

PAPER • OPEN ACCESS

Performance of Some Plant Species Grown in Replacement Design under Different Competition Mode

To cite this article: A. S. A. Dizayee 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **761** 012081

View the [article online](#) for updates and enhancements.

You may also like

- [The Effect of a Number of Irrigations on the Growth and Yield Traits of Three Varieties of Bread Wheat \(*Triticum aestivum* L.\)](#)
Enas Ismail Mohammed
- [The Response of Some Growth and Quotient Indicators to Genetic Combinations of Wheat Bread \(*Triticum aestivum* L.\) within Different Agricultural Dates](#)
Sahira Rheem Shareef and Ahmad Hawas Abdullah Anees
- [Genetic and Phenotypic Stability of Chickpea Genotypes Under the Influence of Different Planting Dates](#)
Ahmed Mageed Harosh Al-Qaisi and Hussein Ali Hindi Al-Bayati

Performance of Some Plant Species Grown in Replacement Design under Different Competition Mode

A. S. A. Dizayee

College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region, Iraq.

Corresponding author's e-mail: aryan.ahmed@su.edu.krd

Abstract. A pot experiments was conducted at Grdarasha Experimental Farm / College of Agricultural Engineering Sciences / Salahaddin University / Erbil, during the winter growing season 2016 and 2017 to study the performance of *Triticum aestivum* L. and *Cicer arietinum* L. in sole cropping and intercropping in the presence of the *Sinapis arvensis* L. in a substitutive experiment arrangement with single, double and triple consortium. Experimental treatments were both pure stands and mix stands. Intercrops were symbolized by numbers and letters as (1A:2B:3C). The preceding number of each letter denotes the proportion of the land occupied by each of the *Triticum aestivum* (A), *Cicer arietinum* L. (B) and *Sinapis arvensis* L. (C). Pot experiment was consist of four modes of competition (full, shoot, root and no-competition) among three competitor plant species. As for wheat the relative plant height 1.05 was obtained in root competition mode, the same effect observed on grain yield relatively with values 1.29. In addition, it appears that mustard in treatment 2A3B1C has significantly outperformed all the other treatments with mean relative values 1.54 and 1.17 respectively in grain and biological yield measured originally as g plant⁻¹.

1. Introduction

During last few decades a number of eco-physiological models on competition between crops and weeds have been created for interpretation competitive ability of the species in mixture combinations and for yield advantages and disadvantages of mixed stand in comparison with their pure stand [1]. *Triticum aestivum* L. is one of the most important crops in terms of cultivated area and productivity, due to the excellent control over weed invasion [2]. *Cicer arietinum* L., grown traditionally under rain-fed environment in most parts in the world belongs to the family Fabaceae [3]. *Sinapsis arvensis* L. is an annual winter plant which belongs to Cruciferea family it has indeterminate upright growth and may reach a height of more than two and a half meter, which proliferates extreme spreading through producing thousands of seeds [2]. Competition is generally understood to refer to the negative effects on plant growth caused by the presence of neighbors, usually by reducing the availability of resources [4]. Through competition, the emergence rate of plant parts (e.g. leaves, pods of branches) is increased and the death rate is decreased. This means that competition reduces the rate of growth and/or increases the probability of death of an individual from what it would be in the absence of neighbors [5]. Competition is a critical interaction in ecology with several experiments carried out to examine the effects of intraspecific and interspecific competition. Interspecific competition for a limiting resource is proposed to be one of the top factors reducing the distribution and abundance of species [6]. Hundreds of experiments have been achieved, inter-specific and intra-specific competition [7]. The main objective of this study was to investigate the effect of wild mustard on the growth and yield of wheat and chickpea, to estimate the impact of competition within grains and legumes.

2. Materials and Methods

These experiment was carried out at Grdarasha Research Farm, College of Agricultural Engineering Sciences / Salahaddin University – Erbil / Iraq on geographical location Lat. 36.2o N, Long. 44.1o E and elevation 470 m above mean sea level under semi guaranteed Iraqi rain zone, during the winter growing season 2016 and 2017, The plants were grown in pots with dimensions 40cm×32cm, to study the quantify



and qualify the reciprocal effects among three competitor plant species wheat *Triticum aestivum*, chickpea *Cicer areitinum* wild mustard *Sinapis arvensis*, to determine representative models for each of vegetative, reproductive characteristics among studied plants for interpretation phenomenon including mechanism of interference and competition as a near-term to crop-weed management solution.

2.1. Agronomical Practice

The competition experiment designed on the basis stated by previous workers [8,9,10] was carried out using pots with dimensions 40cm*32cm. The pots were filled with a sieved soil from the same field.

The pot experiment included four modes of competition:

- Full competitions among three competitor plant species.
- Root competition among three competitor plant species.
- Shoot competition among three competitor plant species.
- No competition among species (control).

Eighteen seeds pot-1 were planted for each of the three competitor plant species (6, 6, 6) inside the pots and then thinned to get targeted densities, replicated three times resulting in 72 experimental units.

Full competition mode seeds were planted in pots isolating them along with the whole plant parts. In the case for shoot competition using transparent plastic as an isolator board between the root system parts of each of the three competitor plant species, while root competition was prevented only vegetative parts by using the same transparent plastic used for root competition, the plastic barrier dimensions were (100) cm height × (38) cm width, but for no competition the three competitor plant species were planted separately from each other's.

2.2. Statistical analysis

Analysis of variance as a general test was done according to the method of experimental design with statistical analysis system [11] program. The differences between means tested by using Duncan multiple ranges test at the probability level ($P \geq 0.05$) for all studied characters. Means of each factor, and their combination followed by different letters in the table, indicate a significant difference between them, while similar letters indicate the non-significant difference between them [12].

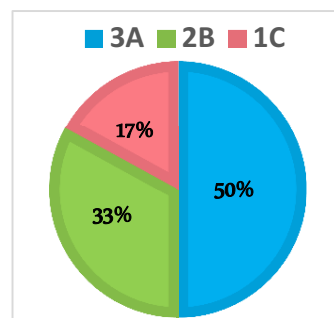
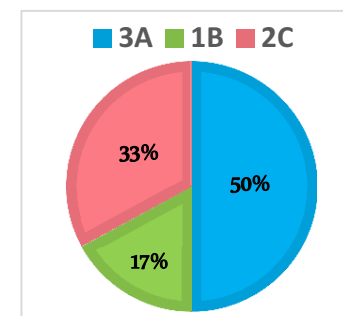
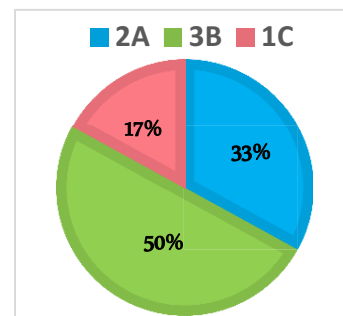
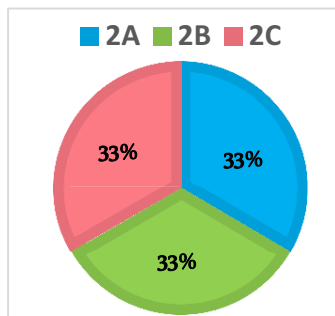
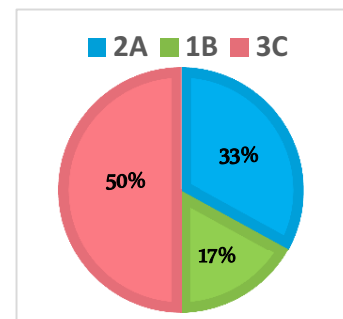
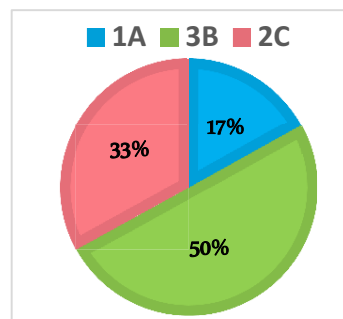
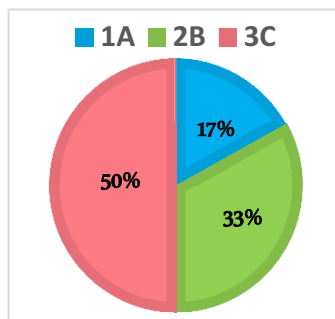
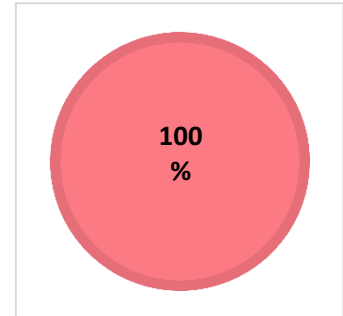
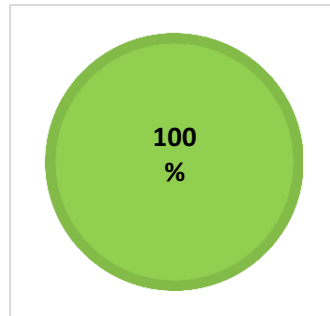
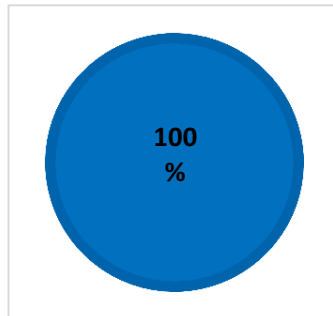


Figure 1. showing land proportions occupied by wheat (A), chickpea (B), mustard (C) for shoot, root, full, no competition at pot experiments.

3.1. Mode of competition (full, root and shoot)

3.1.1. Plant height (cm)

Figure (2) shows that competition modes had a significant effect ($P \geq 0.05$) on the plant height. The highest relative mean value of wheat, chickpea and wild mustard were 1.05, 1.05 and 0.88 in root and full competition respectively, whereas the lowest relative values were 0.95, 0.79 and 0.86 during full, root competition mode of wheat, chickpea and wild mustard respectively. This may be due to the differences in the genetic potential of each crop species and its interactions with the environment. These results are consistent with [13,14] between wheat and rye grass.

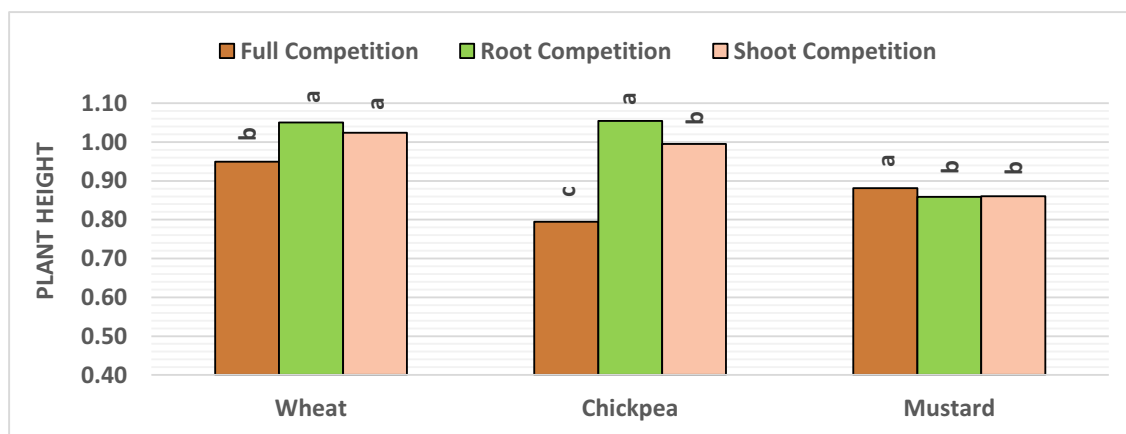


Figure 2 Effect of competition modes on relative plant height in wheat, chickpea and wild mustard relatively to their values at no-competition modes.

3.1.2. Number of tillers and branches plant⁻¹

Full competition had a significant difference between studied species ($P \geq 0.05$), wild mustard produced the highest relative value of number of branches plant⁻¹ among the different competition modes figure (3). The maximum number of branches was produced in full competition mode 1.11, while root competition mode produced minimum number of branches 0.95. The superiority of the relative means of these traits may be due to the plant's ability to absorb sufficient amounts of essential nutrients.

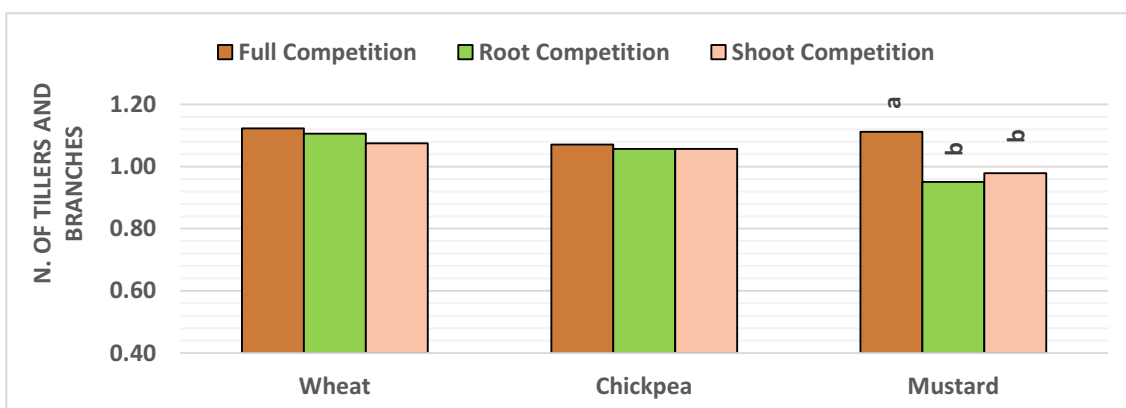


Fig. 3 Effect of competition modes on relative number of tillers and branches in wheat, chickpea and wild mustard relatively to their values at no-competition modes.

3.1.3. Grain or seed number per spike, pod and silique

Competition mode had a significant effect at 95.0% confidence level, (Figure 4). The highest relative mean number of seed pod-1 in chickpea was 0.99 produced in root competition, while the lower relative value was 0.83 produced in the full competition. As for wild mustard, full competition mode recorded the highest relative mean number of seed, while lower number of seeds was recorded in shoot competition their relative mean values were 1.10 and 1.01.

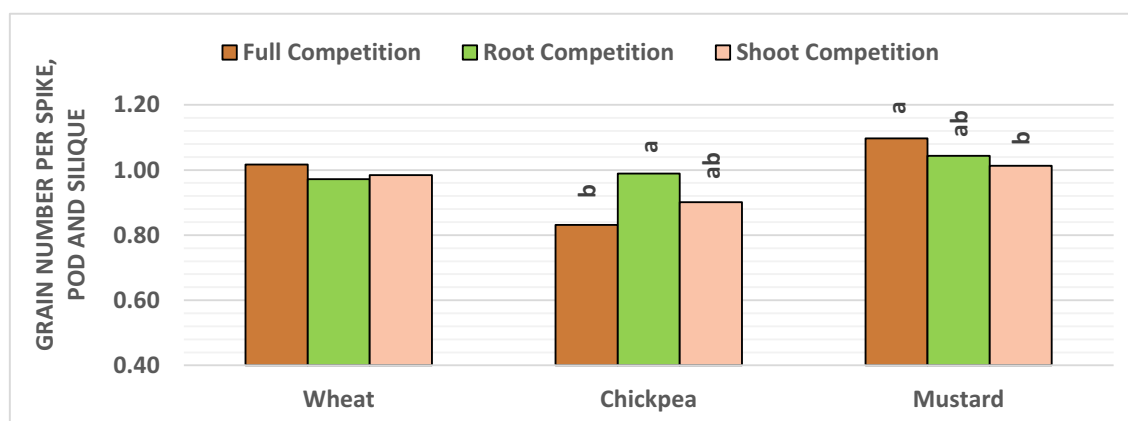


Figure. 4 Effect of competition modes on relative grain or seed number per spike, pod and silique in wheat, chickpea and wild mustard relatively to their values at no-competition modes.

3.1.4. Grain yield per plant

Figure (5) shows the significant effects of competition mode on grain yield of the studied plants at ($P \geq 0.05$). Competition modes significantly affected on grain yield of wheat. The maximum relative value was 1.29 obtained in root competition, while the lower relative mean value was 1.08 achieved in shoot competition. Chickpea and wild mustard in full competition was achieved maximum of seed yield 1.26 and 1.36, while minimum of grain yield was 1.16 and 1.22 achieved in shoot competition. [15] concluded that this is possible because of competition for nutrients and then for light and water under limited factors. These results are consistent with [10].

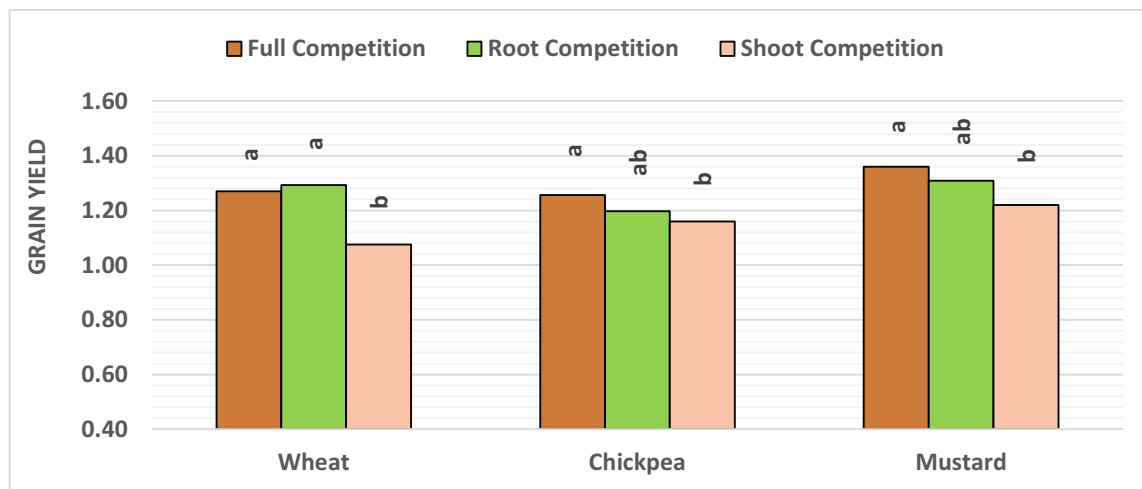


Fig. 5 Effect of competition modes on relative grain yield in wheat, chickpea and wild mustard relatively to their values at no-competition modes.

3.1.5. Biological yield $g\ plant^{-1}$

The data represent in figure (6) revealed that the highest biological yield for wheat was yielded in full competition 1.11, whereas the lowest relative value of biological yield was 0.85 yielded in shoot competition mode. Chickpea and wild mustard possessed the highest relative value of biological yield was 1.29 and 1.10 obtained in full competition mode, while the lowest relative value was 1.11 and 1.02 obtained in the root competition mode respectively. The similar findings were noted by [9,16].

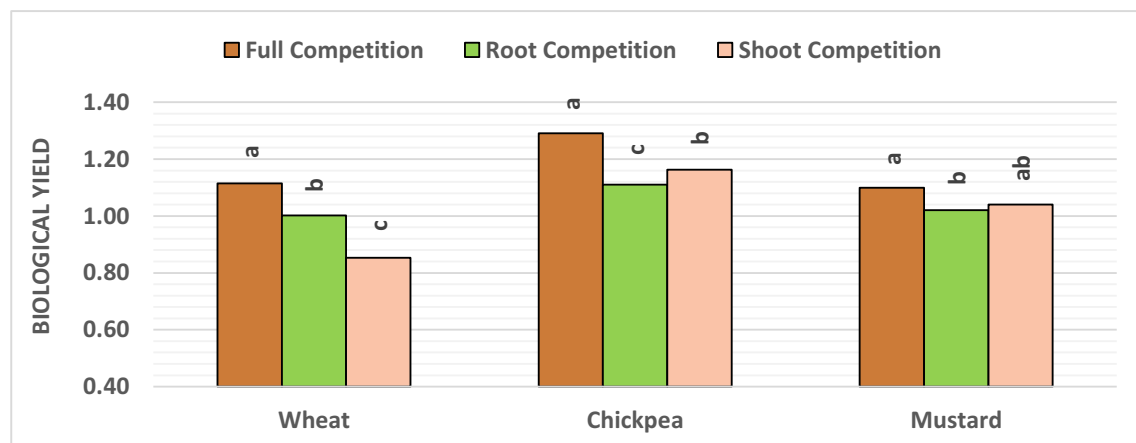
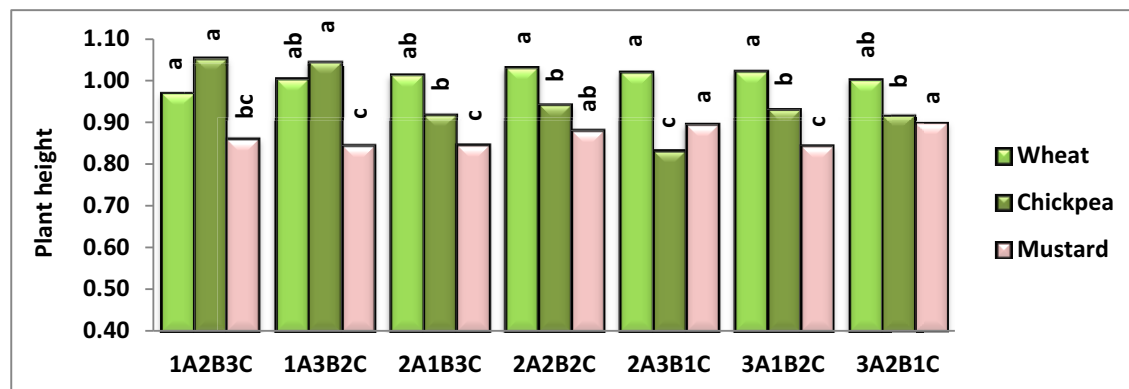


Figure 6 Effect of competition modes on relative biological yield in wheat, chickpea and wild mustard relatively to their values at no-competition modes.

3.2. Combination treatment (Number of plant species per pot in full, root and shoot competition in comparison with pure stands).

3.2.1. Plant height (cm)

Figure (7) exhibits that there were significant effects ($P \geq 0.05$) of the treatment row proportion combinations. Treatment 2A2B2C was resulted the highest relative mean value of plant height 1.03 in compared with treatment 1A2B3C which provided the lowest value of 0.97. These results are agreed with the works of [17] who observed intolerance due to competition for light. [18] Assume that wheat cannot increase both of the plant number of tillers. Therefore, the number of tillers decreases, when competed with weed and rise in plant height. Chickpea plant height produced the higher and lower relative mean value 1.05 and 0.83 in 1A2B3C and 2A3B1C treatment combination. Treatment 3A2B1C recorded the maximum plant height for wild mustard which was 0.90, while minimum relative mean value produced in 3A1B2C



was 0.84.

Figure. 7 Relative plant height of wheat (A), chickpea (B) and wild mustard (C) in their row species treatments corresponding to their values at no-competition mode. As 1, 2 and 3 refer to number of rows per species.

3.2.2. Number of tillers and branches plant⁻¹

Figure (8) noted that there were significant effects ($P \geq 0.05$) for the treatment combination. As a result of treatment 1A2B3C which produced maximum relative mean number branch was 1.23, whereas minimum number was 1.03 in 2A3B1C treatment combination for wheat. These findings are supported by the earlier studies of [19,20].

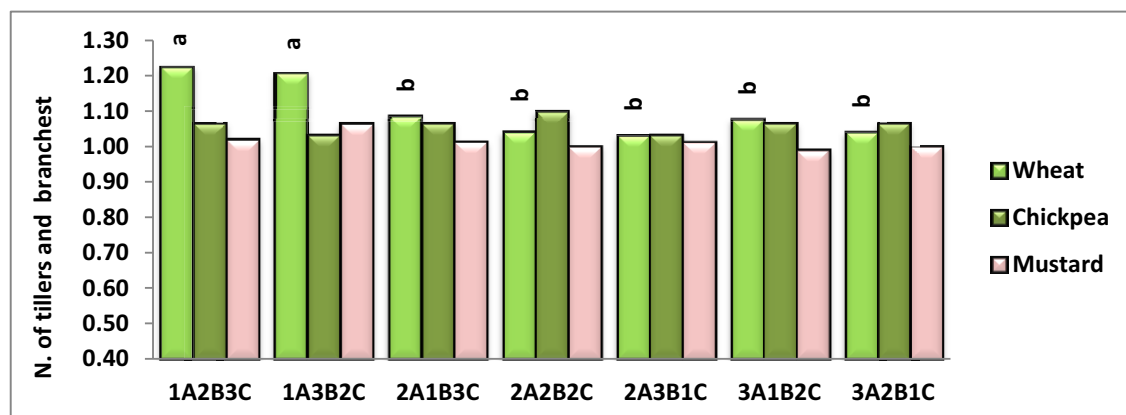


Fig. 8 Relative number of tillers and branches of wheat (A), chickpea (B) and wild mustard (C) in their row species treatments corresponding to their values at no-competition mode. As 1, 2 and 3 refer to number of rows per species.

3.2.3. Grain or seed number per spike, pod and silique⁻¹

Figure (9) presents significant effects ($P \geq 0.05$) of the studied factors on number of grain, were wheat in treatment 3A2B1C was achieved maximum relative mean value was 1.04, while minimum number of grain was 0.91 achieved in 3A1B2C treatment combination. Number of seed is an important yield component and it has a direct effect on wheat yield. [21] has stated that increased plant competition for nutrients and sunlight in later stages led to fading grains in the early stages, because competition between growing grains to absorb preserved matters would produce low grains. These results were consistent with [9,19,22,23].

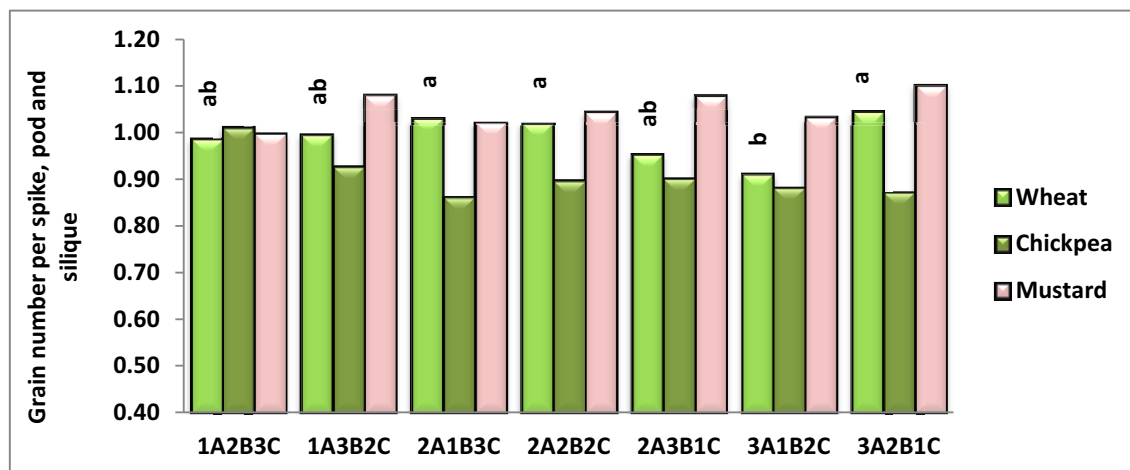


Fig. 9 Relative grain or seed number per spike, pod and silique of wheat (A), chickpea (B) and wild mustard (C) in their row species treatments corresponding to their values at no-competition mode. As 1, 2 and 3 refer to number of rows per species.

3.2.4. Grain yield per plan

Grain yield is a function of various yield components. Analysis of variance stated that wheat plant showed significant differences ($P \geq 0.05$) in wheat grain yield. Data (Figure 10) indicates that the highest relative mean value was 1.31 in treatment 2A3B1C, and the lowest relative grain yield was 1.11 in 2A1B3C treatment combination. It was reported that the decrease in cereal yield is depend on physiological and morphological characteristics similar to wheat and weeds, resulting in a similar affinity towards the use of natural resources and final photosynthesis products [24]. The maximum and minimum relative mean grain yield for chickpea plant was achieved in treatment combination 2A1B3C and 2A2B2C 1.53 and 0.94 respectively. For wild mustard the highest grain yield relative value was 1.54 obtained in 2A3B1C, while lowest relative mean was 0.99 produced by treatment combination 1A2B3C.

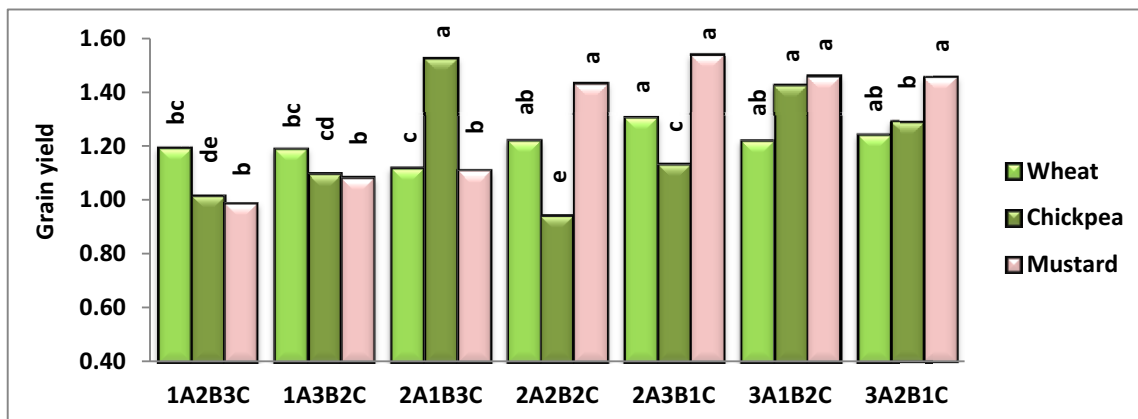
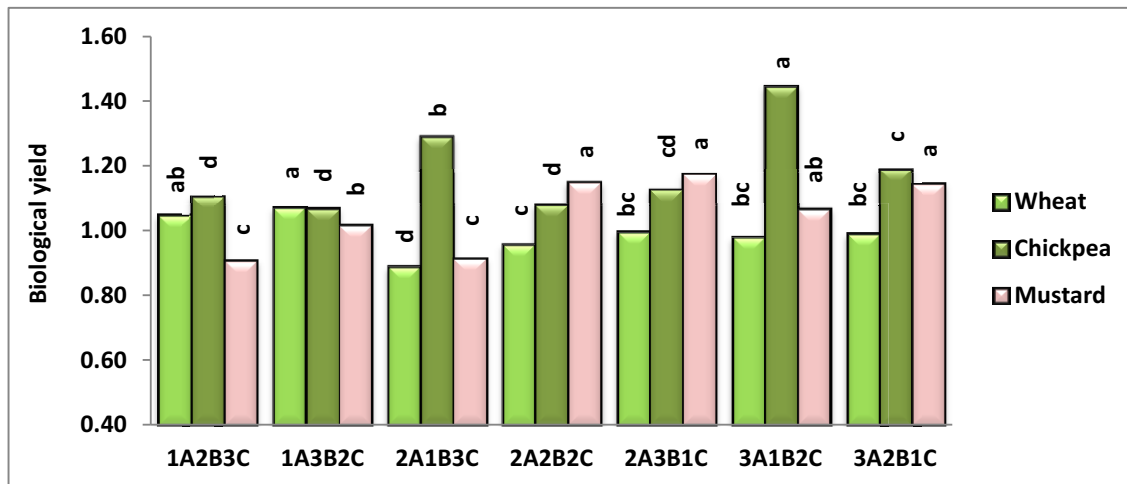


Figure10. Relative grain yield of wheat (A), chickpea (B) and wild mustard (C) in their row species treatments corresponding to their values at no-competition mode. As 1, 2 and 3 refer to number of rows per species.

3.2.5. Biological yield $g\ plant^{-1}$

Biological yield is correlated with plant height and number of tillers. Significant statistical differences were obtained among three competitor plant species of wheat, chickpea and wild mustard, the highest and lowest biological yield for wheat was relatively 1.07 and 0.89 obtained in 1A3B2C and 2A1B3C treatment



combinations. [18] indicated that the biological yield has a strong correlation with plant height and number of tillers. As for chickpea, the highest biological relative mean yield was 1.45 obtained in 3A1B2C, and the lowest relative mean yield was 1.07 recorded in treatment 1A3B2C. Wild mustard recorded higher relative mean value of biological yield in treatment combination 2A3B1C was 1.17, whereas lower mean yield was 0.91 recorded in 1A2B3C treatment combinations (Figure 11).

Figure11. Relative biological yield of wheat (A), chickpea (B) and wild mustard (C) in their row species treatments corresponding to their values at no-competition mode. As 1, 2 and 3 refer to number of rows per species.

4. Conclusion

Wheat crop in general possessed superiority in most of the studied traits, while wild mustard incurred tangible yield losses, simultaneously with the neutral response of chickpea when each genotype occupied a third of the cultivated land area separately in various treatments.

References

- [1] Connolly, J. 1986. On difficulties with replacement-series methodology in mixture experiments. *Journal of Applied Ecology*. pp.125-137.
- [2] Siyahpoosh, A., Fathi, G.A., Z & E., Siadat, S.A.M Bakhshande, A. and Gharineh, M.H. 2012. Competitiveness of different densities of two wheat cultivars with wild mustard weed species (*Sinapis arvensis*) in different densities. *World Applied Sciences Journal*. **20**(5), pp.748-752.
- [3] Erdemci, I. 2018. Investigation of genotype× environment interaction in chickpea genotypes using AMMI and GGE biplot analysis. *Turkish Journal of Field Crops*. **23**(1), pp.20-26.
- [4] Begon, M. 1991. Harper JL and Townsend CR 1996. Ecology: Individuals, populations and communities. 3rd.–Blackwell Science oxford.

- [5] Weiner, J. 1993. Competition among plants. Treballs de la Societat Catalana de Biologia. pp.99-109.
- [6] Inouye, B.D. 2001. Response surface experimental designs for investigating interspecific competition. *Ecology*. **82**(10), pp.2696-2706.
- [7] Gurevitch, J., L. L. Morrow, A., Wallace and J. S. Walsh. 1992. A meta-analysis of competition in field experiments. *The American Naturalist*. **140**(4), pp.539–572.
- [8] Ahmed, K.S. 2004. The competition studies between durum wheat *Triticum durum* and *Brassica napus*. *M.Sc. Thesis*, College of Agriculture Salahaddin University, Plant Production Department. pp.121.
- [9] Marof, S.M.A. 2008. Competitive interference between triticale x triticosecale Rimpai Wittmac and wheat *Triticum sp. L.* under two environmental conditions. *Ph.D. Dissertation*. College of Agriculture Salahaddin-Erbil University. pp.181.
- [10] Mustafa, A.A. 2012. An ecological study for interaction between soft wheat *Triticum aestivum L.* and wild oats *Avena fatua*. *M.Sc. Thesis*. College of Agriculture Salahaddin University, Field Crops Department. pp.93.
- [11] SAS. 2005. Statistical Analysis System. SAS institute Inc., NC, USA. Release. 82.
- [12] Al-rawi, KH. M. & Khalaf Alla A.M. 2000. Design and Analysis Agricultural Experiments. Dar-ALkutub for publishing and printing. Mousel-Iraq. (in Arabic). Pp.388.
- [13] Martin, M.P.L.D. & R.J. Field. 1986. Competition between vegetative plants of wild oat (*Avena fatua L.*) and wheat (*Triticum aestivum L.*). *Weed Research*. **27**, pp.119-124.
- [14] Stone, M.J., H.T. Cralle, J.M., Chandler, T.D., Miller, R.W., Bovey and K.H., Carson. 1998. Above- and belowground interference of wheat (*Triticum aestivum*) by italian ryegrass (*Lolium multiflorum*). *Weed Science*. **46**(4), pp.438- 441.
- [15] Amin, S.M. 2005. Foliar application of different boron levels on some wheat cultivars are response inducer to drought resistance. (Zanko) *Science Journal Salahaddin University*. **17** (2), pp.53-61.
- [16] Mariotti, M., Masoni, A., Ercoli, L. & Arduini, I., 2009. Above- and below- ground competition between barley, wheat, lupin and vetch in a cereal and legume intercropping system. *Grass and Forage Science*, **64**(4), pp.401-412.
- [17] Aziz, F.H. 1985. Crop ecology with particular references to competition within two species crop mixtures. *M.Sc. Thesis*. University College N. Wales. Bangor. UK. pp.147.
- [18] Noshadian, H., Azizi, N.R., Yasari, E. and Kakularimi, A., 2014. Effects of removal time and Canary grass density on wheat yield and yield components. *Institute journal Farm Allied Science*. 3: pp.733-741.
- [19] Martin, R.J., Cullis, B.R. & McNamara, D.W., 1987. Prediction of wheat yield loss due to competition by wild oats (*Avena spp.*). *Australian Journal of Agricultural Research*, **38**(3), pp.487-499.
- [20] Khan, I., G. Hassan, M.I. Khan and Gul. 2007. Effect of wild oat (*Avena fatua L.*) population and nitrogen levels on some agronomic traits of spring wheat (*Triticum aestivum L.*). *Turk journal Agriculture Forest*. 31: pp.91-101.
- [21] Naseri, R., A. Solymanifard, H., Khoshkhabar, A., Mirzaei and K. Nazaralizadeh. 2012. Effect of plant density, on grain yield, yield component and associated traits of three durum wheat cultivar in western Iran. *International journal of Agriculture and Crop Science*. **4**(2), pp.79-85.
- [22] Cudney, D.W., L.S. Jordan, J.S., Holt and J.S. Reints. 1989. Competitive interactions of wheat (*Triticum aestivum*) and wild oats (*Avena fatua*) grown at different densities. *Weed Science*. **37**(4), pp.538- 543.
- [23] Khan, M.A.H. 1993. Effect of method and depth of sowing on the yield and yield components of wheat unpublished *M.Sc. Thesis*, Department of Agronomy, Bangladesh Agricultural University Mymensingh. pp.31-34.
- [24] Sinha, N.K., D. Singh & D.K. Roy. 2009. Economic threshold levels of little seed canary grass in wheat in north Bihar. *Indian Journal of Weed Science*. **41**(3&4),154.