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EFFECT OF SOWING METHODS AND MULCHING ON WEED DENSITY IN WHEAT CROP UNDER DEFICIT IRRIGATION

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ABSTRACT

Water scarcity, high temperature, poor sowing methods and weeds infestation are the limiting factors in crop production. To determine the effect of sowing methods and mulching on weed density in wheat crop under deficit irrigation, an experiment was conducted at New developmental Farm of The University of Agriculture Peshawar, Pakistan under clay loam soil conditions during 2011-12. The experiment was laid out in RCBD with split split plot arrangement having three replications. Three factors i.e. sowing methods, mulch and deficit irrigation with four levels i.e. full irrigation (DI_0), 20% deficit (DI_{20}), 40% deficit (DI_{40}) and 60% deficit (DI_{60}) were studied. Soil moisture was continuously monitored and full irrigation was determined on the basis of MAD 50%. Sowing methods were consisted of raised bed and flat bed cultivation while maize stover was used as mulch. Findings of the study indicated that sowing methods, mulching and irrigation levels had considerably influenced weed density, yield and yield components of wheat. Raised bed cultivation had more number of spikes m^{-2}, 1000-grain weight, grain yield and harvest index with lowest weed density as compared to traditional flat bed sowing. Likewise, application of maize stover @ 4 tons ha^{-1} as a surface mulch enhanced wheat yield and decreased weeds germination. In case of irrigation levels, full irrigation resulted an increase in weeds density, spikes m^{-2}, 1000-grain weight, yield and harvest index of wheat crop. It was concluded that raise bed cultivation, mulching with maize stover and 20% deficit irrigation reduced weeds density and enhanced wheat yield under the semi arid environment of Khyber Pakhtunkhwa.

Key words: Sowing methods, irrigation levels, mulches, weed density, weeds.

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INTRODUCTION

Pakistan is an agriculture-based country having a population about 18 millions, majority of whome is facing water scarcity. Availability of fresh water for irrigation is decreasing due to increase in population growth, inefficient irrigation system and low water productivity. Water scarcity and untimely availability is creating a serious competition between agriculture and other water use that ultimately will lead to severe drought condition. In present water scare situation without practicing deficit irrigation which aims at high water productivity, we will not be able to meet the food and fiber demands of coming generation. Wheat (*Triticum aestivum* L.) is a major source of food all over the world. It is the staple food of Pakistan and provides the major dietary requirements grown on an area of 9.06 millions hectares annually with an average production of 2700 kg ha^{-1} (GOP, 2013). Beside water scarcity, weed infestation, poor sowing methods, high temperature in arid and semi-arid areas are the major reasons for low wheat productivity.

In water scarce areas, water conservation practices are found to be very practical and effective. The conservation technologies includes raised bed planting, surface and subsurface drip irrigation, sprinkler irrigation and laser land leveling of fields. Against the background of the rapid decline in irrigation water potential and low water use efficiency in the flood (conventional) method of irrigation, raised bed system has been introduced in many developing countries of the world. Besides saving large amount of water, it also helps to increase the productivity of crops. Raised-bed planting of wheat is useful in areas where ground water level is retreating and herbicide-resistant weeds are creating a serious problem (Akber *et al.,* 2009).

In arid and semi-arid areas evaporation rate is high, due to which crops need more water to survive and face stress conditions. In order to reduce evaporation, adding a cover to the soil will positively affect the factors that determine evaporation. The use of permanent beds with retention of crop residues as a mulch on the soil surface is helpful in preventing weed seed germination and growth as well as conserving soil moisture. It also helps to improve soil fertility on decomposition. The research findings of the study are expected to be useful for wheat farmers, water users and planners to make economical and efficient use of available irrigation by adopting raised beds and mulching with less weed infestation which compete for water, light and nutrients.

MATERIALS AND METHODS

The experiments were conducted at Research Farm of The University of Agriculture Peshawar, Khyber Pakhtunkhwa located at

34.02°N and 71.46°E. The experiments were conducted during wheat crop growing season (November- April) of 2011-12 and 2012-13. A Randomized Complete Block Design (RCBD) with split-split plot arrangement having four replications was used. The experiment having three factors Sowing Methods**:** Flat bed (FB) and Raised bed (RB). The width of the raised bed was kept 125 cm from furrow to furrow and its top width was 80 cm while it was 25 cm high from ground level. Factor B. Mulching**:** Mulch (M1) and No-Mulch (Mo). Maize stover was used as mulch at 4 t ha^{-1} and Irrigation**:** i) Full irrigation (DIo), ii) 20% deficit (DI_{20}) iii) 40% of deficit (DI_{40}) iv) 60% deficit (DI_{60}).

For irrigation water, from warsak gravity canal was used and the flow rate was measured by a cutthroat flume ($3^{/}\times 4^{//}$) installed at the inlet of the experimental plots. To apply the measured quantity of irrigation water, each plot was irrigated separately. Full irrigation was determined on the basis of MAD 50% (Mahmood and Ahmad, 2005). Soil moisture was continuously monitored at a weekly interval with the help of Gravimetric method. When the soil of the experimental field reached field capacity, wheat variety Seran 2010 was sown with a seed rate of120 kg ha^{-1}. In the raised beds, it was sown with the help of raised bed machinery while in flat beds it was sown with the help of seed drill. The recommended rate of NPK (120-90-60 kg ha^{-1}) was applied to all plots through broadcasting. Full P and K and half N were applied before sowing and the remaining half of N was applied with the second irrigation.

The data on overall weeds m^{-2} as well as individual weed m^{-2} were recorded by throwing one square meter quadrate in the center of the each subplot and the weeds fallen under the quadrate was uprooted, identified and separated. Data regarding number of grains per spike, 1000-grain weight, grain yield and harvest index was recorded accordingly.

Harvest index data were calculated by using the following formula;

$$\text{Harvest Index} = \frac{\text{Economic yield (grain)} \times 100}{\text{Biological yield}}$$

Statistical analysis

The data recorded were analyzed statistically analysis of variance techniques appropriate for a randomized complete block design. Means were compared using the LSD test at 0.05 level of probability, when the F-values were significant (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weed flora and weed density m^{-2}

Data on overall weed density as well as the density of individual weeds m^{-2} are given in Tabl 1 and Table 2. The statistical analysis of the data indicated that sowing methods had considerable influenced on the density of all weeds except *C. arvensis* and *A. visnaga*. Over all weed density and all individual weed density except *P. minor* were significantly influenced by mulching practice. Similarly irrigation levels significantly affected total weed density and individual weed density except *F. indica*, *E. helioscopa* and *A. arvensis*. In sowing methods, higher number of weeds m^{-2} was recorded in flat bed as compared to raise bed. Raised beds efficiently utilized all inputs and helped maintain better soil moisture and nutrients availability for better yield. In raised beds wheat plants rows are closely placed as compared to flat bed which helps to minimize weed density. These results are in agreement with Aggarwal and Gosawami (2003) who reported lower weed density in raised beds than flat bed. Lower weeds m^{-2} was noted in plots covered with maize stover mulch in comparison with no mulch plots that produce higher number of weed of all the observed species. Reason might be that mulching trap sun light that exhibit germination of weed species.Crop residues may selectively provide weed suppression through their physical presence on the soil surface. These lines are in agreement with Jodaugien and Pupalien (2005) who reported reduced weed germination in mulch. Ahmed and Minhas (2007) also reported that the mulch reduced weed biomass about 17%. Din *et al.* (2013) also supported our results. Similarly, higher number of weeds of *R. crispus, C. arvensis* and *A. visnaga* were noted in plots that received 100% irrigation followed by 80% irrigated plots while lower weed m^{-2}were recorded in plots that received 40% irrigation. Available moisture is the most important resource for competition among weeds and plants. The probable reason might be the plenty of water , nutrients availability to weed species. These results are in line with Ihtram *et al.* (2013) and Mirbahar *et al.* (2009) who reported that deficit irrigation inhabits weeds seed germination which and leads to reduced weeds density.

Yield and yield components

Statistical analysis of data exhibited that sowing methods, mulch and deficit irrigation levels had a significant effect on number of grains spike^{-1}, thousand grain weight, grain yield and harvest index (Table-3). None of the interaction was found significant. Raised bed produced more grains spike^{-1} heavier grains, higher grain yield and harvest index than flat bed sowing. The reason could be that the raised beds provides better conditions for seed germination, promotes nutrients availability for its uptake, provide proper sunlight penetration and increase water use efficiency (Mollah *et al*., 2009 and Meisner *et al.,* 2005). These results are in agreement with Shah *et al*. (2013) who reported higher grain yield and its component under raised beds.

The use of surface mulch resulted in higher grains spike^{-1}, 1000-grain weight, grain yield and harvest index as compared to no-mulch plots. Crop residues as surface mulch increase the quantity of soil organic matter on decomposition that increases plant nutrient availability, which favors better plant growth and development (Fakher *et al.,* 2012). Mulch plots produced 6.4% higher grain yield over no-mulch plots . Another reason for increase in grain yield might be the reduced weeds density in mulch plots (Sing *et al*., 2012). These results are in agreement with (Bakht *et al*., 2009) who reported that the maize stover has higher nutrient contents with about 6% of crude protein which initially save water by reducing evaporation from crop field and on decomposition it increases soil fertility and results in better crop yield.

Application of full irrigation had higher number of grains spike^{-1}, 1000-grain weight, grain yield and harvest index as compared to 60% deficit irrigation. The grains per spike is more sensitive to water stress and decrease in soil water potential increase total soil water potential, which may reduce photosynthesis and plant growth (Dencic *et al.*, 2000). These results are in agreement with Maqsood *et al.* (2007) who concluded that the number of wheat grains per spike were more water sensitive.

The grain yield was significantly affected by deficit irrigation levels. Higher wheat grain yield was recorded under full irrigation. Deficit irrigation of 20% did not significantly reduced grain yield of wheat. In contrast, a deficit of 40% and 60% irrigation reduced 9.4 % and 20.8% wheat yield, respectivly. The increase in wheat yield might be due to increase in grains spike^{-1}, heavier 1000 grains weight, and due to the less dynamic fluctuation of soil water (Zhongming *et al*., 2005; Akbar *et al*., 2009; Kilic *et al*., 2010). Increase in irrigation level resulted in better grain yield because of improved crop growth and interception of more photosynthetic radiation over non irrigated plants. Another reason for lower grain yield under stress conditions might be strong matric potential. Actually plants serve more energy to take water from low moist soils, means higher metric potential (Waraich *et al*., 2010).

CONCLUSION

It is concluded from the study that use of wheat straw as mulch material and sowing of wheat on raised bed reduced weed density and enhanced wheat yield as compared to no mulch and the traditional sowing of wheat on flat bed in agro-ecological condition of

Peshawar. The deficit irrigation up to 20% reduced the weed density however on the other hand, the yield of wheat was lower behind 20% deficit irrigation compared to the full irrigation thus the deficit irrigation (40%) under plenty water cannot be the implied as weed management option due to the lower yield obtained.

Table-1. Effect of sowing methods, mulching and deficit irrigation on the densities of *C. arvensis*, *A. visnaga*, *F. indica* and *R. crispus* in wheat field

Treatments		*C. arvensis*	*A. visnaga*	*F. indica*	*R. crispus*
Sowing method (SM)	Raised Bed	4.4	8.5	4.7	4.5
	Flat Bed	5.5	9.3	7.1	5.6
	Significance	ns	ns	**	*
Mulch (M)	No-mulch	5.7	9.7	7.2	6.3
	Mulch	4.2	8.0	4.6	3.8
	Significance	**	**	**	*
Irrigation (DI)	DIo	6.0 a	9.4 a	6.5	5.7 a
	DI_{20}	5.0 a	9.8 a	6.6	5.5 a
	DI_{40}	4.6 b	8.0 b	5.3	4.6 b
	DI_{60}	4.1 b	8.3 b	5.1	4.4 b
	$Lsd_{0.05}$	1.32	0.96	ns	0.47
Interactions	SM x M	ns	ns	ns	Ns
	DI x SM	ns	ns	ns	Ns
	DI x M	ns	ns	ns	Ns
	DI x SM x M	ns	ns	ns	Ns

*Significant at 5% probability level. **Significant at 1 % probability level
Means followed by different letters in each category are significantly different at α=0.05

Table-2. Effect of sowing methods, mulching and deficit irrigation on the densities of *P. minor, E. helioscopia, A. arvensis* in wheat field

	Treatments	*P. minor*	*E. helioscopa*	A. arvensis	Weeds m^{-2}
Sowing method (SM)	Raised Bed	7.1	5.3	6.8	41.2
	Flat Bed	7.8	7.0	8.5	50.7
	Significance	*	*	**	**
Mulch (M)	No-mulch	7.9	7.2	9.0	52.9
	Mulch	7.0	5.1	6.3	39.0
	Significance	ns	**	**	**
Irrigation (DI)	DIo	7.8 b	6.1	8.0	49.5 a
	DI_{20}	8.0 a	6.5	7.8	49.1 a
	DI_{40}	7.2 c	6.1	7.5	43.3 b
	DI_{60}	6.9 d	5.9	7.2	41.9 b
	$Lsd_{0.05}$	0.41	ns	Ns	2.77
Interactions	SM x M	ns	ns	Ns	Ns
	DI x SM	ns	ns	Ns	Ns
	DI x M	ns	ns	Ns	Ns
	DI x SM x M	ns	ns	Ns	Ns

* Significant at 5 % probability level. **Significant at 1 % probability level
Means followed by different letters in each category are significantly different at α=0.05

Table-3. Effect of sowing methods, mulching and deficit irrigation on yield and yield components of wheat during 2011-12.

	Treatments	Grains spike^{-1}	1000-grain weight (g)	Grain yield (kg ha^{-1})	Harvest index (%)
Sowing method (SM)	Raised Bed	43.16	42.13	5.13	42.72
	Flat Bed	41.69	40.53	4.45	40.35
	Significance	ns	*	**	*
Mulch (M)	No-mulch	41.17	40.25	4.63	41.65
	Mulch	43.68	42.41	4.94	41.42
	Significance	**	*	*	ns
Irrigation (DI)	DIo	44.7 a	44.12 a	5.20 a	43.61
	DI_{20}	43.9 a	43.03 a	5.10 a	41.73
	DI_{40}	41.3 b	39.98 b	4.73 b	41.29
	DI_{60}	39.8 c	38.19 b	4.13 b	39.52
	LSD	1.79	2.40	0.26	ns
Interactions	SM x M	ns	ns	ns	ns
	DI x SM	ns	ns	ns	ns
	DI x M	ns	ns	ns	ns
	DI x SM xM	ns	ns	ns	ns

*Significant at 5% probability level, **Significant at 1% probability level, ns- non significant
Means followed by different letters in each category are significantly different at α=0.05

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