



RESEARCH ARTICLE

EFFECT OF INTERCROPS AND SPACINGS ON WEED SUPPRESSION AND YIELD IN WHEAT  
(*TRITICUM AESTIVUM L.*) UNDER ORGANIC CONDITIONS

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ABSTRACT

A field experiment was conducted on silty clay loam soil of Organic farm of Department of Organic Agriculture, CSKHPKV, Palampur with 36 treatments of cropping systems, spatial arrangements and weed management with an objective to study the performance of various intercrops and spacings on weed suppression in wheat during the year 2010-11 & 2011-12. Cropping systems were comprised of wheat + gram, wheat + lentil and wheat + peas and wheat alone with three spatial arrangements of 15 cm, 22.5 cm and 30 cm and three weeding techniques viz. 1 handweeding, 2 handweedings and unweeded check. The interaction between cropping systems with spatial arrangements and weeding techniques was found significant for weed biomass and grain yield. Among the cropping systems, wheat + lentil with wider row spacings of 22.5 cm and 30 cm and 2 hand weedings resulted in significantly lower weed dry weight and higher weed control efficiency resulting in significantly higher wheat equivalent yield over other treatments.

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INTRODUCTION

Wheat (*Triticum aestivum L.*) is the most widely grown crop in the world. India is second largest producer of wheat in world after China. It is a staple food in India and plays an important role in its economy. The wheat production in India has touched a new height of 93.90 m tonnes in 2011-12. In Himachal Pradesh, it raised to total production of 544.44 thousand tonnes in 2012-13 against 61.2 thousand tonnes during 1951-52. Weed management is a key issue in organic farming systems. Weeds not only decrease yield but may lead to complete failure of crop. There is a direct relationship between weed biomass and crop yield so weed suppression gets directly translated into higher yield. Therefore, in order to produce higher yields, weed control is essential for crop by making use of different weeding techniques with different spatial arrangements significantly affecting grain yield. Zand *et al.* (2007) illustrated that 30% grain yield losses are associated with weed infestation. Wheat crop is infested by many weed species. For increasing land use efficiency and weed suppression, intercropping plays a pivotal role. This practice is common with sustainable agriculture and organic farming. Presence of weeds in wheat severely affects the grain yield and biological yield of wheat (Khan and Marwat, 2006) therefore, intercropping is one option for reducing weed problems through non-chemical methods (Vandermeer, 1989). When a legume is grown in association

with another crop (intercropping), commonly a cereal, the nitrogen nutrition of the associated crop may be improved by direct nitrogen transfer from the legume to cereal (Giller and Wilson, 1991). Spacing is another important factor that affects the agronomic characteristics of wheat. Narrow row spacing leads to higher leaf photosynthesis and suppresses weed growth compared with the wider spacing (Dwyer *et al.* 1991). Keeping all these points in mind a field experiment was planned with an objective to determine the effect of various cropping systems and spacings on weed suppression in wheat.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 2010-11 and 2011-12 at the Model Organic Farm of Chaudhary Sarwan Kumar Himachal Pradesh krishi Vishvavidyalaya, Palampur, India. The soil of the experimental site was silty clay loam in texture, acidic in reaction (pH 5.8), medium in available nitrogen and phosphorus and high in available potassium. The experiment was laid out in split-split plot design with three replications. The treatments consisted of 4 cropping systems (wheat + gram, wheat + lentil, wheat + pea and wheat alone) in main plots, 3 spacings (15 cm, 22.5 cm & 30 cm) in sub plots and 3 weed control treatments (1 hand weeding, 2 handweedings and unweeded check) in sub-sub plots. Wheat variety HPW 155 was sown during the first week of November following all organic package of practices except the treatments. Weed population and weed dry weight were recorded at 120 days after sowing using 50cm x 50cm quadrates.

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## RESULTS AND DISCUSSION

### Effect on weeds

#### Weed flora

The major weed flora of the experimental plots consisted of *Phalaris minor* Retz. *Avena fatua* L. and *Lolium temulentum* L. among grasses; *Anagallis arvensis* L., *Vicia* sp. (*V. sativa* L. and *V. hirsuta* L.) and *Stellaria media* L. among broadleaf weeds. On an average, the grasses and broadleaf weeds constituted 58.2 and 41.8 % of total weed population.

#### Effect of cropping systems

All the cropping systems viz. wheat + gram, wheat + lentil and wheat + pea resulted in significantly lower weed dry weight over wheat alone during both the years (Table 1; Fig.1).

**Table 1. Effect of treatments on weed dry weight and weed control efficiency**

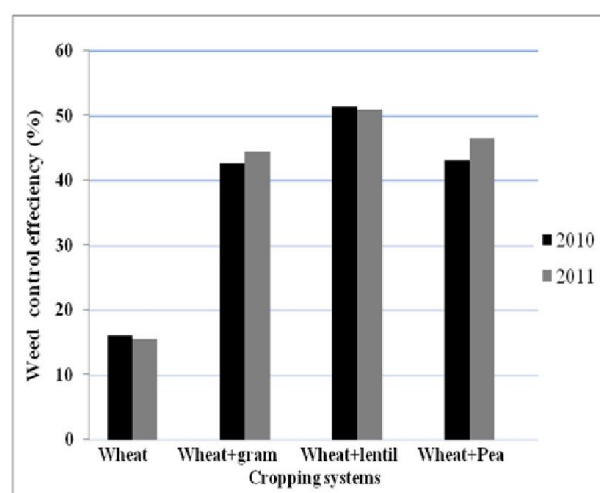
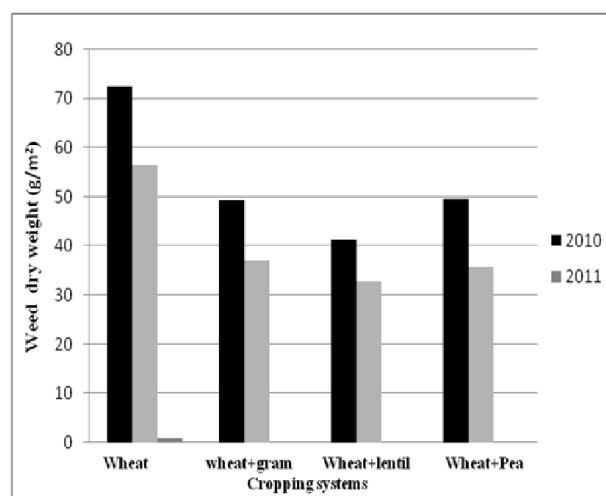
Treatments	Weed dry weight (g/m <sup>2</sup> )		Weed control efficiency (%)	
	2010-11	2011-12	2010-11	2011-12
<b>Main plots:</b>				
<b>Cropping systems</b>				
Wheat	72.4	56.4	16.1	15.6
Wheat + gram	49.4	37.1	42.7	44.5
Wheat + lentil	41.2	32.8	51.4	50.9
Wheat + pea	49.5	35.8	43.1	46.5
CD (P=0.05)	6.5	5.0	-	-
<b>Sub-plots: Row Spacings (cm)</b>				
15	45.4	34.8	47.4	47.9
22.5	58.0	41.5	32.8	35.9
30	56.7	45.2	34.3	32.3
CD (P=0.05)	7.4	5.3	-	-
<b>Sub-Sub plots: Weed management</b>				
1 Handweeding	38.2	30.6	55.7	54.2
2 Handweedings	34.6	24.4	59.9	63.5
Unweeded check	86.3	66.8	-	-
CD (P=0.05)	7.4	5.3	-	-

Vandermeer (1989) and Banik *et al.* (2006) have also reported that for weed suppression intercropping plays a pivotal role. Among various cropping systems evaluated, wheat + lentil was observed to be the most effective in suppressing the weeds which resulted in significantly lower weed dry weight and highest weed control efficiency over other cropping systems. However, it was at par with wheat + gram and wheat + peas during the second year of experimentation with respect to weed dry weight.

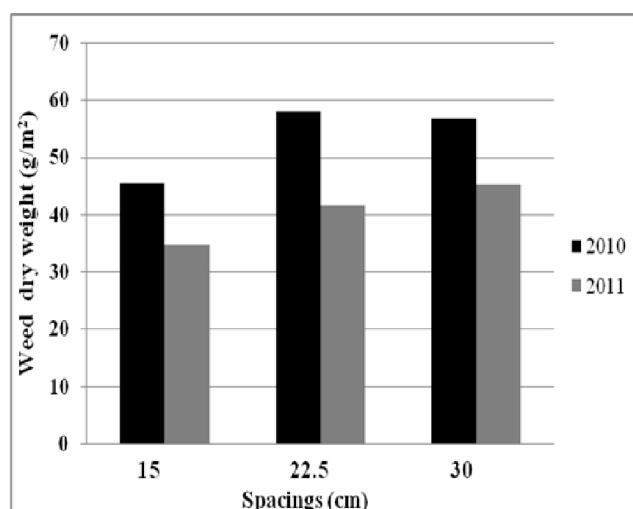
#### Effect of spacings

Among the spacings, wider row spacing of 22.5 cm and 30 cm being at par in respect of weed dry weight resulted in significantly higher weed dry matter accumulation over narrow spacing of 15 cm during both the years of experimentation because in wider spatial arrangements weeds were not suppressed effectively by crop plants and thus grew freely resulting in higher weed dry weight and lower weed control

efficiency. Similar results have also been reported by Dwyer *et al.* (1991), who observed that narrow row spacing suppressed weed growth effectively as compared to wider row spacings (Fig. 2).



**Fig.1. Effect of cropping systems on weed dry weight and weed control efficiency**



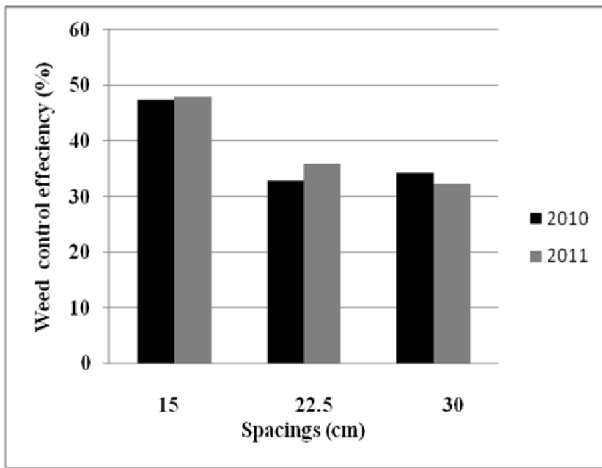


Fig. 2. Effect of spacings on weed dry weight and weed control efficiency

Effect of weed management

Among the weed management treatments, 2 HW though resulted in lower weed dry weight accumulation and higher weed control efficiency as compared to 1 HW but the differences were non-significant. Whereas, unweeded check recorded significantly the highest weed dry matter accumulation during both the years of experimentation (Fig.3).

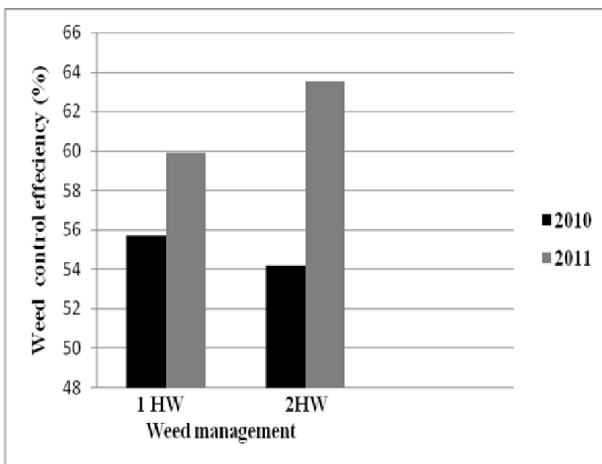
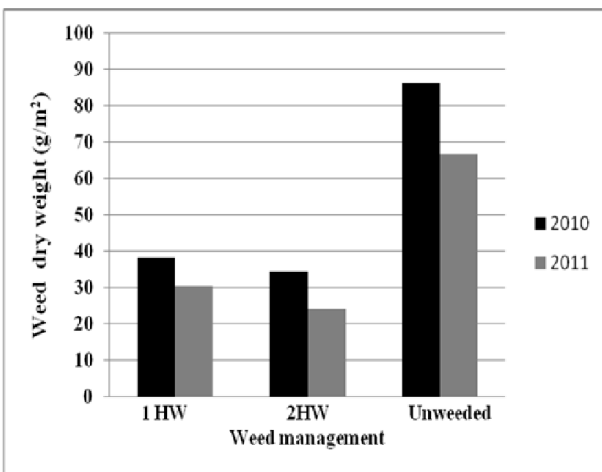


Fig. 3. Effect of weed management treatments on weed dry weight and weed control efficiency

Effect on crop

Wheat yield attributes

The yield attributes of wheat viz. effective tillers/m row length, grains/spike and 1000-grain weight were affected significantly due to cropping systems, spacings and weed management treatments (Table 2). Effective tiller/m row length and grains/spike were significantly higher in wheat + lentil intercropping system over other systems during both the years of experimentation. 1000-grain weight though was comparatively higher in wheat + lentil cropping system as compared to other systems but the differences were non-significant except wheat alone which recorded significantly lower values of 1000-grain weight. Among spacings, narrow row spacing of 15 cm recorded significantly lower values of number of effective tillers/m row length, grains/spike and 1000-grain weight, however, there was no significant differences in wider row spacings of 22.5 cm and 30 cm during both the years of experimentation. Among weed management treatments unweeded control recorded significantly lowest values of effective tillers, grains/spike and 1000-grain weight over one hand weeding and two hand weedings which were statistically at par with one another. The yield attributes in unweeded control were impaired probably because of higher crop-weed competition in these treatments.

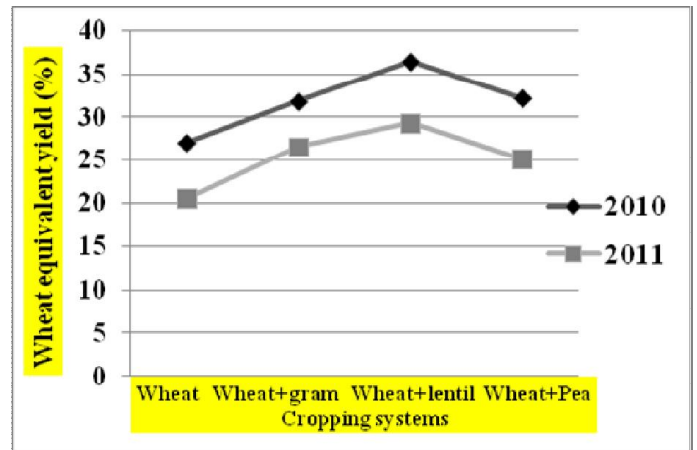


Fig. 4. Effect of cropping systems on wheat equivalent yield

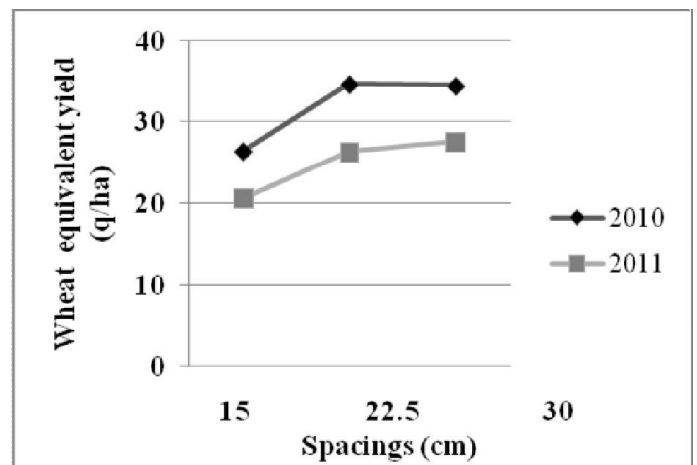


Fig. 5. Effect of spacings on wheat equivalent yield

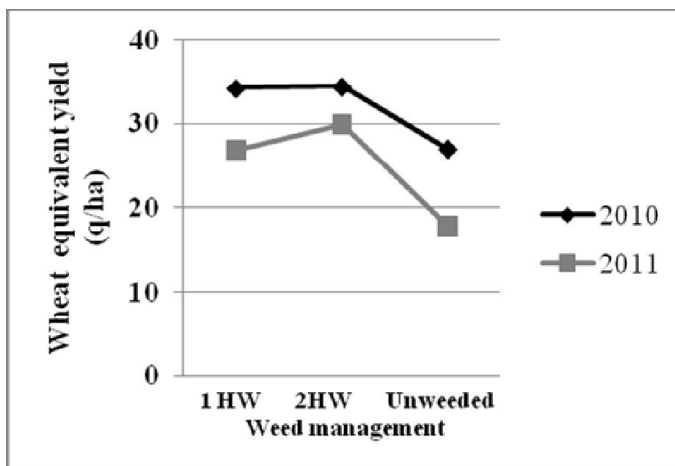


Fig.6. Effect of weed management on wheat equivalent yield

14.5, 13.1 and 34.8 % during first year and 10.6, 16.7 and 42.5 % during the second year over wheat + gram, wheat + pea and wheat alone, respectively (Table 2; Fig. 4). Similarly, wheat + gram and wheat + pea resulted in respectively 17.8 and 19.2 % higher yield during the first year and 29.3 and 22.4 % higher yield during the second year over wheat alone due to the suppression of weeds by the inter-crops which ultimately resulted in lower weed dry matter accumulation in these treatments (Table 1). Vandermeer (1989) and Giller and Wilson (1991) have also supported the role of intercrops in weed suppression.

### Effect of spacings

Among the spacings, wider row spacings of 22.5 cm and 30.0 cm being at par with one another resulted in significantly higher wheat equivalent yield over narrow row spacings of

Table 2. Effect of various treatments on yield attributes of wheat and wheat equivalent yield

Treatments	Effective tillers/m row		Grains/spike		1000-grain weight (g)		Wheat equivalent yield (q/ha)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Main plots: Cropping systems								
Wheat	38.5	40.0	35.4	37.2	40.2	42.5	27.0	20.5
Wheat + gram	41.6	43.2	39.6	41.1	45.7	43.8	31.8	26.5
Wheat + lentil	45.7	49.8	42.8	45.7	46.5	45.7	36.4	29.3
Wheat + pea	40.9	43.6	40.5	39.6	46.1	44.9	32.2	25.1
CD (P=0.05)	2.8	2.4	1.9	2.2	1.5	1.2	2.3	2.0
Sub-plots: Row Spacings (cm)								
15	35.6	32.8	32.4	32.8	41.1	38.9	26.4	20.6
22.5	43.8	48.2	41.9	45.6	46.7	47.6	34.7	26.3
30	45.6	51.4	44.5	47.7	46.0	46.2	34.5	27.6
CD (P=0.05)	3.2	3.5	2.9	2.6	1.8	2.1	1.8	2.2
Sub-Sub plots: Weed management								
1 Handweeding	40.8	47.2	42.2	45.2	47.6	48.6	34.2	26.8
2 Handweedings	43.0	49.5	44.9	46.3	48.8	50.5	34.4	29.9
Unweeded check	31.2	35.7	31.7	34.6	37.4	33.6	27.0	17.8
CD (P=0.05)	3.2	3.5	2.9	2.6	1.8	2.1	1.8	2.5

Table 3. Interaction effect of cropping system and weed management on wheat equivalent yield and dry matter of weeds

Treatments	Weed Management					
	1 HW		2HW		Unweeded check	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Cropping systems	Wheat equivalent yield (q/ha)					
Wheat	27.2	19.7	31.0	26.5	23.1	15.2
Wheat + gram	35.1	28.3	33.5	31.5	26.8	19.7
Wheat + lentil	39.9	32.6	39.1	33.3	30.2	22.0
Wheat + pea	34.7	26.9	34.0	28.5	27.9	19.9
	Dry matter of weeds (g/m <sup>2</sup> )					
Wheat	51.0	43.2	47.2	35.2	118.9	90.9
Wheat + gram	34.5	23.6	31.8	18.2	81.8	56.8
Wheat + lentil	28.4	30.2	23.1	22.9	72.1	58.4
Wheat + pea	38.9	25.6	36.4	21.3	73.2	60.7
	CD (P=0.05)					
	Wheat equivalent yield		Wheat equivalent yield		Dry matter of weeds	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
i. Two weed management treatments at same cropping system	2.8	3.4	3.0	3.5		
ii. Two cropping systems at fixed or different weed management levels	2.1	2.5	4.2	3.8		

### Wheat equivalent yield

#### Effect of cropping systems

Among all the cropping systems, wheat + lentil intercropping system recorded higher wheat equivalent yield to the tune of

15.0 cm during both the years of experimentation despite of the fact that the weed dry weight was significantly lower in narrow spacings due to more weed suppression. This can be attributed to more competition of intercrop with the main crop for various resources in narrow row-spacing.

### Effect of weed management

Weed management treatments affected the wheat equivalent yield significantly (Table 2). Among the weed management treatments, 2 HW resulted in comparatively higher wheat equivalent yields as compared to 1 HW but the differences were non-significant except the wheat equivalent yield during 2011-12, where 2 HW produced significantly higher yield over 1 HW. Unweeded check recorded significantly lowest wheat equivalent yield during both the years of experimentation.

### Interaction effect

Interaction effects of cropping systems and weed management on wheat equivalent yield and dry matter accumulation of weeds were found significant (Table 3). It is evident from the table that irrespective of the cropping systems the weed control treatments produced significantly higher wheat equivalent yield and lower dry matter accumulation of weeds over unweeded control. Two hand weedings produced significantly higher wheat equivalent yield and lower weed dry weight over one hand weeding in the plots where wheat was taken as alone. Whereas, in the inter-cropping systems there was no significant differences in yield between one and two hand weedings except in wheat + gram inter-cropping system during 2010-11 where the yield was significantly higher indicating thereby that legume intercrops had smothering effect on weeds and weed crop competition was reduced. Irrespective of weed management treatments wheat + lentil cropping system resulted in significantly higher wheat equivalent yield and lower weed dry weight over wheat + gram and wheat + pea during both the years. This may be attributed to the reason that lentil might have suppressed the weeds more effectively due to its thick growth as compared to gram and pea. There was no significant difference in the yield as well as weed dry weight in wheat + gram and wheat + pea inter-cropping systems except in two hand weedings during the second year of study, where, wheat + gram produced significantly higher wheat equivalent yield as compared to wheat + pea intercropping system.

### Conclusion

It can be concluded from this study that from weed suppression point of view wheat + lentil cropping system with wider row spacing of 22.5 cm and 30 cm in combination with one handweeding resulted in as higher wheat equivalent yield and lower weed dry weight as in plots hand weeded twice due to more suppression of weeds in this treatment which was followed by wheat + gram and wheat + pea indicating thereby that intercropping of legumes in wheat needs only one handweeding at initial stages (35-40 DAS) and intercrop takes care of the second flush of weeds through smothering effect.

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