the lowest values in the first and second seasons respectively. The highest values of number of leaves/plant were obtained by application of Goal + Select (twice), in both seasons. Application of Goal + Select (twice) gave also the highest values of bulb weight, followed by hand hoeing (twice), with no significance differences between them. Control treatment appeared the lowest values of number of leaves/plant and bulb weight, in both seasons. These results were in line with that revealed by Jilani *et al.* (2007) who recorded that different weed management practices had profound effect on the weight of bulbs.

Table 4. Response of plant height, No of leaves/plant and bulb weight of onion to plant density and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016			2016/2017		
		Plant height (cm)	No of leaves/ plant	Fresh Bulb weight (g)	Plant height (cm)	No of leaves/ plant	Fresh Bulb weight (g)
Plant density (A):							
240 000 plant/ fed.		65.56	10.36	68.90	67.36	9.95	67.44
300 000 plant/ fed.		68.47	11.44	66.86	71.56	10.70	66.00
400 000 plant/ fed.		70.86	12.39	63.39	72.25	11.72	64.44
L.S.D at 5%:		3.85	0.35	3.45	2.71	0.49	N.S
Weed control treatments (B):							
Hand hoeing (twice)		72.78	10.89	78.90	71.00	10.72	75.33
Goal + Select (once)		70.56	11.50	70.56	70.17	11.78	70.30
Goal + Select (twice)		65.89	12.50	79.78	67.83	12.78	78.30
Ecopart + Select (once)		57.78	11.17	57.83	68.11	11.56	67.78
Ecopart + Select (twice)		66.95	12.17	73.78	66.78	9.11	71.59
Control		75.83	10.17	37.44	78.44	8.78	32.46
L.S.D at 5%:		3.36	0.38	3.14	2.99	0.24	4.10
Interaction (A x B):							
240 000 plant/ fed.	Hand hoeing (twice)	66.67	10.00	84.04	65.33	9.83	80.56
	Goal + Select (once)	69.17	11.00	75.67	67.33	11.67	73.78
	Goal + Select (twice)	60.00	12.00	82.67	68.33	12.33	80.55
	Ecopart + Select (once)	59.17	9.67	61.33	65.83	9.67	64.67
	Ecopart + Select (twice)	61.67	9.17	77.67	61.17	6.83	77.56
	Control	76.67	10.33	32.00	76.17	9.33	27.50
300 000 plant/ fed.	Hand hoeing (twice)	74.17	10.83	76.33	72.17	10.33	74.33
	Goal + Select (once)	70.83	11.00	70.33	71.17	10.67	69.89
	Goal + Select (twice)	73.33	12.50	81.33	69.67	12.67	79.34
	Ecopart + Select (once)	54.17	10.50	53.50	73.00	11.50	75.67
	Ecopart + Select (twice)	68.33	13.83	75.00	62.50	10.50	59.67
	Control	70.00	10.00	44.67	80.83	8.50	37.11
400 000 plant/ fed.	Hand hoeing (twice)	77.50	11.83	76.33	75.50	12.00	71.11
	Goal + Select (once)	71.67	12.50	65.67	72.00	13.00	67.22
	Goal + Select (twice)	64.33	13.00	75.33	65.50	13.33	75.00
	Ecopart + Select (once)	60.00	13.33	58.67	65.50	13.50	63.00
	Ecopart + Select (twice)	70.83	13.50	68.67	76.67	10.00	77.56
	Control	80.83	10.17	35.67	78.33	8.50	32.78
L.S.D at 5%:		5.81	0.66	5.44	5.18	0.42	7.10

Plant height, number of leaves per plant and fresh bulb weight were significantly affected by the interaction between onion density and weed control treatments, in both seasons (Table 4). The tallest plants were recorded with the highest onion density (400 000 plant/fed.) or moderate onion density (300 000 plant/fed.) under control treatments, in the first and second seasons, respectively; while, the shortest plants were recorded with moderate density when applied with Ecopart + Select (once) or Ecopart + Select (twice), in the first and second seasons, respectively. The highest values of No of leaves/plant were reported under moderate density when applied with Ecopart + Select (twice), and with highest density when applied with Ecopart + Select (once), in the first and second seasons, respectively; whilst, the lowest values were reported with low onion density when applied with Ecopart + Select (twice), in both seasons. The combination between low density (240 000 plant/fed.) and hand weeding (twice) gave the maximum values of bulb weight, while the combination between low density and control treatment gave the lowest values. These results were true in both seasons.

Data in Table 5 revealed that onion density had a significant effect on neck diameter and bulbing ratio in the second season only, and on bulb diameter in both seasons. Planting onion at low density (240 000 plant/fed.) appeared the highest values of neck diameter, bulb diameter and bulbing ratio, while planting at high density (400 000 plant/fed) appeared the lowest values. These results were true in both seasons.

Table 5. Response of neck and bulb diameter, and bulbing ratio of onion to plant density and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016			2016/2017		
		Neck diam. (cm)	Bulb diam. (cm)	Bulbing ratio	Neck diam. (cm)	Bulb diam. (cm)	Bulbing ratio
Plant density (A):							
240 000 plant/ fed.		1.95	5.79	0.35	2.03	5.68	0.38
300 000 plant/ fed.		1.83	5.43	0.35	1.79	5.29	0.34
400 000 plant/ fed.		1.65	5.13	0.32	1.36	5.00	0.27
L.S.D at 5%:		N.S	0.42	N.S	0.12	0.46	0.02
Weed control treatments (B):							
Hand hoeing (twice)		3.09	5.98	0.45	1.75	6.03	0.30
Goal + Select (once)		1.47	5.29	0.28	1.22	5.00	0.23
Goal + Select (twice)		1.81	5.65	0.30	1.92	5.92	0.32
Ecopart + Select (once)		1.49	5.65	0.27	1.52	5.60	0.28
Ecopart + Select (twice)		1.53	5.85	0.26	1.95	5.70	0.34
Control		1.49	3.10	0.48	2.00	3.69	0.51
L.S.D at 5%:		0.37	0.24	0.09	N.S	0.27	0.11
Interaction (A x B):							
240 000 plant/ fed.	Hand hoeing (twice)	3.43	6.42	0.48	2.28	6.35	0.38
	Goal + Select (once)	1.83	5.88	0.31	0.87	5.50	0.16
	Goal + Select (twice)	1.95	7.18	0.30	2.03	6.05	0.32
	Ecopart + Select (once)	1.30	5.73	0.23	1.57	5.98	0.26
	Ecopart + Select (twice)	0.94	5.72	0.17	1.80	5.85	0.31
	Control	2.27	3.80	0.61	3.63	4.32	0.84
300 000 plant/ fed.	Hand hoeing (twice)	2.73	6.07	0.41	1.45	5.70	0.25
	Goal + Select (once)	1.15	5.37	0.21	2.35	5.43	0.42
	Goal + Select (twice)	1.78	6.65	0.29	1.70	5.92	0.30
	Ecopart + Select (once)	1.53	6.10	0.25	1.43	5.95	0.25
	Ecopart + Select (twice)	2.48	5.97	0.43	2.73	5.68	0.48
	Control	1.28	2.43	0.52	1.08	3.07	0.35
400 000 plant/ fed.	Hand hoeing (twice)	3.10	5.47	0.47	1.52	6.03	0.26
	Goal + Select (once)	1.42	4.63	0.31	0.45	4.07	0.11
	Goal + Select (twice)	1.68	6.62	0.31	2.03	5.80	0.34
	Ecopart + Select (once)	1.65	5.13	0.32	1.57	4.88	0.32
	Ecopart + Select (twice)	1.15	5.87	0.20	1.32	5.57	0.24
	Control	0.92	3.07	0.30	1.28	3.67	0.35
L.S.D at 5%:		0.63	0.42	0.15	1.07	0.46	0.19

Weed control treatments significantly differentiated bulb diameter and bulbing ratio in both seasons, and neck diameter in the first season only. Hand weeding (twice) attained the greatest values of neck diameter in the first season and bulb diameter in both seasons, while control treatment attained the greatest values of bulbing ratio in both seasons and neck diameter in the second season. these results was in agreements with that found by Hussain *et al* (2008) who indicated that bulb size was the largest in the hand weeded plots followed by pendimethalin, while minimum bulb size was observed in the weedy check plots.

Neck diameter, bulb diameter and bulbing ratio were significantly affected by the interaction between the plant density and weed control treatments in both seasons. The highest combination in respect to neck diameter was obtained with low onion density (240 000 plant/fed.) under hand weeding (twice) or control treatments, whilst the lowest combination was obtained with high onion density (400 000 plant/fed) under control or Ecopart + Select (once) treatments, in the first and second seasons, respectively. The highest interaction for bulb diameter were obtained with low onion density under Ecopatrt + Select (twice) or hand weeding (twice), in the first and second seasons, respectively; while the lowest interaction were obtained with moderate onion density (300 000 plant/fed) under control treatment, in both seasons. The highest values of bulbing ratio were obtained by the combination between high onion density and control or hand weeding (twice) treatments, in the first and second seasons, respectively. While the lowest values of bulbing ratio were obtained by the combination between high onion density and Ecopart + Select (twice) in the first season; and by the combination between moderate onion density and control treatments, in the second season (Table 5).

4- Bulb yield and its components:

Data presented in Table 6 indicate that plant density significantly differentiated average bulb weight, marketable yield/fed., culls yield/fed., and total yield/fed., in both seasons. Average bulb weight was increased by decreasing the plant density. The lowest plant density (240 000 plant/fed.) resulted in an increase in average bulb weight by 6.62 and 14.09% in the first season; and by 10.39 and 18.71% in the second season over the other densities of 300 000 and 400 000 plant/fed., respectively.

This results was in coincide with that found by Kantona *et al.* (2003) who reported a decrease in bulb weight as the plant population per square meter increased from 50 to 200 plants likely due to competition associated with closely spaced plants that resulted in lower bulb weight per plan. Kahsay *et al.* (2013) and Geries, L. S. M. and Azza E. Khaffagy(2018) also reported that average bulb weight increased with increasing intra row spacing.

Marketable yield/fed. for onion grown under moderate density (300 000 plant/fed.) were higher than those under other densities by 10.49 and 0.53% in the first season, and by 12.33 and 4.13% in the second season, over the densities of 240 000 and 400 000 plant/fed., respectively. The moderate plant density (300 000 plant/fed.) resulted in a decrease in culls yield/fed by 11.70 and 41.50% in the first season; and by 43.35 and 54.90% in the second season over the other densities of 240 000 and 400 000 plant/fed., respectively. Total yield/fed. for onion grown under high density (400 000 plant/fed.) were higher than those under other densities by 17.33 and 10.26% in the first season, and by 12.45 and 15.05% in the second season, over the densities of 240 000 and 300 000 plant/fed., respectively. Increasing total yields/fed under high density was confirmed by many researcher. Karsanbhai (2003) and Misra *et al*., (2016) showed high yield at less spacing (10×10 cm). Kumar *et al.* (2018) demonstrated that fresh bulb yield was maximum in T1S2 (10×10 cm) might be due to more number of bulb produced per unit area. Plants also have used maximum nutrients for production of more number of bulbs.

Table 6. Response of yield and yield and yield components of onion to plant density and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016				2016/2017			
		Aver. bulb weight (g)	Mark. bulb yield (t/fed.)	Culls bulb yield (t/fed.)	Total bulb yield (t/fed.)	Aver. bulb weight (g)	Mark. bulb yield (t/fed.)	Culls bulb yield (t/fed.)	Total bulb yield (t/fed.)
Plant density (A):									
240 000 plant/ fed.		70.38	12.01	2.65	14.66	90.73	11.44	4.06	15.50
300 000 plant/ fed.		66.01	13.27	2.34	15.60	82.19	12.85	2.30	15.15
400 000 plant/ fed.		61.69	13.20	4.00	17.20	76.43	12.34	5.10	17.43
L.S.D at 5%:		2.34	0.22	1.22	1.42	8.41	0.78	0.74	0.69
Weed control treatments (B):									
Hand hoeing (twice)		73.13	15.91	3.05	18.96	97.75	14.09	5.03	19.11
Goal + Select (once)		68.83	14.47	2.45	16.92	86.83	13.49	2.59	16.08
Goal + Select (twice)		76.68	16.52	2.58	19.10	97.49	15.65	3.79	19.44
Ecopart + Select (once)		67.93	12.13	3.25	15.38	89.24	12.18	3.51	15.69
Ecopart + Select (twice)		67.99	13.32	4.66	17.98	84.48	12.96	6.11	19.07
Control		41.61	4.60	1.99	6.59	42.90	4.89	1.89	6.77
L.S.D at 5%:		5.30	0.70	0.88	0.93	7.38	1.04	0.94	1.20
Interaction (A x B):									
240 000 plant/ fed.	Hand hoeing (twice)	72.99	15.67	2.55	18.22	97.943	13.55	4.33	17.87
	Goal + Select (once)	80.02	13.25	1.67	14.92	87.34	14.03	1.47	15.50
	Goal + Select (twice)	77.21	14.73	0.94	15.67	111.41	13.08	6.31	19.39
	Ecopart+Select (once)	71.03	10.94	2.97	13.91	102.16	10.63	3.76	14.39
	Ecopart+Select (twice)	73.80	12.79	6.03	18.83	100.53	12.29	6.46	18.75
	Control	47.23	4.67	1.76	6.43	45.01	5.07	2.03	7.09
300 000 plant/ fed.	Hand hoeing (twice)	67.62	14.58	2.40	16.98	96.67	14.99	3.65	18.64
	Goal + Select (once)	64.30	14.70	1.97	16.67	91.71	14.27	0.87	15.14
	Goal + Select (twice)	79.76	18.01	1.46	19.47	90.49	15.28	0.96	16.24
	Ecopart+Select (once)	69.00	13.28	3.09	16.37	85.52	12.20	2.36	14.56
	Ecopart+Select (twice)	73.22	13.92	3.61	17.52	94.74	14.54	4.58	19.12
	Control	42.18	5.12	1.48	6.61	34.01	5.83	1.38	7.21
400 000 plant/ fed.	Hand hoeing (twice)	78.76	17.49	4.20	21.68	98.64	13.72	7.11	20.83
	Goal + Select (once)	62.18	15.45	3.71	19.16	81.44	12.17	5.43	17.60
	Goal + Select (twice)	73.07	16.82	5.35	22.16	90.58	18.59	4.08	22.67
	Ecopart+Select (once)	63.77	12.18	3.68	15.85	80.05	13.72	4.41	18.14
	Ecopart+Select (twice)	56.96	13.24	4.35	17.58	58.17	12.04	7.29	19.33
	Control	35.42	3.99	2.74	6.73	49.68	3.78	2.25	6.02
	L.S.D at 5%:	9.18	1.20	1.53	1.61	12.78	1.80	1.63	2.08

As shown in Table 6, average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. were significantly affected by the used weed control treatments, in both seasons. Application of Hand weeding twice, Goal + Select (once), Goal + Select (twice), Ecopart + Select (once) and Ecopart + Select (twice) increased average bulb weight by 75.75, 65.42, 84.28, 63.25 and 63.40%; marketable yield/fed by 245.87, 214.57, 259.13, 163.70 and 189.57%; culls yield/fed. by 53.27, 23.12, 29.65, 63.32 and 134.17%; and total yield/fed. by 187.71, 156.75, 189.83, 133.38 and 172.84% in the first season, respectively as compared to control treatment. In second season, the application of Hand weeding twice, Goal + Select (once), Goal + Select (twice), Ecopart + Select (once) and Ecopart + Select (twice) increased average bulb weight by 127.86, 102.40, 127.25, 108.02 and 96.92%; marketable yield/fed by 188.14, 175.87, 220.04, 149.08 and 165.03%; culls yield/fed. by 166.14, 37.04, 100.53, 85.71and 223.28%; and total yield/fed. by 182.27, 137.52, 187.15, 131.76 and 181.68, respectively as compared to control treatment. The increases in average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed

under different weed control treatments mainly due to effectiveness of these treatments on reducing weed density in onion , which ultimately increased the nutrient availability for the crop, similar conclusion was obtained by Marwat *et al.* (2003). Many researcher revealed to the important of weed control treatments on increasing onion yield. Kalhapure (2013) revealed that weed management with three hand weedings (HW) at 20, 40 and 60 DAT recorded significantly maximum in all yield attributes of onion. Hussain *et al.* (2008) revealed that the maximum onion yield was recorded in the hand weeded plots followed by pendimethalin as compared to weedy check. Uygur *et al.* (2010) found that weed-free check caused 76.3% increase in the onion yield when compared with weedy checks.

Average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. were significantly affected by the interaction between the two studied factors in both seasons (Table 6). The maximum values of average bulb weight were observed by the combination between plant density of 240 000 plant/fed. and application of Goal + Select (once) or Goal + Select (twice) , in the first and second seasons, respectively; while the lowest values were observed when onion planted at density of 300 000 or 400 0000 plant/fed. under control treatment, in the first season and second seasons, respectively. The highest values of marketable yield were observed when onion was planted under density of 300 000 or 400 0000 plant/fed. and applied with Goal + Select (twice), in the first and second seasons, respectively; while the lowest values were obtained by planting onion at density of 400 000 plant/fed. under control treatments. The lowest values of culls yield/fed was observed by the combinations between density of 240 000 plant/fed. and treatment of Goal + Select (twice), and between density of 300 000 plant/fed. and treatment of Goal + Select (once), in the first and second seasons, respectively; while the highest values were observed by planting onion at density of 240 000 or 300 000 plant/fed. and application of Ecopart + Select (twice), in the first and second seasons, respectively. The highest values of total yield/fed. were obtained under density of 400 000 plant/fed. when applied with Goal + Select (twice), in both seasons; while, the lowest values were obtained by planting onion at density of 240 000 or 300 000 plant/fed. under control treatments.

D- Onion bulb quality:

Data presented in Table 7 revealed that plant density of onion had a significant effect on single bulbs% and double bulbs%, in both seasons. While, the differences between means of bolters% did not reach the level of significance, in both seasons. Planting onion at low density (240 000 plant/fed.) recorded the highest values of single bulbs, and double bulbs%, while planting at high density (400 000 plant/fed) recorded the lowest values, in both seasons.

Table 7. Response of single bulbs%, double bulbs and bolters% of onion to plant density and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016			2016/2017		
		Single bulbs %	Double bulbs %	Bolters %	Single bulbs %	Double bulbs %	Bolters %
Plant density (A):							
240 000 plant/ fed.		83.96	1.79	0.74	77.10	2.70	1.04
300 000 plant/ fed.		83.51	1.39	0.82	75.44	1.53	1.00
400 000 plant/ fed.		82.71	1.16	0.86	73.28	1.46	0.90
L.S.D at 5%:		0.44	0.35	N.S	2.14	0.41	N.S
Weed control treatments (B):							
Hand hoeing (twice)		86.43	1.87	0.71	85.48	1.96	1.05
Goal + Select (once)		88.61	1.23	0.77	78.34	2.70	0.75
Goal + Select (twice)		88.78	1.90	0.62	88.09	1.37	0.64
Ecopart + Select (once)		86.68	1.06	0.83	68.31	1.81	0.90
Ecopart + Select (twice)		86.11	1.02	0.72	70.70	1.91	0.82
Control		63.75	1.60	1.17	60.71	1.62	1.71
L.S.D at 5%:		1.33	0.50	0.27	2.41	0.42	0.37
Interaction (A x B):							
240 000 plant/ fed.	Hand hoeing (twice)	91.08	2.36	0.68	91.80	3.38	1.79
	Goal + Select (once)	91.01	2.72	0.74	76.00	2.25	0.46
	Goal + Select (twice)	89.81	2.32	0.70	88.73	0.30	0.39
	Ecopart + Select (once)	86.70	1.11	1.01	71.45	4.03	0.73
	Ecopart + Select (twice)	81.67	0.99	0.50	74.23	4.12	0.59
	Control	63.48	1.25	0.81	60.37	2.12	2.26
300 000 plant/ fed.	Hand hoeing (twice)	81.59	1.81	0.82	86.08	1.73	0.79
	Goal + Select (once)	86.43	0.60	0.80	68.22	2.03	1.05
	Goal + Select (twice)	89.61	2.20	0.57	94.94	2.25	0.71
	Ecopart + Select (once)	87.83	0.92	0.82	68.52	0.68	1.11
	Ecopart + Select (twice)	88.67	0.61	0.78	70.28	0.86	1.10
	Control	66.93	2.22	1.11	64.61	1.63	1.22
400 000 plant/ fed.	Hand hoeing (twice)	86.61	1.44	0.63	78.56	0.77	0.56
	Goal + Select (once)	88.39	0.37	0.76	90.79	3.82	0.73
	Goal + Select (twice)	86.93	1.18	0.60	80.60	1.55	0.82
	Ecopart + Select (once)	85.52	1.15	0.67	64.95	0.73	0.85
	Ecopart + Select (twice)	87.99	1.47	0.89	67.60	0.77	0.77
	Control	60.83	1.34	1.60	57.15	1.12	1.66
L.S.D at 5%:		2.30	0.86	N.S	4.18	0.72	0.63

Data also revealed to a significant difference in single bulbs%, double bulbs% and bolters% due to weed control treatments, in both seasons. Application of Goal + Select (twice) appeared the highest values of single bulbs in both seasons, and double bulbs in the first season, while application of Goal + Select (once) appeared the highest values of double bulbs in the second season. Control treatment appeared the highest values of bolters%, and the lowest values of single bulbs%, in both seasons. Goal + Select (once) treatment appeared the lowest values of bolters% in both seasons, and double bulbs% in the second season.

The highest combination for single bulbs% were obtained under low onion density when applied with hand weeding, in both seasons. The highest combination for double bulbs were obtained under low onion density, when applied with Goal + Select (once), or hand weeding (twice), in the first and second seasons, respectively. The combination between onion low density and control treatment appeared the highest values of bolters% in the second season. The combination between high onion density and control treatment appeared the lowest values of single bulbs in both seasons, while, the combination between low onion density and Goal + Select (twice) treatment appeared the lowest values of double bulbs% and bolters%, in the second seasons.

Data as shown in Table 8 indicated that small bulbs%, bulb diameter and TSS% were significantly affected by onion density in both seasons. It was noticed that onion plants grown under high density recorded the highest values of small bulbs% in both seasons, while those grown under low density recorded the highest values of bulb diameter and TSS%, in both seasons. The lowest values of small bulbs% were recorded under low onion density, while, the lowest values of bulb diameter and TSS% were recorded under high onion density, in both seasons. These results were confirmed with that reported by Dawar *et al.* (2007) they found that Higher planting density significantly increased, weight of small bulbs (738.11 g ha^{-1}), and by Jilani *et al.* (2009) they revealed that minimum plant population (20 plants/m^2) had significantly larger bulb diameter (5.493 and 5.877 cm) during both years against smaller bulb diameter of wider plants density (40 plants/m^2).

Table 8. Response of small bulbs%, bulb diameter and TSS% to row spacing and weed control treatments during 2015/2016 and 2016/2017 seasons.

Treatments		2015/2016			2016/2017		
		Small bulbs %	Bulb diamet.	TSS%	Small bulbs %	Bulb diamet.	TSS%
Plant density (A):							
240 000 plant/ fed.		13.51	7.03	14.98	19.17	6.99	14.39
300 000 plant/ fed.		14.28	6.53	13.64	22.13	6.33	13.53
400 000 plant/ fed.		15.27	6.24	13.43	24.27	6.03	13.25
L.S.D at 5%:		0.46	0.41	0.67	2.26	0.08	0.31
Weed control treatments (B):							
Hand hoeing (twice)		10.99	7.43	14.30	11.52	6.97	14.17
Goal + Select (once)		9.40	6.94	14.14	18.21	6.67	13.39
Goal + Select (twice)		8.69	7.32	15.02	11.02	8.58	14.67
Ecopart + Select (once)		11.43	6.22	14.47	28.98	4.68	13.44
Ecopart + Select (twice)		12.15	6.82	13.82	25.44	6.92	13.74
Control		33.47	4.88	12.35	35.96	4.85	12.93
L.S.D at 5%:		1.22	0.42	0.51	2.54	0.27	0.43
Interaction (A x B):							
240 000 plant/ fed.	Hand hoeing (twice)	5.87	7.85	15.36	3.03	7.52	14.13
	Goal + Select (once)	5.53	7.50	14.82	21.28	7.37	13.97
	Goal + Select (twice)	7.17	7.71	15.59	6.76	9.14	15.25
	Ecopart + Select (once)	11.20	6.53	15.63	23.80	5.15	14.97
	Ecopart + Select (twice)	16.85	7.37	13.92	24.89	7.41	14.19
	Control	34.46	5.20	14.56	35.25	5.33	13.86
300 000 plant/ fed.	Hand hoeing (twice)	15.76	7.65	13.58	11.64	6.91	14.61
	Goal + Select (once)	12.17	6.76	14.53	29.02	6.50	13.83
	Goal + Select (twice)	7.62	7.35	15.20	3.38	8.15	14.22
	Ecopart + Select (once)	10.43	5.85	13.59	29.96	4.80	12.39
	Ecopart + Select (twice)	9.94	6.75	13.81	26.69	6.91	13.56
	Control	29.74	4.84	11.12	32.10	4.70	12.56
400 000 plant/ fed.	Hand hoeing (twice)	11.32	6.78	13.97	19.88	6.49	13.75
	Goal + Select (once)	10.48	6.56	13.06	4.33	6.14	12.36
	Goal + Select (twice)	11.29	6.90	14.26	22.92	8.44	14.53
	Ecopart + Select (once)	12.65	6.27	14.18	33.20	4.10	12.98
	Ecopart + Select (twice)	9.66	6.34	13.73	24.75	6.44	13.48
	Control	36.22	4.61	11.37	40.51	4.53	12.37
L.S.D at 5%:		2.11	N.S	0.88	4.40	N.S	0.75

The results showed that small bulbs%, bulb diameter and TSS% were significantly responded to weed control treatments in both seasons. Control treatments recorded the highest values of small bulbs, in both seasons; while, Goal + Select (twice) recorded the highest values of bulb diameter in the second season, and TSS% in both seasons. The lowest values of small bulbs were recorded under Goal + Select (twice) treatment, in both seasons; while the lowest values of bulb diameter in the first season,

and TSS% in both seasons were recorded under control treatments.

From data in Table 8, It could be noticed that small bulbs and TSS% were significantly affected by the interaction between the two factors; while, this effect did not reach the level of significance on bulb diameter. These results were true in both seasons. High onion density under control treatment gave the highest values of small bulbs%, in both seasons. Low onion density under Ecopart + Select (once), or Goal + Select (twice) treatments gave the highest values of TSS%, in the first and second season, respectively. The lowest combination for small bulbs% were recorded by planting onion at low density when applied with Goal + select (once), or hand hoeing, in the first and second seasons, respectively. While, the lowest combination for TSS% were recorded by using moderate onion density under control treatment, or when using high density under Goal + Select (once) treatment, in the first and second season, respectively.

5- Economic feasibility study:

Data in Table 9 showed that the highest onion density (400 000 plant/fed.) appeared the highest values of gross income, gross margin and percentage of benefit/ cost ratio total cost, while the lowest density (240 000 plant/fed.) appeared the lowest values. In respect to the effect of weed control treatments on gross margin, it could be arranged in a descending order as follows: Goal + Select (twice), hand weeding (twice), Ecopart + Select (twice), Goal + Select (once) and Ecopart + Select (once) respectively. Un-weeded check treatments gave the lowest values of gross income, gross margin and the percentage of benefit/ cost ratio by 11039 and -4411 LE, and - 0.71%, respectively. Using of highest plant density (400 000 plant/fed.) and application of Goal + Select (twice) treatment gave the highest values of gross income, gross margin and percentage of benefit/cost ratio (39182 LE, 23172 LE and 2.45 %, respectively). These results were in line with that obtained by Gaharwar *et al.* (2017) and Geries, L. S. M. and Azza E. Khaffagy(2018) they revealed that Spraying of herbicide oxyfluorfen 23.5% EC 0.1-0.15 kg a.i./ha 15-20 DAT + 1HW at 45 DAT recorded highest gross return as well as net return and scored highest cost benefit ratio 1:2.09. However, treatment T5-Spraying Oxyfluorfen 23.5% EC 0.-0.15 kg a.i./ha before planting +1HW at 40-60 DAT ranked second in control of weed growth and gained the higher bulb yield with monetary returns.

Table 9. Economic evaluation for onion crop as affected by plant density and weed control treatments as the mean for 2015/2016 and 2016/2017 seasons.

Treatments		Total bulb yield (t/fed.)	Total Costs (L.E./fed)	Gross income (L.E./fed)	Gross margin (L.E./fed)	Benefit/ Cost ratio (B/C)
Plant density (A):						
240 000 plant/ fed.		15.08	16081	26135	10055	1.60
300 000 plant/ fed.		15.38	16031	27974	11943	1.70
400 000 plant/ fed.		17.32	15981	29172	13191	1.80
Weed control treatments (B):						
Hand weeding (twice)		19.04	17450	33232	15782	1.90
Goal + Select (once)		16.50	15755	29973	14218	1.90
Goal + Select (twice)		19.27	16060	34717	18657	2.16
Icobart + Select (once)		15.54	15640	27019	11379	1.73
Icobart + Select (twice)		18.53	15830	30583	14753	1.93
Control		6.68	15450	11039	-4411	-0.71
Interaction (A x B):						
240 000 plant/ fed.	Hand weeding (twice)	18.05	17500	31972	14472	1.83
	Goal + Select (once)	15.21	15805	28536	12731	1.81
	Goal + Select (twice)	17.53	15110	30710	14600	1.91
	Icobart + Select (once)	14.15	15690	24262	8572	1.55
	Icobart + Select (twice)	18.79	15880	30076	14196	1.89
	Control	6.76	15500	11256	-4244	-0.73
300 000 plant/ fed.	Hand weeding (twice)	17.81	17450	31990	14540	1.83
	Goal + Select (once)	15.91	15755	30106	14351	1.91
	Goal + Select (twice)	17.86	16060	34258	18198	2.13
	Icobart + Select (once)	15.47	15640	27660	12020	1.77
	Icobart + Select (twice)	18.32	15830	31736	15906	2.00
	Control	6.91	15450	12094	-3356	-0.78
400 000 plant/ fed.	Hand weeding (twice)	21.26	17400	35734	18334	2.05
	Goal + Select (once)	18.38	15705	31276	15571	1.99
	Goal + Select (twice)	22.42	16010	39182	23172	2.45
	Icobart + Select (once)	17.00	15590	29136	13546	1.87
	Icobart + Select (twice)	18.46	15780	29936	14156	1.90
	Control	6.38	15400	9766	-5634	-0.63

REFERENCES

A.O.A.C. (1975). "Official Methods of Analysis of the Association of Official Agriculture Chemists". Twelfth Ed. published by the Association of Official Agriculture Chemists. Washington, D.C. 832.

Ali, Md. I.; Md. M. Islam; Md. S. Islam; Md. N. H. Mehedi; Md. S. Haque; T. Sarmin and Md. S. A. Al Mamun (2020). Effect of plant density on growth and yield attributes of different onion varieties. International J. of Applied Res., 6 (1): 19-23.

Anonymous (2005). Select 2 EC label. Walnut Creek, CA: Valent USA Corp.

Ashton, F.M. and T.J. Monaco (1991). Weed Science: Principles and Practices, 3rd Edition. Wiley, New York.

Awas, G.; T. Abdisa; K. Tolesa and A. Chali (2010). Effect of intra-row spacing on yield of three onion (*Allium cepa* L.) varieties at Adami Tulu Agricultural Research Center (mid rift valley of Ethiopia). J. Hort. and Forestry. 2 (1): 7- 11.

Badaruddin, M. and M. A. Haque (1977). Effect of time of planting and spacing on the yield of onion (*Allium cepa* L.). Bangladesh Hort., 5 (2): 23-29.

Carlson, H. L and D. Kirby (2005). Effect of Herbicide Rate and Application Timing on Weed Control in Dehydrator Onions. University of Florida, Intermountain Res. and Extension Center, Number, 115: p. 4.

Cimmyt (1988). "From Agronomic Data to Farmer Recommendation: An Economic Work Book" D.F: pp. 31- 33.

Dawar, N. M.; F. K. Wazir; M. Dawar and S. H. Dawar (2007). Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar. Sarhad J. Agric. 23 (4): 911-912.

FAOSTAT (2019). Food and Agriculture Data. Food and Agriculture Organization doi: http://www.fao.org/ faostat/en/#data/QC.

Gaharwar, Anjali M.; N. Patil and J. D. Ughade (2017). Effect of integrated weed management on growth, yield and economic returns on onion (*Allium cepa* L.). The Asian J. of Hort., 12 (2): 193-197.

Geries, L. S. M. and Azza E. Khaffagy(2018). Efficiency of weed control methods and planting population on controlling weeds and their economic feasibility of onion productivity. J. Plant Production, Mansoura Univ., Vol. 9 (12): 1021 - 1030.

Ghalwash A. M.; I. E. Soliman and A.E. Khaffagy (2008). Effect of some weed control treatments on transplanted onion (*Allium cepa, L.*) Yield and its associated weeds. J. Plant Prot. Path Mansoura Uni. 33: 941-952.

Ghosheh, H. Z. (2004). Single Herbicide Treatments for Control of Broadleaved Weeds in Onion (*Allium cepa*). Crop Prot. 23: 539-542.

Gomez, K. A. and A. A. Gomez (1984). Statistical procedures for agricultural research (Second Ed.) John Willey and Sons, New York, pp: 680.

Harun-or-Rashid, A. R. M. (1998). Effects of NPKS on growth and yield of onion at different plant spacing M. S. thesis, Dept. Hort., BAU, Mymensingh. 72p.

Hussain, Z.; K. B. Marwat; S. I. A. Shah; Shahnaz A. Arifullah and N. M. Khan (2008). Evaluation of different herbicides for weed control in onion. Sarhad J. Agric. 24 (3): 453-456.

Jackson, M. L. (1967). Soil chemical analysis. Prentice Hall Private, Itd, New York.

Jilani, M. S.; M. Q. Khan and S. Rahman (2009). Planting densities effect on yield and yield components of onion (*Allium cepa* L.). J. Agric. Res., 47(4).

Jilani1, M. S.; M. Ramzan and K. Waseem (2007). Impact of weed management practices on growth and yield of some local genotypes of onion. Pakistan. J. Weed Sci. Res. 13(3-4): 191-198.

Jones, H. A. and L. K. Mann. (1963). Onions and their allies, botany, cultivations and utilization. Leonard Hill, London.

Kahsay, Y.; D. Belew and F. Abay (2013). Effect of intra-row spacing on yield and quality of some onion varieties (*Allium cepa* L.) at Aksum, Northern Ethiopia. African Journal of Plant Science, 7 (12), pp. 613-622.

Kalhapure, A.H.; B.T. Shete and P.S. Bodake (2013). Integrated weed management in onion (*Allium cepa)*. Indian Journal of Agronomy 58 (3): 408-41.

Kantona, R. A. L.; L. Abbeyb; R. G. Hillac; M. A. Tabil and N. D. Jane (2003). Density affects plant development and yield of bulb onion (*Allium cepa* L.) in Northern Ghana. J. Veg. Crop Prod. 8 (2): 15-25.

Karsanbhai, P.V. (2003). Effect of spacing and nitrogen on growth, yield and quality of onion (Allium cepa L.) var. local white. M.Sc Anand Agricultural University Anand, Gujarat.114 p.

Khokhar, K. M.; T. Mahmood; M. Shakeel; M. F. Chaudhry (2006). Evaluation of integrated weed management practices for onion in Pakistan. Crop Prot. 25: 968–972.

Khushk, A. M.; N. M. Miano; A. H. Ansari and M. I. Mari (1990). Influence of inter and intra row spacing of the yield and yield components of onion (*Allium cepa* L.). Sarhad J. Agric. 69 (2): 147-150.

Kumar, H.; J. V. Sing; A. Kumar and M. Singh (1998). Study on the effect of spacing on growth and yield of onion cv. Patna Red. Indian J. Agric. Res. 32(2): 134-138.

Kumar, P.; Savita; S. Kumar; V. Thakur; D. Kaur and A. Kamboj (2018). Effect of planting density and inorganic fertilizers on growth and yield of onion. Int. J. Curr. Microbiol. App. Sci. 7 (6): 3246-3250.

Mani, V. S. and K. C. Gautam (1976). A national strategy for weed control. Pesticides, 10 : 15.

Mann, L.K. (1952). Anatomy of garlic bulb and factors affecting bulb development. Hilgardia, 21: 195 - 228.

Marwat, K. B.; I. A. Khan and Z. Hussain (2003). Efficacy of different herbicides for controlling weeds in onion. Pak. J. Weed Sci. Res. 9 (3-4): 225-228 MINFAL. 2006. Agricultural Statistics of Pakistan. Ministry of Food, Agric. Livestock, Govt. of Pakistan, Islamabad.

Melander, B. and P. Hartvig (1997). Yield responses of weed-free seeded onions (*Allium cepa* L.) to hoeing close to the row. Crop Prot. 16: 687-69.

Misra, A.D.; S. Babu; G. Yadav and B. Gudade (2016). Response of common onion (Allium cepa L.) to spacing and planting time in Manipur valley of North-East India. Vegetable Science. 43 (1):112-116.

Murata, S.; A. Yamashita; Y. Kimura; K. Motoba; T. Mabuchi and Y. Miura (2002). Mechanisms of Selective Action of a Protoporphyrinogen IX Oxidase-Inhibiting Herbicide Pyraflufen-ethyl between Wheat (*Triticum aestivum*) and Cleavers (*Galium aparine*). J. Pesticide Sci. 27, 47-52.

Panse, R.; A. Gupta; P.K. Jain; D. S. Sasode and S. Sharma (2014). Efficacy of different herbicides against weed flora in Onion (*Allium cepa* L.). J. Crop &Weed, 10 (1) : 163-166.

Patel, C. L.; Z. G. Patel and R. B. Patel (1983). Integrated weed management in onion bulb crop. Indian J. Weed Sci., 15: 7-10.

Piper, C.S. (1950). Soil and plant analysis. Inter-science Publishers Inc, New York.

Purewal, S. S. and K. S. Dargan (1962). Fertilizer and spacing experiments with onion crop. Indian J. Agron. 7: 46-53.

Pushpa, U.; and M. R. Choudhary (2019). A review on efficacy of weed management methods in onion. International Journal of Current Microbiology and Applied Sciences, 8 (2), 895-905.

Rahim, M. A.; A. Husain and M. A. Siddque (1983). Production of bulbs and storage ability of three cultivars on onion (*Allium cepa* L.). punjab Vegetable Grower, 17/18: 13-20.

Ramalingam, S. P.; C. Chinnagounder; M. Perumal and M. A. Palanisamy (2013). Evaluation of new formulation of Oxyfluorfen (23.5% EC) for weed control efficacy and bulb yield in onion. American Journal of Plant Sciences, 4 (4): 890-895.

Rapparini, G. (1994). The development of mechanical methods and chemical products in the control of infestations. Inf. Agrar. 50: 111–112.

Rashid, M. A. and M. M. Rashid (1976). Effect of spacing on the yields of onion. Bangladesh Hort. 4 (2):18-22.

Rizk. T. Y.; M. T. Fayed; S. M. El-nagar and H. Fawzy (1991). Effect of plant spacing on weeds, growth, yield and its components of onion (*Allium cepa* L.). Egyptian Agron. (Special Issue): 71-80.

Sanjeev, A.; K.S. Sandhu and S. Ahuja (2003). Weed management through the use of herbicides in cabbage–onion relay cropping system. Ann. Biol. 19, 27–30.

Sikder, M.; F. Mondal; D. Mohammed; M. S. Alam and M. B. Amin (2010). Effect of spacing and depth of planting on growth and yield of onion. J. Agrofor. Environ. 4 (2): 105-108.

Uygur, S.; R. Gürbüz and F. N. Uygur (2010). Weeds of onion fields and effects of some herbicides on weeds in Cukurova region, Turkey. Afr. J. Biotechnol., 9 (42): 7037-7042.

Vanhala, P. and K.T. Tiilikkala (1999). Effects of physical weed control on carrot and onion quality. In: Hagg M., Ahvenainen R., Evers A.M., Tiilikkala K.T., eds. Agri-Food Quality II: Quality Management of Fruits and Vegetables – from Field to Table (Turku, Finland, 22–25 April 1998). Plant Production Res., Turku, Finland, 218–221.

Ware, G. W. and J. P. McCollum (1975). Producing vegetable crops, second edition. G. W. Ware and J. P. McCollum, eds. The Interstate Printers & Publishers Inc., Danville, IL. pp. 359-377.

المحصول والجودة والتقييم الاقتصادي للبصل المنزرع بكثافات مختلفة تحت ظروف معاملات مكافحة الحشائش

رفعت علام مرعى[1] ، لبيب صبحى ميخائيل جريس[1] و عبدالعال محمد عبدالكريم[2]

[1]قسم بحوث البصل - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة- مصر.

[2]المعمل المركزي لبحوث الحشائش، مركز البحوث الزراعية، الجيزة، مصر

اقيمت هذه الدراسة خلال موسمى 2016/2015 و 2017/2016 في محطة البحوث الزراعية بشندويل، محافظة سوهاج، لدراسة تاثير الكثافة النباتية لمحصول البصل ومعاملات مكافحة الحشائش على النمو الخضرى والمحصول والجودة لمحصول البصل. وقد استخدم فى هذه التجربة تصميم القطع المنشقة مرة واحدة، حيث تم وضع كثافة البصل (240 و300 و 400 الف نبات للفدان) فى القطع الرئيسية، بينما تم وضع معاملات مقاومة الحشائش (النقاوة اليدوية مرتين، و الجول مع السلكت سوبر مرة واحدة، والجول مع السلكت سوبر مرتين، والايكوبارت مع السلكت سوبر مرة واحدة، والايكوبارت مع السلكت سوبر مرتين، والكنترول بدون معاملة) فى القطع الشقية. اظهرت نباتات البصل النامية فى الكثافة المرتفعة (400 الف نبات للفدان) اعلى القيم من من طول النبات وعدد الاوراق بالنبات، بينما اظهرت الكثافة المنخفضة (240 الف نبات للفدان) اقل القيم، وذلك في كلا الموسمين. كان المحصول الكلى للفدان للبصل المنزرع فى الكثافة العالية اعلى من مثيله المنزرع فى الكثافة المنخفضة فى كلا الموسمين. اعطت نباتات البصل المنزرع فى الكثافة المنخفضة اعلى القيم من الابصال المنفردة%، والابصال المزدوجة%، بينما اعطت النباتات المنزرعة فى الكثافة المرتفعة اقل القيم، وذلك فى كلا الموسمين. تم الحصول على اعلى القيم من عدد الاوراق للنبات، ووزن البصلة، من خلال معاملة الجول مع السلكت سوبر مرتين، فى كلا الموسمين. انخفض متوسط وزن البصلة والمحصول التسويقى للفدان والمحصول الكلى للفدان، معنويا تحت معاملة الكنترول، فى كلا الموسمين. من خلال هذا البحث يمكن ان نوصى بزراعة البصل تحت الكثافة النباتية المرتفعة (400 الف نبات للفدان) مع تطبيق معاملة الجول مع السلكت سوبر (مرتين)، حيث حققت هذه المعاملة اعلى القيم من الدخل الكلى للفدان وصافى الربح للفدان ونسبة الربح الى التكاليف.