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Effect of barley-fodder vetch strip intercropping on forage yield in weedy and weed free treatment

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ABSTRACT: An experiment was conducted to investigate the effect of row intercropping and weed control on forage yield of barley (Hordeumvulgare) and fodder vetch (Viciavillosa) in Jolgeh-Rokh of Khorasan-Iran during 2013. A strip plot experiment base on randomized complete block design with three replications was carried out. Factor A belonged to four cropping systems (intercropping with 3 and 4 row space, barley as sole crop and fodder vetch as sole crop) and factor B belonged to two levels of weed management treatment (hand weeding, and control). Results showed that dry matter accumulation in barley and vetch significantly affected by cropping systems. The highest dry matter accumulation observed for intercropping with 3 row space. The lowest dry matter accumulation belonged to sole cropping. Results showed that dry matter decreased by higher row space. Intercropping produced higher dry matter compare with sole cropping. Dry matter accumulation rate and total dry matter weight affected by weed management. The highest dry matter yield of barley, fodder vetch and mixed cultivation, produced by 3 row space. Biological yield of barley (53.7%), fodder vetch (37.6%) and mixed crops (48.9%)decreased in the presence of weeds. Land equivalent ratio (LER) was higher for inter cropping treatments compare with sole cropping. Higher row space decrease LER. Results showed that intercropping is potentially effective in controlling weeds in absence of weeding and herbicides treatments.

Keywords: rowintercropping, dry matter yield, barley, fodder vetch

INTRODUCTION

Global demand for cereals increased by growth population during recent decades and will raised at future. Higher agricultural production needs higher input consumption. Intensive farming is characterized by high use of inputs. Intensive farming results in soil erosion, environmental pollution due to chemicals and fertilizer abuse, and the emergence of chemical resistant weeds and pests. Diversity between planted crops proposed as a solution to diminishintensive agriculture problems (Poggio, 2005). Intercropping is a stable way offood production (Tsubo & Thobatsi, 2009). Intercropping is the practice of growing two or more crops in proximity (Thobatsi, 2009).The benefit of intercropping is producing higher yield compare with sole cropping due to better utilize of resources specially in mixture cultivation of legume and cereals (Poggio, 2005).

Some benefits of intercropping are higher yield stability, higher use efficiency of sunlight, water and soil nourishment elements and reduced labor requirement (Ofori & Stern, 1987; Thobatsi, 2009 Banik *et al*.,2006),higher competitive ability by weeds (Hauggaard-Nielsen et al. 2001a; THobatsi, 2009) and higher nitrogen fixation rate by legumes (Hauggaard-Nielsen et al. 2001a). Most of studies showed that higher yield is due to intercropping legumes with other crops (Morris & Garrity, 1993).

Barley and fodder vetch are planted in Iran solely. Studies showed that intercropping of barley and vetch as cereal-legume results in higher yield and advanced resources efficiency (Chen *et al*., 2004). In such cropping systems different planted species compete with each other. The competition is between above ground organs as well as root system (Aerts, 1999).

Intercropping is one of integrating weed management methods which has lower environmental impacts compare with chemical weed management.Barley yield reduced 40-60 percent by weed interference in sole cropping (Thobatsi, 2009). Weed suppression by crop variation is one of intercropping aids (Poggio, 2005). In intercropping, using legumes as cover crop results in weed suppression due to high growth and nitrogen fixation. Weed population reduced 39 percent at barley-soybean mix compare with barley sole cropping method (Thobatsi,

2009). Weil and Mac Fadden (1991) reported that weeds suppressed by high barley density in barley-soybean intercropping at early growing season. Thobasti (2009) reported that weed dry matter accumulation reduced 15 to 89 percent according to maiz growth habit, in cowpea mixed system. Olasantan(1994) reported that weeds defeat highly in maize-cassava intercrop due to higher leaf area index and LER. Lower weed growth reported at onion-celery intercrop compare with sole crop system (Baumann et al., 2003).

The aim of the present study was to determining the proper row space at barley-fodder vetch intercropping system in respect of producing dry matter yield, defeat weeds and land equivalent ratio.

MATERIALS AND METHODS

The experiment was carried out at in Jolgeh-Rokh of Khorasan-Iran during 2013 growing season. Field ploughed anddisk harrowed. Finally thirty tonnes of animal manure applied to the field. Extensive agricultural system carried and chemicals (fertilizers and pesticides) did not apply during growing season. A strip plot experiment base on randomized complete block design with three replications was carried out. Factor A belonged to four cropping systems (intercropping with 3 and 4 row space, barley as sole crop and fodder vetch as sole crop) and factor B belonged to two levels of weed management treatment (hand weeding, and control). Blocks striped to two equal divisions in order to performing weed controlling treatments. One part belonged to control treatment and the second part belonged to hand weeding treatment.Bahman cultivar of barley and Mashhad variety of fodder vetch was planted in hills with 20 cm distance from each other. Seeds planted in 8×7.5 m^2plots. Replacement intercropping system was applied. A half of plot belonged to each crop in barley-fodder vetch treatments. Row spacewas 35 and 60 cm for barley and fodder vetch respectively. Final plant population was the same at sole and intercropping systems. Sampling performed every 14 days. Two random plants from each treatment cut and oven dried at 70°C and weighted by a digital scale. The advantage of intercropping compare with sole cropping evaluated using LER (land equivalent ratio) equation:

$$LER=\frac{Y_{ij}}{Y_{ii}}+\frac{Y_{ji}}{Y_{jj}}$$

Wheare:

Yii and Yjj : barley and fodder vetch yield at sole cropping respectively

Yij and Yji: barley and fodder vetch yield at intercropping system respectively

Analysis of variance performed using MSTATC software. Mean comparison performed using Duncan's multiple range test at 5% probability level.

RESULTS AND DISCUSSIONS

Dry matter yield

Results showed that the highest yield produced by 3 row space inall cropping systems. Higher row space resulted in lower dry matter yield. Dry matter yield was higher in intercropping system compare with sole cropping system in both row spaces. The highest and lowest yield belonged to mixed cultivation (2223 gr/m^2) and fodder vetch sole crop (705 gr/m^2) in 3 row space respectively. Barley dry matter yield enhanced 80 to 84 percent by intercropping compare with sole crop system. Higher row space resulted in lower yield. The beneficiary of intercrop decreased by 4 row space (table 1). Nitrogen fixation by vetch resulted in higher dry matter accumulation at intercrop treatment. Nitrogen is an essential element for dry matter production, thus higher N rate resulted in higher yield.The share of barley in producing dry matter was higher than those of vetch at intercrop treatment. The result was in agreement with Wall et al. (1991).

Table 1. dry matter yield of barley, fodder vetch and mixed cultivation (gr/m^2) as affected by row space

Treatments	Mean		
	Barley	Fodder vetch	Total
3 row space	1561.2 b	662.3 c	2223.5 a
4 row space	1452.9 c	672.9 c	2125.8 b
Barley sole cropping	1791.0 a	0 d	1791.0 c
Fodder vetch sole cropping	0 d	705.3 a	705.3 d

There was no significant difference between means with the same letters in each column

Results showed that intercropping at 3 row space produced higher dry matter yield compare with barley sole cropping (table 1). According to the results of this study, complementary effect of barley-fodder vetch just belonged to 3 row space. Rezvan-Bidokhti (2004) reported that dry matter yield is higher at tow intercropping compare with strip intercropping system.

Biological yield decreased by weeds significantly. Biological yield of barley (64.3%), fodder vetch (62.4%) and mixed crops (51.1%) decreased in the presence of weeds (table 2). At the presence of weeds, biological yield of vetch decreased more compare with barley.

Table 2. dry matter yield (gr/m^2) as affected by different weed controlling treatments

Treatments	Mean		
	Barley	Fodder vetch	Mixed
Hand weeding	1598.5a	687.7a	2286.2a
Without weed control	859.6b	258.5b	1118.1b

There was no significant difference between means with the same letters in each column

Competitive ability of canopy is enhanced by interspecific competition and complementary effect of species on each other and thus results in higher weed suppression. Finally crop yield is increased by due to lower weed population and biomass (Banik et al., 2007).

The highest (2113 gr/m^2) and lowest (340 gr/m^2) dry matter yield produced by hand weeding treatment at 3 row spaceand vetch sole cropping without weed control, respectively. At sole cropping treatment, biological yield of barley and vetch decreased 48.7 and 55.2% by weeds respectively. Effect of intercropping on weed suppression decreased by higher row space(table 3). Biological yield of sorghum decreased about 20% in weed presence compare with hand weeding treatment at intercropping system (Sanjani, 2007).

Dry matter yield was higher at 3 row space compare with sole barley in both weed controlling treatments. At 4 row space, biological yield decreased 47.7% at the presence of weed compare with hand weeding treatment.

Weed suppression was 42.5 percent higher in barley-fodder vetch intercropping compare with sole cropping. Weed suppression is enhanced by intercropping due to higher land coverage and shading, interspecific competition, higher early growth rate, and induction of seed secondary dormancy of weeds (Shippers and Kropff, 2001). Banik et al (2006) reported that the yield of wheat and pea decreased at the presence of weeds compare with hand weeding treatment.

Table 3. dry matter yield of crops as affected by interaction between weed and row space

treatments		Barley	Fodder vetch	Total
Hand weeding	3 row space	1400.9b	712.4c	2113.3a
	4 row space	1341.4cd	650.5de	1991.9b
	Barley sole crop	1580.7a	0 g	1580.7d
	Vetch sole crop	0 i	770.3a	770.3i
Without weed control	3 row space	882.3de	291.4d	791.1cd
	4 row space	764.4g	205.3f	969.7f
	Barley sole crop	810.3ef	0 g	810.3d
	Vetch sole crop	0 i	340.5b	340.5b

There was no significant difference between means with the same letters in each column

Land equivalent ratio (LER)

Results showed that LER was higher at row intercropping compare with sole cropping. The highest LER (1.64) belonged to 3 row space. Thus 62 percent more land is required for producing the same yield by sole crop compare with intercropping method. Thus land use efficiency was higher in intercropping compare with sole cropping system. LER of each crop in the mixture was less than sole crop but the total LER was higher than one. LER decreased by higher row space (table 4). The lowest LER belonged to 4 row space. LER of barley decreased 25% at 4 row space. The results showed the symbiosis effect of vetch on barley growth due to nitrogen fixation. Morphological and physiological differences are the main facts of proper symbiosis between cereals and legumes (Akuda, 2001). The competition for water and nutritional elements affects by different root length, radial spread and density of intercropped plants and results in higher LER.

Table 4. LER as affected by row spacing

Treatments	Mean		
	Barley	Fodder vetch	Total
3 row space	0.95a	0.69a	1.64a
3 row space	0.90b	0.59b	1.49b
4 row space	0.86c	0.59b	1.45b
4 row space	0.81d	0.65ab	1.46b

There was no significant difference between means with the same letters in each column

Results showed that at the weed presence LER was higher for intercropping system compare with sole cropping. LER of barley sole cropping enhanced form 79% to 84% at the presence of weeds. LER of vetch sole cropping enhanced too, form 51% to 72% at the presence of weeds (table 5). Barley-fodder vetch mixed cultivation resulted in lower weed population. Barley yield enhanced by mixed cultivation probably due to nitrogen fixation of vetch root system. It supposed that intercropping results lower chemical and labor inputs due to biological weed suppression. Makinde et al (2009) reported that Maize-leaf vegetable cultivation results in LER equal to 1.77 because of better land coverage and higher weed suppression.

Table 5. LER as affected by weeding treatments

Treatments	Men		
	Barley	Fodder vetch	total
Hand weeding	0.79a	0.51b	1.30b
Without weed control	0.84a	0.72a	1.56a

There was no significant difference between means with the same letters in each column

LER of barley sole cropping was higher than fodder vetch which showed that mixed cultivation of these two crops prepare a better condition in respect of water, nutritional elements and sunlight. Barley benefited more than fodder vetch in this mixed cultivation system. LER was lower in hand weeded plots compare with control plots (table 6). The lowest LER belonged to hand weeding plots with 4 row space.

Table 6. LER as affected by row space

treatments		mean		
		Barley	Fodder vetch	Total
Hand weeding plots	3 row space	0.88b	0.57c	1.46b
	4 row space	0.69c	0.53c	1.22d
Without weed control	3 row space	0.99a	0.80a	1.79a
	4 row space	0.69c	0.60b	1.29c

There was no significant difference between means with the same letters in each column
Legume nodulation induces by cereal-legume intercropping and results in higher nitrogen fixation (Banik et al., 2006). Hiebsch et al. (1995) reported that LER enhanced by maize-soybean due to higher weed suppression and better resources consumption.

CONCLUSION

Results showed that dry matter yield enhanced by intercropping. The highest yield produced by 3 row space. Barley- fodder vetch intercropping with 3 row space resulted in high yield. At the higher row space biological yield was close to those of sole cropping system. Weed suppression and LER enhanced by intercropping. The highest LER belonged to 3 row space in both weeding treatments. At intercropping system, measured traits of barleyimproved more compare with fodder vetch which showed that barley benefited more than vetch. At sole cropping weeds growth at empty spaces among canopy. At intercropping there is less empty spaces because of balancing effect of crops on each other. Results showed that intercropping is a proper way to enhance yield and control weeds.

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