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Effect of intercropping patterns of chickpea and Dragon's head (*Lallemantia iberica* Fish. et Mey.) on yield, yield components and morphological traits of Dragon's head under different weed management

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ABSTRACT

An experiment was conducted at the Research Farm of the Faculty of Agriculture, University of Tabriz, Iran in 2012 to study the effect of intercropping of chickpea and Dragon's head on yield, yield components and morphological traits of Dragon's head as affected by four weed management time. The experiment was laid out in RCB design with three replications. Intercropping patterns included; a_1, a_2, a_3, a_4, a_5 and $a_{6:}$ respectively, pure stand of chickpea, pure stand of Dragon's head, additive intercropping of optimal density of chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon's head. Four times of weeds control levels were; b_1, b_2, b_3 and b_4: complete control, no weeds control, control after 2-4 weeks after emergence, control after 5-7 weeks after emergence. Results showed that sole Dragon's head produced the highest grain and biological yield. Among the intercropping systems, sole Dragon's head recorded the highest mean number of lateral stem, number of capsule per main and lateral stem and plant height. Significant differences were observed in yield and yield components of Dragon's head with increasing of weed population. Considering the experimental findings, sole cropping and complete weed control recommended for Dragon's head grain yield.

Key words: Chickpea, Dragon's head, Intercropping, Weed management, Yield.

INTRODUCTION

In recent years, a trend in agricultural production systems has changed towards achieving high productivity and promotes sustainability over time. Farmers are developing different crop production systems to increase productivity and sustainability since ancient times. This includes crop rotation, relay cropping and intercropping of major crops with other crops. Intercropping, the agricultural practice of cultivating two or more crops in the same space at the same time is an old and commonly used cropping practice which aims to match efficiently crop demands to the available growth resources and labor. The most common advantage of intercropping is the production of greater yield on a given piece of land by

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making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height, and nutrient requirements based on the complementary utilization of growth resources by the crops (Andrew and Kassam, 1976). Nitrogen fixing legumes generally do not need nitrogen fertilizer, whereas, the non-legumes requires additional mineral nitrogen for optimum growth. Besides its own nitrogen requirement, legumes may contribute additional nitrogen to the soil, which can be used by the other crop in the intercrop or the succeeding crops. Higher nutrient uptake and better water use efficiency have also been suggested (Dallal, 1974; Baker and Norman, 1975). Intercrops often reduce pest incidence and improve forage quality by increasing crude protein yield of forage. These include risk of crop loss due to adverse environmental conditions, need for balanced diet, and the desire to optimize the use of labour and to optimize the use of land. The advantage is often expressed as a land equivalent ratio (LER). LER greater than one indicates that more sole cropped land than intercropped is required to produce a given amount of product.

Chickpea is a very sensitive crop to weed competition, which generally results in heavy yield loss. The reduction in grain yield may vary from 23% to 87% depending on the weed species and their densities in various countries (Bhan and Kukula, 1986). Weeds mainly compete with crop for nutrients, soil moisture, and sunlight by covering over crop and space. Severity of yield loss depends upon weed infestation, duration of infestation as well as climatic conditions which affect weed and crop growth. Weeds can remove plant nutrients from soil more efficiently than crops. Therefore, weeds are of crucial importance since effective and proper weed control time will result in higher seed yields of chickpea. Delayed weeding until late stages could result in irreversible damage due to weed competition. Dragon's head (*Lallemantia iberica* Fish. et Mey.) is an annual herb that belongs to Lamiaceae family and spreads in southwestern Asia and Europe (Ursu and Borcean, 2012). It grows well in arid zones and requires a light well-drained soil (Ion *et al.*, 2011). Dragon's head is a valuable species, *i.e.* all plant parts (leaves or seeds) can be economically used (Hedrick, 1972). However, it is mainly cultivated for its seeds that contain about 30% oil with iodic index between 163 and 203. These seeds are used traditionally as stimulant, diuretic and expectorant as well as in food (Naghibi, 1999).

Due to the lack of relevant information, the present research was conducted to determine the effects of intercropping patterns of chickpea and Dragon's head and timing of weed removal on yield and yield components and morphological traits of Dragon's head.

MATERIALS AND METHODS

Site description and experimental design

The field experiment was conducted in 2012 at the Research Farm of the University of Tabriz, Iran (latitude 38°05_N, longitude 46°17_E, altitude 1360 m above sea level). The climate of research area is characterized by mean annual precipitation of 285 mm, mean annual temperature of $10^{\circ C}$, mean annual maximum temperature of $16.6^{\circ C}$ and mean annual minimum temperature of $4.2^{\circ C}$. The experiment was arranged in a Randomized Complete Block Design, with three replications and two treatments. The treatments were represented by the following; different planting patterns treatment: a_1, a_2, a_3, a_4, a_5 and $a_{6:}$ respectively, pure stand of chickpea, pure stand of Dragon's head, additive intercropping of optimal density of chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon's head. Four time of weeds control levels were; b_1, b_2, b_3 and b_4: complete control, no weeds control, control after 2-4 weeks after emergence, control after 5-7 weeks after emergence. All plots were irrigated immediately after sowing.

Measurement of traits

To specify plant heights, number of capsule per main and lateral stem and lateral stem number ten plants were selected from the middle of the plots and then, they were measured. Also to determine of grain yield and biological yield an area equal to 1 m^2 was harvested from middle part of each plot considering marginal effect. Harvested plants were dried in $25^{\circ C}$ and under shadow and air flow then grains were separated from their remains by threshing.

Statistical analysis

Statistical analysis of the data was performed with MSTAT-C software. Duncan multiple range test was applied to compare means of each trait at 5% probability.

RESULTS AND DISCUSSION

Statistical analysis of the data indicated that different intercropping patterns and weed management practices had significant effect on plant height of Dragon's head (Table 1). Maximum plant height (49.8 cm) was obtained in additive intercropping of optimal density of chickpea + 50% of optimum density of Dragon's head under unweeded treatment (a_4b_2 treatment). Minimum plant height was recorded in the a_2b_1 treatment (Figure 1). However, this value was not significantly different from the mean plant height recorded under a_4b_1 and a_5b_1 treatments. The canopy characteristics of crops are not constant, but may change due to the presence of other crops species (Caldwell, 1987). This result is similar with finding of Silwana and Lucas (2002) who reported that plant height of maize intercropped with both beans and pumpkin were adversely affected by intercropping conditions. Maize plants were taller for sole crops compared to when intercropped with beans, both in the presence of weed infestation. In other results, (Thwala and Ossom, 2004) did not find any significant difference in plant height between mono cropping and intercropping of maize with sugar bean and ground nuts. According to Akobundu (1993), on average, maize and beans on unweeded plots were 17% taller than those in weeded plots due to competition for light between crops and weeds.

Table 1. Analysis of variance of selected parameters of Dragon's head affected by intercropping patterns and weed control treatments.

S.O.V	df	**Mean square**			
		Height of Plant	Lateral stem	number of Capsule per plant	number of Capsule per lateral steam
Block	2	1.858	0.582	25.724	15.66
Intercropping	4	81.178**	4.495**	1697.961**	193.683**
Weed control	3	168.24**	6.416**	3135.174**	774.72**
Interaction	12	5.726**	0.458**	81.992**	11.675**
Error	38	1.558	0.066	17.321	0.769

** = Significant at 1% probability level.

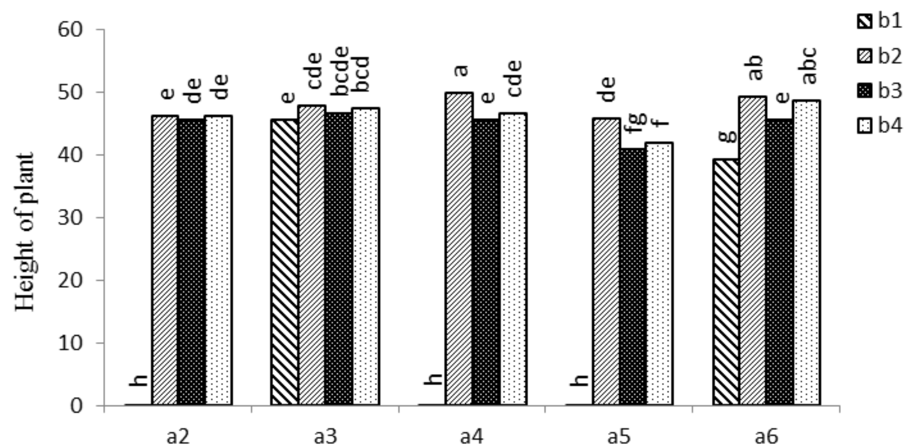

Fig. 1. Effect of different patterns of intercropping with times of weed control on height of plant of Dragon's head. a_1: pure stand of chickpea, a_2: pure stand of Dragon's head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon's head. b_1: complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

Lateral stem of Dragon's head significantly affected by intercropping patterns and weed removal times (Table 1). Dragon's head plants in the sole cropping system and complete weed controlling treatment produced the highest mean number (3.8 lateral stem in plant) of lateral stem and this was significantly different from the other cropping systems (Figure 2). Additive intercropping of optimal density of chickpea + 100% of optimum planting density of Dragon's head under unweeded treatment a_6b_2 produced the least lateral stem which was not significantly different from the a_5b_4, a_6b_4, a_4b_2 and a_5b_2 treatments (Figure 2). Alizade et al., (2009) reported that the lateral stem of *Ocimum basilicum* and *Phaseolus vulgaris* decreased in intercropping system under no weeds control treatments.

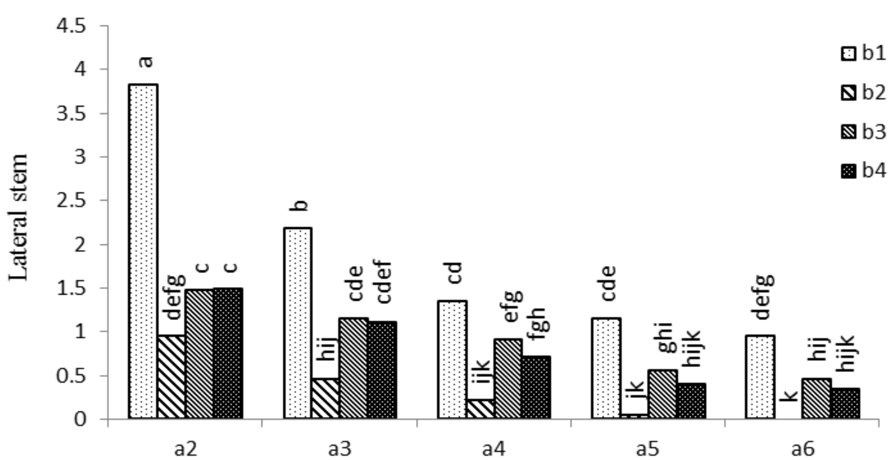

Fig. 2. Effect of different patterns of intercropping with times of weed control on lateral stem of Dragon's head. a_1: pure stand of chickpea, a_2: pure stand of Dragon's head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of optimum

density of Dragon's head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

As the results showed, intercropping of chickpea and Dragon's head and weed removal times had significant effect on number of capsule per main and lateral stem of Dragon's head (Table 1). Highest number of capsule per main (71.9) and lateral stem (27.6) was obtained in Dragon's head sole cropping under complete control of weeds (a_6b_2 treatment) (Figures 3 and 4). Possible reason for higher capsule number per plant and lateral stem in sole Dragon's head might be attributed to no inter-specific competition. Similar results are reported by Azim Khan et al. (2012).

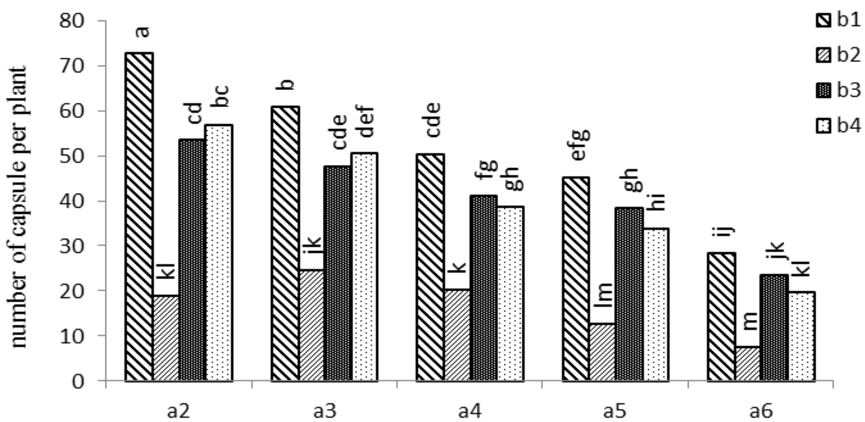

Fig. 3. Effect of different patterns of intercropping with times of weed control on number of capsule per plant of Dragon's head. a_1: pure stand of chickpea, a_2: pure stand of Dragon's head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon's head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

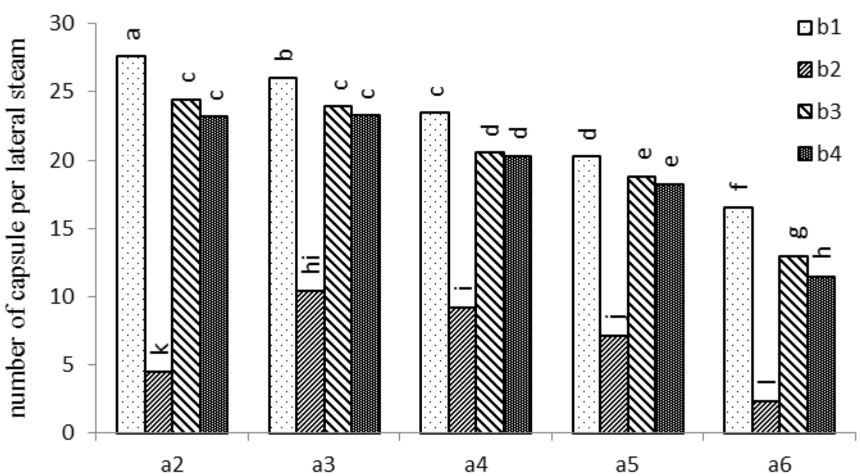

Fig. 4. Effect of different patterns of intercropping with times of weed control on capsule per lateral stem of Dragon's head. a_1: pure stand of chickpea, a_2: pure stand of Dragon's head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of

optimum density of Dragon's head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

There was no significant difference in the 100-seed weight of Dragon's head seeds among the various cropping systems as shown in Table 2, but this trait significantly affected by weeds removal times. Highest 1000-seed weight (10.2 gr) of Dragon's head was obtained under complete weed control treatment and lowest 1000-seed (2.7 gr) was recorded under no weed control treatment (Figure 5). This might be attributed to less competition of Dragon's head with weeds under complete with control treatment. Our results are in agreement with finding of Thobasti (2009). A non-significant difference in 1000-seed weight between sole and intercropped crops was also reported by Francis et al. (1987) and Thwala and Ossom (2204). However, Wright (1981) reported higher 1000-seed weight of soybean under intercropping than sole cropping conditions.

Table 2. Analysis of variance of selected parameters of Dragon's head affected by intercropping patterns and weed control treatments.

SOV	df	Mean square			
		1000 grain weight	Grain yield	Biological yield	Harvest index
Block	2	98.207	13.533	468.588	174.432
Intercropping	4	41.619 ^{ns}	233.226**	3827.56**	48.664^{ns}
Weed control	3	158.589*	424.755**	11456.41**	1387.782**
Interaction	12	26.567^{ns}	20.779**	271.402**	14.682^{ns}
Error	38	40.422	2.255	74.124	45.59

Ns=Non significant; * and ** = Significant at 5% and 1% probability level, respectively.

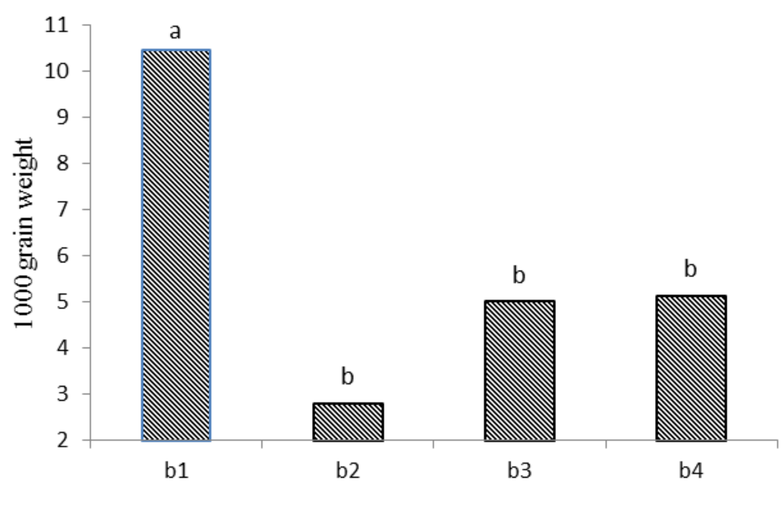

Fig. 5. Effect of times of weed control on 1000 grain weight of Dragon's head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

Different intercropping patterns and weed control treatment significantly affected grain and biological yield of Dragon's head (Table 2). Dragon's head mono crop produced significantly higher grain yield (29.68 gr) than all the intercrop treatments under weed complete control and also highest biological yield (118.9 gr) was obtained in sole cropping patterns of Dragon's head under complete control of weeds (Figures 6 and 7). In agreement to this research, the general trend in most intercropping experiments is that the grain yield of a given crop in a mixture are less than the yield of the same crop grown alone, but in total productivity per unit of land is usually greater than for sole crop (Natarajan and willy, 1981). Competition for soil moisture and nutrients could have been high and might have caused the yields of Dragon's head to drop significantly. As the duration of weed presence increased the seed yield decreased. This was a likely result of major weed species competition with Dragon's head and their biomass accumulation. Wide variations in seed yield losses may be due to differences in intensity of weed infestation and presence of different weed species. Another research result shows that weeds present a serious threat to the crop and yield losses up to 98% (Solh and Pala, 1990).

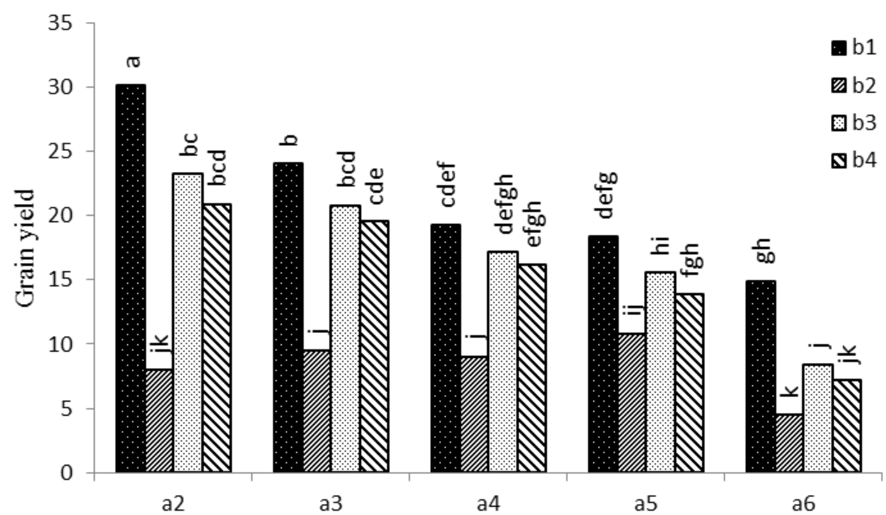

Fig. 6. Effect of different patterns of intercropping with times of weed control on grain yield of Dragon's head. a_1: pure stand of chickpea, a_2: pure stand of Dragon's head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon's head. b_1: complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

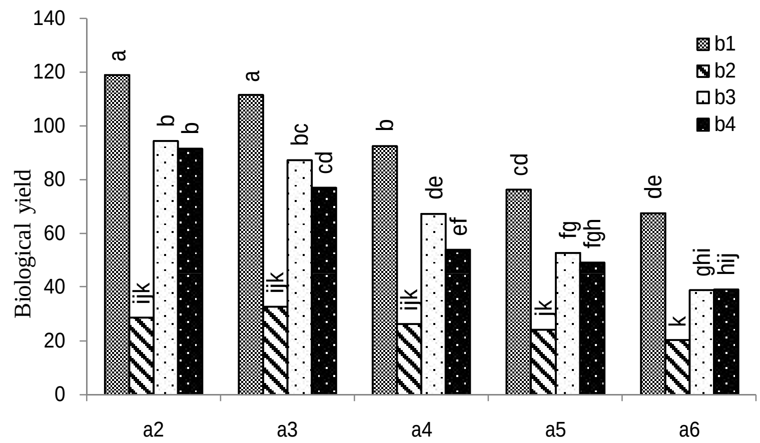

Fig. 7. Effect of different patterns of intercropping with times of weed control on biological yield of Dragon’s head. a_1: pure stand of chickpea, a_2: pure stand of Dragon’s head, a_3: a_4, a_5 and a_6, additive Intercropping of optimal density of Chickpea + 25%, 50%, 75% and 100% of optimum density of Dragon’s head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

According to the results showed, weed control treatments significantly affected harvest index of Dragon’s head at 1% probability level but, intercropping of chickpea and Dragon’s head and interaction had no effect on this trait (Table 2). The maximum amount of harvest index (33.41 %) was obtained from complete weed control treatment and minimum harvest index was obtained in control treatment of weed control (Figure 8). The enhancement of yield and its components of Dragon’s head in the weeded treatments might be attributed to the high efficiency in elimination of weeds and consequently decreased the competitive ability of weeds against Dragon’s head. In this respect, the increments due to application of hand weeding were reported in yield and yield components by Kushwah and Vyas (2005), Jan et al. (2000) and Pandya et al. (2005).

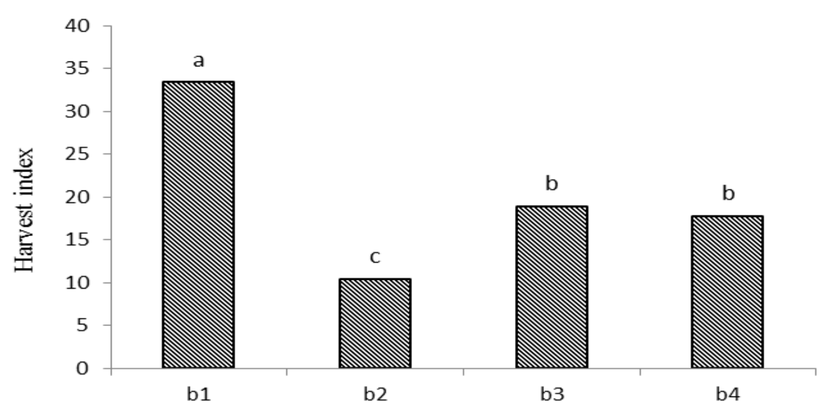

Fig. 8. Effect of times of weed control on harvest index of Dragon’s head. $b_{1:}$ complete control, b_2: no weeds control, b_3: control after 2-4 weeks after emergence and b_4: control after 5-7 weeks after emergence.

CONCLUSION

Intercropping chickpea with Dragon’s head caused significant reductions in Dragon’s head yield due to competition. However, better grain yield was obtained in plots where weeds completely controlled. Consequently, combination of sole cropping of Dragon’s head and complete control of weeds was superior to other treatments and gave the overall best grain yield in Dragon’s head.

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