EFFECT OF PLANT DENSITY ON COMPETITION BETWEEN SOFT WHEAT *Triticum aestivium* and WILD OAT *Avena fatua*.

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ABSTRACT

The competition between two soft wheat species (*Tritium aestivum*) and wild Oat(*Avena fatua*) in pure and mixed stands experiments were carried out in pots, green house in College of Science / University of Salahaddin during 1st December 2011 to 7thApril 2012. For wheat plant, the concerned plant characteristics were: plant height, number of tillers/plant, length of flag leaves, length of spikes, number of grains/spike, total shoot dry weight are concerned. For wild Oat the concerned plant characteristics were: Plant height, number of tillers/plant, length of flag leave, length of inflorescence, number of seeds/ inflorescence, total shoot dry weight. The results indicated that in both species the growth characterized and yield components were affected by increasing plant density. The vegetation growth, yield components and competitive ability of wheat was higher in low densities in comparison with wild Oat, while that of wild Oat was in adverse direction. Also plant growth characteristics and competition ability was increased at high density. Wheat had double competitive ability than Oat at extreme high density, while Oat was more competitive than wheat at low density.

Key words: density, competition, pot experiment, wheat and wild Oat.

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INTRODUCTION

The wheat grain is regarded as a source of vitamins, minerals, and proteins, while the refined grain is mostly starch. It is one of the top three most produced crops in the world. It is a political crop in the world (Abdulhamid, 2011). Wild Oat **(***Avenafatua***)** is type of grass, Order (Cyperales), and Family (Poaceae). The roots are small, numerous and fibrous penetrating into the soil to a depth of several feet. Competition is a struggle between individuals or/and groups of

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plants for resources. Competition has both beneficial and detrimental effects (Aspinal, 1960; Aziz and Mahdi, 1991). Competition is in two type's intra-specific competition (Competition occurs between similar species such as in wheat individuals, another type is inter-specific competition (Competition occurs between different species such as wheat and wild Oat. The first author who characterized plant competition, stated that "all plants of a given place are in a state of war with respect to each other (Darwin ,1859), other workers Donald (1963) ; Aziz (1985) were suggested that competition as a struggle for existence, and struggle would be more severe between closely related species (intra-specific competition) than between distance ones (inter-specific competition). Competition is under stress of plant density, which is defined as the number of plants within a given unit area, or it is describe as the amount of space left between plants (Harper, 1977; Silverton, 1984). The more closely spaced plants are, the higher the density. The density will divided in to three groups: a. High density plants are more closely to each other and the distance between them few, then appear which species have high ability to competition, b. Medium density plants are in optimum distance and c. Low density this type described by the number of few individuals plants per unit area (Aspinal, 1960; Aziz, 1985).

There are many experimental design have been applied to interpretation the competition between plants, there are systematic and unsystematic designs for agricultural and ecological studies. Systematic experimental design is in two types: replacement and additive. The additive design refers to those experiments where both density and proportion of a species are varied in mixture. While, the replacement series experiment involves growing two species in varying proportions, including monoculture, whilst maintaining a constant overall stand density (Pukridge and Donald, 1967; Abdulhamid, 2011). Usually competition occur after seed germination nearly by one month, seeds of weed germinate and growing up before crops, competition occur between shoots , roots and both between crop and weed, shoots competition for sun light and roots competition for space, nutrients and water. The greater density is the more competition that occurs for resources as light water and nutrients (Donald, 1963;Zimdahl, 1988). Competition for water and most essential element referred to as root competition, while competition for light and foliar fertilization with the essential or/and trace element referred to as shoot competition (Pukridge, 1968).

Many studies have been carried out on competition between plants either in equal or in different densities as mentioned by have a close plant density relationship (Aziz, 1985) competitive than wheat while wheat was more competitive than short pea and leafless pea in field experiment was more competitive than wheat. The studies of Carlson and Hill, (1985); Zimdahl (1988) indecated that the increase density of plant cause decrease plant growth

and increase plant dry weight. The study of Aziz *et al*.(1997) and Ali (2001) on competition between wheat and C*yphalariasyricae* indicated wheat plant was stronger than C*ephalariasericae* and increasing severity was caused by increasing density. An investigation was carried out by Watkinson (1981) to study the effect of density on plant growth, the authour found that increasing in wheat density decreased growth and grain yield of *Agrostemagithaga*. The study of Mustafa (2012) who investigated the effect of different plant densities on competition of wheat with wild Oat. He observed that both crops were lost grain yield by decreasing number of tillers, which occur by increased density of wheat. Also an investigation was carried out on shoot and root competition between ***(****Triticumaestivum****)*** and ***(****Serianecephalaria****).*** They found that the severity of competition in both species increased with increasing plant density (Aziz,1997; Robinson *et al.,* 2010).

Competition Equation Models:

A varieties of equations and models have been created and reviewed by Adul and Aziz (1987); Aziz (1987). The term unity (1.0) has been widely used to identify the degree of competition between plants and to assess the yield advantages. Excluding the concept "Aggressivity" which has a value of zero (0), positive values are more aggressive than the negative values. So if one species has greater value than (1.0) it is "dominant", more competitive and has yield advantages. Less than unity means less competitive and has yield disadvantages. If the value is equal to (1.0) it means that both species have equal competitive ability and the yield equal to that of their pure stands. Because pure stand yield already have a unity value. The symbols used for these competition functions listed by Willey (1979a) and review by Silverton (1984); Ali (2001), based on yield per unit area viz.:

Yaa = yield in pure stand of Wheat (species a).
Ybb = yield in pure stand of species wild Oat (species b).
Yab = mixture yield of species a.
Yba = mixture yield of species b
Zab = sown proportion of species a in mixture with species b.
Zba = sown proportion of species b in mixture with species a.

1. Relative yield (RY): proposed by De Witt (1960) in (3), he found that the variation n performance due to interference between species in mixture, it defined as the ratio of its yield in mixture to its yield in monoculture either for per plant or per unit area yield.

$$RYa = \frac{Yab}{Yaa} \; or RY = \frac{Yba}{Ybb} \ldots (1)$$

2. Relative yield total (RYT): It is defined as the sum of (relative yield) of the two species in mixture situation, proposed by De itt and Van den Bergh (1965). The need for RYT arises because two species may compete for the same "space" but have different yields as a result of competitive ability for growth resources. It is also useful as an index for the niche relationship between the two species and to assess the yield advantages.

$$RYT = \frac{Yab}{Yaa} + \frac{Yba}{Ybb} \ldots (2)$$

3. Competitive ratio (CR): proposed by Willey and Rao (1980) defined as measure of inter competition to indicate the number of times by which one component is more competitive than other.

$$CRa = \frac{Yab}{Yaa \times Zab} \div \frac{Yba}{Ybb \times Zba} \ldots (3)$$

4. Aggressivity: This defined as the deference between the two standardized yields of the species in mixture, proposed by Me Gilchrist (1965).

$$Aab = \frac{Yab}{Yaa \times Zaa} - \frac{Yba}{Ybb \times Zbb} \ldots (4)$$

MATERIALS AND METHODS

The experiment conducted in 1st December 2011 in green house / College of Science. The design was completely randomized design (CRD) under additive design with three replicates, totally number of pots are 71 with diameter of 25 cm and height 35cm, added of each pot loam soil, sown each grain and seed for both species wheat and wild oat at depth of 5cm and 3cm respectively, with density of 1, 2, 4, 6, 8, 10, 12, 14, 16 plants/ pot for pure stands of wheat and wild Oat. While, for mixtures were as follows (1a+1b), (2a+2b), (4a+4b), (6a+60), (8a+8b), (10a+10b), (12a+12b), (14a+14b), (16a+16b). After 40 days added 20ml of N.P.K fertilizers, that prepared by mixing 50 gm of fertilizer with 1000 ml of water, and daily watered when required. Harvesting of the plants carried out at 7th April 2012). The shoot parts were cut above surface of soil. The vegetative plant growth ere measured in pots as follows. (Note: a= Wheat, b= Wild Oat).

Wheat:

Plant height/cm, number of tiller/plant, length of flag leave, number of grain/spike, length of spike (cm) and total shoot dry weight, dried in oven at 70c^{o} for 48h (Aziz,1985).

Wild Oat:

Plant height/cm, number of tiller/plant, length of flag leaf/cm: it is the last plant leaves on the tillers, number of seed/inflorescence, length of inflorescence/cm, total shoot dry weigh dried in oven at 70 ^{o}Cfor 48h (Aziz, 1985).

Competition interpretation

For interpretation the competition ability of the species in the mixture combination the RY, CR, A, RYT as mention before was applied. The statistical analysis was evoked, when the results was significant, L.S.D at 0.05 probability was applied using the SPSS computer program Aziz (1985).

RESULTS AND DISCUSSION

Wheat:

Plant height (cm):

It is appear from Tables 1 and 3, the wheat height decrease with increase density in both pure and mixed stands. The taller plant was 78.50 cm at D1 (1 plant/pot), while the shorter plant was 46.2cm at density D16 (16 plants/pot). In case of mixture treatment the taller plant was 75.00 cm at density 1a+1b plant/pot, while the shorter plant was 44.69 cm at density of 8w+8a plants/pot. The significantly ($P<0.05$), increasing plant height with density, may be due to the intra-specific or/and inter-specific competition for light that caused by etiolating phenomenon. The results were agree with that of Aziz (1985); Aziz *et al*.1997; Maroof (2007).

Number of tillers/plant:

It is obviously clear from Tables 1 and 3 that the number of tillers of wheat in either in pure and mixed stands was decrease with increase plant density, the maximum number was 8.75/plant at D2 (2 plants /pot), while the minimum number was 1/plant at D10, D14, D16. The same situation was happened in mixture combination, the maximum number was 3.75/plants at density 2a+2b, while the minimum number was 1/ plant at density of 6a+6b. The significant differences ($P< 0.05$), may be due to competition for space (nutrient, water and light), this result agree with Carlson and Hill (1985); Ahmad (2004); Mustafa (2011).

Length of flag leave (cm):

Tables 1 and 3 show that the tallest flag leave was obtained at low density and vice versa in high density from 29.00 to 21.1cm at density of 1 - 16 plants/pot. The same situation were noticed in mixture treatment that ranged from 22.00 to 11.995 cm at density 1a+1b and 7a+7b plants/pot, also this phenomena may be due to competition for more important resources, the results was significant ($P<0.05$), this is in accordance with the results of previous workers (Aziz, 1985; Aziz, 1997; Abduhamid, 2011).

Length of spike (cm):

Tables 1 and 3 revealed that the maximum length of spike in pure stand wheat at low density, while the minimum number was at high density ranged from 13.75 to 4.50cm. The same situation was happened in mixture combinations of which ranged from 8 to 3 cm. The results may be attributing to competition for main resources, could be water, nutrients and light. (Ali,2001; Donald, 1963; Ahmad, 2004; Mustafa, 2012).

Number of grain/spike

Obviously clear from Table 1 and 3 in pure stand wheat the number of grain/spike was 40.25 grain/spike at second density D2, while at D16 (16 plants/pot) was 19.5 grain/spike, also in mixed stand the maximum number was 44 grain/spike at D1 and the minimum number was 15.28 grain/spike at D15 (15 plants/pot). The results was significantly ($P<0.05$). May be due to most factors affecting on grain light especially at phase grain filling and plant maturity, this result agree with (Ahmad, 2004; Abdulhamid, 2011; Mustafa, 2012).

Total shoot dry weight (gm):

The results of total shoot dry weight presented in Table (4). It is revealed that the shoot dry weight was affected positively by density the high value was 47.6 gm at density D16 (16 plants / pot), while the low value was 9.34 gm at D1 (1 plant/pot). Same case was occur in mixed stand the value between 22.22-11.40 gm at lowest and height density. The results were significant ($P< 0.05$) due to early harvesting also the plants was not reached to maturation phase, this result is agree with that of Ali (2001) and Ahmad (2004).

Wild Oat:

Plant height (cm):

It is appearing from Tables 2 and 3 the wild Oat height was significantly (P< 0.05) decrease with increase plant density in pure stand and mixed stand. The taller plant was 70.50 cm at D1 (1 plant/pot), while the shorter plant was 45.8 cm at D16 (16 plants/pot). In case of mixture treatment the taller plant was 67.50 cm at density 1a+1b (1 plant/pot), while the shorter plant was 42.20 cm at density 8a+b (8 plants/pot), it is appear that the plant height was affected by density, this may be due to the intra-specific and inter-specific competition for light and effected by etiolating, the results was significantly (P<0.05), this is agree with result of Aziz (1985), Ali (2001) and Abdulhamid (2011).

Number of tillers/plant:

Obviously clear from Tables 2 and 3 the number of tillers of wheat either in pure stand and mixed stand was decreased with increasing plant density, the maximum number was 12.5/plant at D2 (2 plants/pot), while the minimum number was 3/plant at density D10, D14. The same situation was happened in mixture combination the maximum number was 3.75/ plant at density of 2a+2b, the minimum number was tiller/plant at density 7a+7b. The significant

Table 1: *The effect density on plant growth of wheat in pure stand.*

Density	Plant height/cm		Number of tillers/plant		Length of flag leave/cm		Length of spike/cm and length of inflorescence/ Cm		Number of grain/spike and number of seed/ inflorescence	
PLANT	wheat	Wild oat	Wheat	Wild oat	Wheat	Wild oat	wheat	Wild oat	wheat	Wild oat
1a+1b	75.00	67.50	2.50	3.00	22.00	16.00	6.50	11.00	44.00	22.50
2a+2b	60.65	60.75	3.00	3.50	14.50	18.50	8.00	11.00	35.00	21.00
3a+3b	55.00	54.20	2.20	3.50	13.50	16.30	5.85	11.15	23.30	19.50
4a+4b	48.75	50.20	1.35	2.55	12.25	13.25	3.50	10.73	15.68	12.80
5a+5b	47.10	48.21	1.10	2.20	15.20	14.90	4.70	6.90	18.90	19.60
6a+6b	46.50	45.60	1.10	1.00	13.40	14.50	3.00	7.20	16.50	10.50
7a+7b	45.70	43.31	1.00	1.78	11.96	15.43	5.00	7.29	15.28	8.14
8a+8b	44.69	42.26	1.06	1.19	12.70	13.90	5.00	5.94	16.25	5.31
Total	481.4	467.53	17.10	22.22	123.01	137.00	49.30	79.96	118.90	133.20
Mean	53.48	51.94	1.90	2.47	13.70	15.20	5.48	8.85	13.21	14.80

differences may be due to competition for space (nutrient, water and light) this is agree with result of (Carlson and Hill,1985;Ali, 2001 and Ahmad, 2004 and Abdullwhid, 2011).

Length of flag leaves (cm):

Tables 2 and 3 show that the tallest flag leaves was obtain at low density and vice versa at high density ranged from 27.50 to 12.90 cm at density 1-6 plants/pot. The same situations were noticed in mixture treatment which was between18.50 and 12.90 cm at density 2a+2b and 8a+8b plants/pot. Also these phenomena may be due to competition for more important resources, and the results was significantly ($P<0.05$), and this is in accordance to the results of Aziz *et al*. ,1997; Aziz and Mahdi, 1991; Maroof,2007; Abdulhamid (2011) .

Length of spike/cm:

Tables 2 and 3 revealed that the maximum spike length of pure stand Oat was at low densities; while the minimum number was obtain at high density ranged from 16.50 to 23.30 cm. The same situation was happened in mixture combination which was ranged from 11.15 to 5.94 cm. The results was significant ($P<0.05$), this is may be due to competition modes which is attribute to competition for main resources, could be water and nutrients (Maroof, 2007; Mustafa, 2012)

Number of seed/spike:

Obviously clear from Tables 2 and 3 in pure stand oat the number of seed/spike was 38.20 at first density, while at D16 (16 plants /pot) was 9.80 grain/spike. Also in mixed stand the maximum number was 22.50 grain/spike at first density, and the minimum number was 5.31 grain/spike at D16 (16 plants/pot). The results was significant ($P<0.05$), may be due to most important factors affecting on seed production such as light especially the phase of seed filling and maturity. This is agree with results of other workers (Puckridge, 1968 and Pukridge and Donald, 1967; Scheiter, 2007).

Total shoot dry weight (gm):

In this experiment the results of total shoot dry weight presented in Table 4. It is revealed that the shoot dry weight was affected positively by density, the high value was 59.52 gm D16 (16 plants/pot), while the low value was 24.96 gm at first density. Same case was occurred in mixed stand with value of 37.43

and 14.55 gm at lowest and height density. This state may be due to early harvesting and also even the plants were not reached maturation phase. This results were agree with McGilchris (1965); Aziz and Mahdi (1991); Abdulhamid (2011).

Competition interpretation:

As shown in Table 5 when a simple equation models used for interpretation the results of competition. The results of RY indicated that when density increases the RY of wheat in mixture was decreased in comparison with that of pure stands that ranged from 0.43 to 1.22. The higher value of RY was at density D1, while the lower value was obtained at density D16. The reveres results were exactly produced by Oats (ranged from 0.37 to 0.67). In term of RYT which is an indicator of advantage or disadvantage of growing two species together, its values were decreased from D1 from Table 5 that the competitive ability of wheat to word oats was decrease by increase plant density. From D1 to D6 wheat was more competitive than Oats, while from density D8 to D16 the results were adverse.

Table 2: *The effect of density on some plant growth of wild Oat.*

Density	Plant height/cm	Number of tillers/plant	Length of flag leave/cm	Length of spike/cm	Number of grain/spi
D1	78.50	5.50	29.00	6.10	39.00
D2	73.75	8.75	15.00	13.75	40.25
D4	73.13	2.75	21.40	9.13	37.50
D6	61.58	2.40	20.90	6.08	27.88
D8	60.88	1.50	20.40	6.38	23.88
D10	56.40	1.00	18.90	5.25	25.25
D12	54.25	1.80	15.54	7.40	23.10
D14	51.90	1.00	13.30	5.15	20.70
D16	46.20	1.00	12.10	4.51	19.50
Total	556.59	25.70	166.54	63.74	257.06
Mean	61.84	2.86	18.50	7.08	28.56
$L.S.D_{(0.05)}$	59.10	1.63	2.36	2.36	31.20

Table 3: *The effect density on some plant growth in mixed stand.*

Density	Plant height/ cm	No. of tillers/plant	Length of flag leave/cm	Length of inflorescence/cm	No. of seed/inflorescence
D1	70.50	12.00	27.50	16.50	38.20
D2	65.60	12.50	20.10	15.10	20.80
D4	61.20	5.50	16.60	10.50	14.20
D6	60.20	7.00	12.90	11.10	14.70
D8	57.20	4.40	14.02	13.00	10.90
D10	55.60	3.00	170.00	9.70	12.40
D12	53.50	5.00	14.10	2.30	11.30
D14	50.50	3.00	18.40	6.40	12.20
D16	45.80	3.24	16.90	9.10	9.80
Total	520.10	55.64	310.52	93.70	144.50
Mean	57.79	6.18	34.50	10.41	16.06
L.S.D$_{(0.05)}$	59.10	1.68	8.36	2.36	31.20

In case of Oats it was adversely in parallel directions with that of wheat, it is less competitive than oats at first four densities, while it is more competitive at last five densities in comparison with that of pure stand densities. It is appear that wheat was twice competitive than oats at density D1,while wild Oat was one and half time more competitive than wheat at density D14.The aggressively indicator of competitive ability between species presented in Table 5. It is revealed and exhibited the same style of competitive ratio in which wheat value was positive at first four densities and negative at last five densities. That means situation may be rate response wheat and oat to environment factors e.g. water and nutrient, or may be light intensity (Carlson and Hill, 1985; Aziz and Mahdi, 1991; Raoof, 2007; Robinson *et al.,* 2010; Abdulhamid, 2011).

Table 4: *The effect of plant density (No. of Plant/Pot) on total dry weight.*

Density	WHEAT		OAT	
	Non-competition	Full competition	Non-competition	Full competition
D1	9.34	11.40	24.96	14.55
D2	16.81	12.70	27.17	15.21
D4	26.42	14.15	44.03	16.33
D6	33.30	14.25	48.10	17.84
D8	33.18	15.35	48.58	25.44
D10	34.17	18.04	49.59	33.01
D12	42.39	19.01	52.34	34.15
D14	45.97	20.26	57.00	36.75
D16	47.60	22.22	59.52	37.43
Total	289.18	147.38	411.29	230.71
Mean	32.13	16.38	45.70	25.63
L.S.D$_{(0.05)}$	191.43	1.376	204.10	184.93

Table 5 : *Competitive ability of the species in mix stands.*

Density	RY		RYT	CR		A
	Wheat	Oat		Wheat	Oat	
D1	1.22	0.58	1.80	2.10	0.48	0.64
D2	0.76	0.56	1.32	1.36	0.74	0.20
D4	0.54	0.37	0.91	1.46	0.69	0.17
D6	0.43	0.37	0.80	1.16	0.86	0.06
D8	0.46	0.52	0.98	0.88	1.13	-0.06
D10	0.53	0.67	1.20	0.79	1.26	-0.14
D12	0.45	0.65	1.10	0.69	1.44	-0.20
D14	0.44	0.64	1.08	0.69	1.45	-0.20
D16	0.47	0.63	1.10	0.75	1.34	-0.16
Total	5.30	4.99	10.29	9.88	9.39	0.31
Mean	0.59	0.55	1.14	1.10	1.04	0.03

CONCLUSION

1-The disadvantages of Oat growth when grown with wheat
2-The wild Oat lost the yield production of wheat especially at low density.
3-The competition ability of species was changed with densities, wheat was more competitive at low densities, while oat was more competition at high densities.

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تأثير الكثافة النباتية على التنافس بين نبات القمح *Triticumaesativium* ونبات الشوفان البري *Avenafatua*

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المستخلص

التنافس بين نوعين من النباتات وهما القمح *Triticumaestivium* والشوفان البري *Avenafatua* في تجربة عندما يكون النبات مزروع لوحده وعندما يكون النباتين مزروعين سوية في أصص في البيت الزجاجي الموجود في كلية العلوم/ جامعة صلاح الدين، خلال الفترة من بداية شهر كانون الأول 2011 إلى 7 نيسان 2012. القياسات التي أخذت للقمح هي: ارتفاع النبات، عدد الفروع/ النبات، طول ورقة العلم، طول السنابل، عدد الحبوب/ السنبلة، الوزن الجاف للمجموع الخضري. أما بالنسبة للشوفان فقد أخذت قياسات: عدد التفرعات/ النبات، طول ورقة العلم، طول النورة الزهرية، ومجموع الوزن الجاف للمجموع الخضري. بينت النتائج إن كلا النوعين قد تأثر فيها النمو وحاصل الغلة بزيادة الكثافة. لقد كانت القابلية التنافسية للقمح في أعلى قيمتها عند الكثافات الواطئة، بالمقارنة مع الشوفان البري بشكل معاكس فالقابلية التنافسية زادت عند زيادة الكثافة. كان القمح له ضعف القابلية التنافسية مما في الشوفان عند الحد الأدنى للكثافة، بينما الشوفان كان أكثر قابلية تنافسية عند الكثافات العالية.

الكلمات المفتاحية: الكثافة، التنافس، تجربة اصص، قمح و شوفان بري.