Pak. J. Weed Sci. Res. 17(4): 397-406, 2011

WEED MANAGEMENT STUDIES IN WHEAT-VEGETABLE INTERCROPPING SYSTEM AND PLANTING PATTERNS

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ABSTRACT

A field experiment was carried out to assess the weed management studies in wheat-vegetable intercropping system and planting patterns at the Research Farm, Faculty of Agriculture, Gomal University D. I. Khan, Pakistan during winter season 2009-2010. Randomized complete block with sixteen treatments replicated thrice. Wheat variety "Sahar" was planted at seeding rate of 125 kg ha^{-1}. Experiment was conducted during winter 2009 and recommended doses of farm yard manure and NPK were applied. Statistical analysis of the data revealed that highly significant (P≤0.01) differences were observed for biological yield, grain yield, weeds density, fresh and dry weed biomass. Among the planting geometries, single row sole wheat depicted maximum biological (13.93 t ha^{-1}) as well as grain yield (5.173 t ha^{-1}). The highest reduction in weed density was recorded in treatment having 4 row strip wheat + 2 row onion. Similarly dry weed biomass was also highly significantly (P≤0.01) reduced by 4 row strip sole wheat + 2 row onion. The instant results suggest that intercropping in wheat could be used as a viable weed management approach.

Keywords: Grain yield, intercropping, planting pattern, vegetable, weed management, weeds, wheat.

INTRODUCTION

For increasing land use efficiency and weed suppression, intercropping plays a pivotal role (Banik *et al.,* 2006). A practice often associated with sustainable agriculture and organic farming, intercropping is one form of polyculture, using companion planting principles. It is commonly used in tropical parts of the world and by various indigenous people (Altieri, 1991). Intercropping is a common feature in traditional farming of small land holders. It provides farmers with a variety of returns from land and labour, often increases the

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efficiency with which scarce resources are used and reduces the failure risk of a single crop that may be susceptible to environmental and economic fluctuations. The objective of enhanced cropping intensity can also be achieved through intercropping. The need for increased production of vegetables can also be fulfilled through their intercropping in wheat. Besides, intercropping of compatible crops use resources very efficiently and provides yield advantage over sole crops. 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).

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). In organic production systems, weeds emerging after the critical period may not cause direct damage to the current crop (Radosewich and Holt, 1984; Wilson *et al*., 1988). Weed growth suppression is an explanation of intercropping yield advantage, which can be applied to diminish herbicide use in agriculture (Poggio, 2005). At adequate density, the yield of uniformly distributed crop plants can be optimized by suppressing weeds (Weiner *et al.,* 2001). Intercropping is encouraged throughout the world as higher number of effective nodules under intercropping system over pure stand of legume is an indication that more atmospheric nitrogen fixation in the crop mixture (Maingi *et al.*, 2001). In intercropping the available resources needed for plant growth and development such as light, water and nutrients are utilized more efficiently by the crops as compared to sole or pure stand of a crop. Thus it is believed that efficient utilization of resources results in yield advantages. Multiple cropping systems are also prevalent in many parts of the world and farmers in the temperate region have used alternating strips of corn and soybeans (Sullivan, 2003). As farmers have small land holding in our country therefore intercropping is the only option for the farmers to grow more than one crop in a single season for getting higher net return.

In light of the above mentioned discussion, the present study was conducted with the objectives to decipher the potential of intercropping of onion and garlic in wheat for environment friendly weed management in different planting geometries and intercropping systems under the agro-climatic conditions of Dera Ismail Khan.

MATERIALS AND METHODS

A field experiment was conducted to assess the effect of different plant geometries and intercropping systems on weed suppression in wheat-vegetable intercropping system at the Agronomic Research Area, Faculty of Agriculture, Gomal University D. I. Khan, Pakistan during winter season 2009-2010 using RCB design with three replications. Wheat variety "Sahar" was planted in rows at seed rate of 125 kg ha^{-1} with a plot size of 18 m^2. Garlic cultivar Faisalabad white and onion cultivar Swat-1 were used in the experiment. The different planting geometries/treatments included in the study were;

Single row sole wheat
2 row strip sole wheat
3 row strip sole wheat
4 row strip sole wheat
2 row strip wheat + 1 row onion
3 row strip wheat + 1 row onion
4 row strip wheat + 1 row onion
2 row strip wheat + 2 row onion
3 row strip wheat + 2 row onion
4 row strip wheat + 2 row onion
2 row strip wheat + 1 row garlic
3 row strip wheat + 1 row garlic
4 row strip wheat + 1 row garlic
2 row strip wheat + 2 row garlic
3 row strip wheat + 2 row garlic
4 row strip wheat + 2 row garlic.

Land was ploughed, leveled and then recommended dose (20-25 t ha^{-1}) of Farm Yard Manure (FYM) was incorporated into the soil. Nitrogen, Phosphorus and Potassium (NPK) were applied @ 120-60-60 kg ha^{-1} using urea, single super phosphate (SSP) and sulphate of potash (SOP), respectively. Full doses of phosphorus and potassium and half dose of nitrogen were applied before sowing, while remaining dose of nitrogen was added to the experimental plot after a month (Baloch, 2008). The field was irrigated as per need and all other agronomic practices were applied uniformly.

Data Collection and Analysis

To record biological yield, wheat was harvested, bundled, sun dried and were weighed. The data was then converted into t ha^{-1} by using the following formula:

$$\text{Biological yield (t ha}^{-1}\text{)} = \frac{\text{Weight of sample (kg) x 10000}}{\text{Area harvested (m}^2\text{) x 1000}}$$

Grain yield was recorded after threshing of wheat of each treatment separately and then was converted to t ha^{-1} by using the following formula:

$$\text{Grain yield (t ha}^{-1}\text{)} = \frac{\text{Weight of sample (kg) x 10000}}{\text{Area harvested (m}^2\text{) x 1000}}$$

For recording fresh and dry weed biomass, the weeds in individual plots were removed at the crop maturity/harvested stage, whereas, for dry weed biomass, weeds were kept in electric oven (set at 70°C) for 72 hours and then dry biomass was recorded with Sartorius balance. The data recorded was subsequently converted into m^2.

All the data recorded were statistically analyzed using MSTATC software. The purpose of analysis of variance was to determine the significant effect of treatments on weeds management and wheat yield. DMR test was applied when analysis of variance showed significant effects for treatments (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Weed Density (m^{-2})

The mean values regarding weed density is shown in Table-1. Data showed that different treatments significantly ($P<0.001$) affected the weed density (m^{-2}). It was observed that weed density was higher in treatments having pure stands of wheat as compared to the rest of the treatments. This might be due to the open space for weeds to germinate and establish. Increasing number of rows of onion as well as garlic in wheat increased the weed suppression. However, one row of onion and garlic were also effective in suppressing the weeds but more than one row was more effective. In a similar study it was observed that less weed production under monocropped chickpea over monocropped wheat may be due to better weed smothering efficiency of pulse crops (Midya *et al.,* 2005). Thus it is concluded that intercropping of onion and garlic could be used for weed suppression in wheat as reduction in weed density accelerates growth of the crop plants at early growth stages (Ejaz *et al*., 2003).

Fresh Weed Biomass (g m^{-2})

Statistical analysis of the data revealed that fresh weed biomass in different cropping geometries was highly significantly ($P \leq 0.01$) affected (Table-1). Maximum weed density (76.67 g m^{-2}) was recorded in treatment having 4 rows strip sole wheat followed by 4 rows strip sole wheat + 1 row onion (70 g m^{-2}). Minimum fresh weed biomass was noted in 2 rows strip sole wheat + 2 row garlic (51.67 g m^{-2}). All other treatments produced fresh weed biomass that was statistically comparable. However, it was observed that all the intercropping treatments decreased the fresh weed biomass probably due to the effective utilization of resources and severe inter-specific competition. As higher plant population of crop plants decrease the fresh and dry weed biomass (Khan *et al.* 2009) therefore it could be concluded that the concept of onion or garlic in wheat should be popularized in the area under discussion. Although total weed control is not feasible through intercropping in wheat but a big proportion of weed biomass could be discouraged. Due to more space between strips at planting geometry of four rows, competition between wheat plants and weeds for space, nutrients and light was less compared to the other geometries (Ejaz *et al*., 2003). Less weed biomass production and weed density under intercropping system is due to higher inter-specific competition combined with complementarity between intercrop species that improve the crop stand competitive ability towards weeds (Hauggaard-Nielson *et al.,* 2003).

Dry Weed Biomass (g m^{-2})

Table 1 depicted highly significant ($P \leq 0.01$) differences among different means with respect to dry weed biomass. Mean values of dry weed biomass revealed highly significant ($P \leq 0.01$) differences in different planting geometries. Maximum dry weed biomass (28.33 g m^{-2}) was observed in 4 rows strip sole wheat + 1 row onion and 4 rows strip sole wheat + 2 row onion each. While minimum dry weed biomass (15.33 g m^{-2}) was recorded in single row sole wheat followed by 2 rows strip sole wheat (16.67 g m^{-2}). Decreasing weed biomass in intercropped treatments depicted that weeds could be successfully suppressed through onion and garlic intercropping wheat. However, more studies are required to explore the possibility of weed suppression in wheat in combination with other methods of weed control. In an intercropping experiment, Banik *et al.* (2006) reported that intercropping wheat and chickpea increase total productivity per unit area improve land use efficiency and suppress weeds, a menacing pest in crop production.

Biological Yield of Wheat (t ha^{-1})

The total biomass per hectare expresses the overall growth and developmental potential of a crop while the grain yield per hectare is a function of the integrated effect of the yield components which are influenced differently by growing conditions and patterns of crop association. The mean values of biological yield and grain yield is presented in Table 1. Mean values demonstrated that maximum biological yield (13.93 t ha^{-1}) was obtained in single row sole wheat followed by 2 rows strip sole wheat (13.63 t ha^{-1}). Both these treatments were statistically at par with each other. Minimum biological yield (7.20 t ha^{-1}) was obtained in 2 row strip wheat + 2 rows garlic. All other values were intermediate and statistically identical. As biological as well grain yield are equally important for the farmers in our country therefore higher biological yield suggest that intercropping of onion or garlic has no negative effect on the biological yield of wheat. Higher biomass yield per hectare in intercrop combinations has also been reported by Thakur and Sharma (1988) and Singh *et al.* (1986).

Grain Yield of Wheat (t ha^{-1})

Mean values regarding grain yield is presented in Table-1 which clearly depicted that highly significant differences were observed in different planting geometries for grain yield. Maximum grain yield of 5.17 t ha^{-1} was obtained in single row sole wheat followed by 2 rows strip sole wheat (4.47 t ha^{-1}). Minimum grain yield (2.23 t ha^{-1}) was exhibited by 3 row strip wheat + 2 rows garlic. The contribution of each component crop towards total biomass yield was fairly higher enough to compensate these losses. This clearly lead to the conclusion that growth factors and other resources were utilized more effectively and efficiently leading to greater dry matter production in intercropping systems rather than in monoculture of the component crops. The reduction in wheat yield due to garlic intercrop was considerably higher which might be attributed to its competitive effect.

Table 1. Effect of wheat-vegetable intercropping system on weeds and wheat.

Treatments	Weed density (m^{-2})	Fresh weed biomass ($g\ m^{-2}$)	Dry weed biomass ($g\ m^{-2}$)	Biological yield ($t\ ha^{-1}$)	Grain yield ($t\ ha^{-1}$)
Single row sole wheat	35 BC	63 BCDE	15.33 G	13.93 A	5.17 A
2 rows strip sole wheat	38 AB	63.67 BCD	16.67 G	13.63 AB	4.47 B
3 rows strip sole wheat	37.67 AB	69.67 AB	19.67 F	12.70 BC	4.12 BC
4 rows strip sole wheat	41.67 A	76.67 A	26.67 AB	12.20 CD	4.00 BCD
2 rows strip sole wheat + 1 row onion	28.67 DEFG	55 EF	21.33 EF	10.20 FGH	3.97 BCD
3 rows strip sole wheat + 1 row onion	31 CDE	66.33 BC	24.67 CD	11.30 DEF	3.82 CD
4 rows strip sole wheat + 1 row onion	32.33 CD	70 AB	28.33 A	11.77 CDE	3.73 CDE
2 rows strip sole wheat + 2 rows onion	29.67 DEF	57.33 DEF	23 DE	9.70 GH	3.42 DEF
3 rows strip sole wheat + 2 rows onion	25.67 FG	55 EF	25 BC	9.80 GH	3.47 DEF
4 rows strip sole wheat + 2 rows onion	24.33 G	56.33 DEF	28.33 A	10.80 EFG	3.18 EF
2 rows strip sole wheat + 1 row garlic	31 CDE	58.33 CDEF	21 F	9.20 H	3.15 EF
3 rows strip sole wheat + 1 row garlic	32 CD	59 CDEF	24 CD	9.03 H	3.15 EF
4 rows strip sole wheat + 1 row garlic	29.67 DEF	64 BCD	27 A	10.10 FGH	3.67 CDE
2 rows strip sole wheat + 2 rows garlic	25.33 FG	51.67 F	21 F	7.20 I	3.02 F
3 rows strip sole wheat + 2 rows garlic	26.33 EFG	58 CDEF	24 CD	10.07 GH	2.23 G
4 rows strip sole wheat + 2 rows garlic	28 EFG	64.33 BCD	23.67 CD	9.77 GH	3.12 EF
LSD	4.492	7.379	1.788	1.120	0.5551

Means sharing the same letters are non-significant at 1% level of probability.

On contrary onion showed very little competitive effects because of its better association. In an intercropping study temporary intercropping was shown to be excellent method to improve the quality of organic durum wheat in the Mediterranean environmental conditions (Tosti and Guiducci, 2010). Intercropping, a practical application of ecological principles such as diversity, competition and facilitation in agriculture is gaining increasing interest in order to combine high productivity and reduced use of external inputs (Hauggaard-Nielsen *et al.,* 2008, 2009ab). Khan *et al.* (2009) reported that intercropping in wheat is possible option for suppressing weeds. The instant results suggest that the concept of intercropping in wheat should be popularized for weed suppression in wheat.

CONCLUSION

All the treatments had a significant effect on the biological and grain yields of wheat along with great influence on the weeds density and their fresh and dry biomass. Among the planting geometries, the yields were greatest in single row sole wheat. However, the treatment of 4 row strip wheat + 2 row onion showed the highest reduction in weed density. Similarly, weed dry weight highly reduced by 4 row strip sole wheat + 2 row onion. The instant results suggested that intercropping in wheat could be used as a viable weed management approach.

ACKNOWLEDGEMENT

This study is a part of PhD dissertation and will be submitted to Gomal University Dera Ismail Khan, Pakistan.

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