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Department of Weed Science
NWFP Agricultural University, Peshawar-25130, Pakistan
Ph.92-91-9216542/9218206/5842589; Fax: 92-91-9216520
website:www.wssp.org.pk/

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WEED SUPPRESSION BY HIGHER SEEDING RATE AND ROW SPACING OF WHEAT

Muhammad Azim Khan[1], Shafaq Ahsan[1], Farhatullah[2], Gul Hassan[1] and Anwar Nawaz Khan[1]

ABSTRACT

An experiment was conducted at Agricultural Research Farm, NWFP Agricultural University Peshawar during Rabi 2006-07 to study the effect of seeding rate and row spacing of wheat on weeds and grain yield. The experiment was laid out in Randomized Complete Block design with split plot arrangement, having three replications. Wheat seed rates (100, 120 and 140 kg ha^{-1}) were assigned to main plots while row spacing 20, 24, 30 and 40 cm were assigned to sub plots. Results indicated that closer row spacings were more effective in decreasing the weed density while higher seeding rates did not affect the weed density. It is concluded from the data obtained that weeds and yield related parameters of wheat were affected by seed rates as well as by row spacings. Findings also suggested that higher seed rate (140 kg ha^{-1}) of wheat and closer row spacing (24 cm) can be used effectively to suppress the weeds. This cultural control method should be incorporated in integrated weed management packages.

Key words: Wheat, weeds, seed rate, row spacing, grain yield

INTRODUCTION

Wheat *(Triticum aestivum* L.) is the foremost among cereals and indeed among all crops, as direct source of food for human beings. In Pakistan, it ranks first among the cereal crops and occupies about 66% of annual food crop area. It is the cheapest source of food for great deal of population of the world, and supplies 73 % of the calories and protein in the average diet (Heyne, 1987). Wheat being a staple food is a popular and widely cultivated crop in Pakistan. Therefore increasing per unit production is the only answer to feed this highly populated country.

Human beings practically attain all their food directly or indirectly from plants. Cereal crops belong to Gramineae (Poaceae) family and produce edible grains which provide about one-half of man's food calories and a major portion of his nutrient requirements. Thus the focus of the researchers' is to increase the per unit area production. The increased yield is achieved largely by adopting

[1] Department of Weed Science, NWFP Agricultural University Peshawar, ahmadzaipk@yahoo.com
[2] Department of Plant Breeding and Genetics, NWFP Agricultural University Peshawar, Pakistan

advanced cultural practices like using certified seed of improved varieties, optimum seed rate, timely sowing, proper irrigation, proper and timely use of herbicides, insecticides and fertilizer etc. Narrow spacing may be one of the possible ways of suppressing weeds as the soil surface is quickly covered and consequently leaving a meager chance for weed growth. Narrow row spacing also has the higher leaf photosynthesis and suppresses weed growth compared with wider row spacing (Dwyer *et al.* 1991). It helps in maximizing light interception, penetration and distribution in crop canopy. Weeds are the most serious pest reducing the growth and yield of wheat in addition to several other factors. Khan and Hassan (2002) reported that *Avena fatua, Phalaris minor, Poa annua, Cirsium arvense, Convolvulus arvensis, Ammi visnaga, Chenopodium album, Fumaria indica, Anagallis arvensis, Carthamus oxyacantha, Cynodon dactylon,* and *Euphorbia helioscopia* are the major and competitive weeds in wheat fields of NWFP, Pakistan.

Weed control is the basic requirement and the major component of crop management in the production system (Young *et al.* 1996). Weeds cause one of the biggest problems in agriculture. They use the soil fertility, available moisture, nutrients and compete for space and sunlight with crop plants, which result in yield reduction. Weeds deteriorate the quality of farm produce and consequently reduce the market value (Pervaiz and Qazi 1992). Weeds being the unwanted plants grow in wheat fields and considerably decrease the grain yield. All available weed control methods are tested to suppress the weeds; however, proper row spacing is one of the most important factors affecting the growth of crop and weeds in early stages of the crop development. Wilson *et al.* (1995) showed that an increased seeding rate of barley reduced the initial growth of wild oats seedlings. Blue e*t al*. (1990) and Nazir *et al*. (1987) reported that 100 kg was the most effective in producing taller wheat plants and higher wheat grain yield as compared to low seeding rate. In similar studies, Otteson e*t al.* (2008) concluded that seed rate had the largest impact on tiller numbers without negatively influencing yield. Wheat accumulated greater biomass at a faster rate under the 15-cm row spacing than the 30-cm row spacing (Chen e*t el.* 2008).

Weed infestation is a serious problem in wheat crop. Uncontrolled weeds can reduce wheat yield by 25-30% in Pakistan (Nayyar *et al.* 1994) or even higher depending upon weed infestation. Weeds affect the growth of the desired crops species due to the competition, allelopathy and by providing habitat for other harmful organism. The major losses in wheat yield at the national level due to weed infestation amount to a grain loss of 1.25-2.5 million tons per year (Ahmed *et al.* 1984). Annual losses in wheat amount to more than 28 billions at the national level and 2 billions in NWFP (Hassan and Marwat, 2001).

Keeping in view the importance of weeds and huge losses in agricultural crop and especially in wheat an experiment was conducted to investigate the impact of seeding rate and row spacing on weeds and grain yield of wheat.

MATERIALS AND METHODS

Field experiment was conducted in order to study the effect of seed rate and row spacing on weeds and yield components of wheat. The study was conducted at Agricultural Research Farm, NWFP Agricultural University Peshawar, during November 2006. Randomized Complete Block (RCB) design with split plot arrangement was used in the experiment with sub plot size of 5 x 1.5 m^2. Seed rates of 100, 120 and l40 kg ha^{-1} of wheat were assigned to main plots and row spacing i.e. 20, 24, 30 and 40 cm were assigned to sub plots. There were three replications. Variety of wheat "Inqilab 91" was used in the experiment. Sowing was done by hand hoe. Recommended dose of fertilizer (NP=135:50) was used and irrigation was done as per requirement.

Data were recorded on weed density m^{-2} at 30 and 60 days after sowing (DAS), fresh weed biomass (m^{-2}) at 100 days after sowing, leaf area $tiller^{-1}$ (cm^2), 1000-grain weight (g) and grain yield of wheat (Kg ha^{-1}).

The data collected was statistically analyzed using MSTATC software program. The purpose of ANOVA was to determine the significant effect of treatments on weeds and wheat. The LSD test at 5% probability level was applied when ANOVA showed significant differences between treatments (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weed Density (m^{-2}) at 30 days after sowing (DAS)

Statistical analysis of the data showed that seeding rate of wheat had non-significant effect while row spacing and their interaction had a significant ($P<0.05$) effect on weed density m^{-2} at 30 days after sowing (Table-1). Data exhibited that maximum weed density (5.78 m^{-2}) was recorded in 40 cm row spacing and minimum weed density (3 m^{-2}) was recorded in 20 cm row spacing. Among seed rates, maximum weed density (5.25 m^{-2}) was recorded in 120 kg ha^{-1} and minimum weed density (3.67 m^{-2}) was observed in 140 kg ha^{-1}. Among interaction between seed rate and row spacing, the highest weed density (7 m^{-2}) was observed in seed rate of 120 kg ha^{-1} with 30 cm row spacing and lowest (2.33) value was recorded in 140 kg ha^{-1} with 20 cm row spacing. Overall data indicated that with the increasing seed rate, the weed density (m^{-2}) at 30 days after sowing decreased. In a similar way, with the increasing row spacing, the density increased. The present results revealed that higher seed rate and closer row spacing can suppress weeds. Our results were in line with those reported by Rasmussen (2004) who reported that with the decreasing row spacing the weed density was decreased. Seeding rate of 100 kg ha^{-1} with row spacing of 30 cm is common in our country therefore the farmers should be educated to make the crop more competitive against the weeds. As herbicides are extensively used in wheat crop in our country, therefore, there is a possibility to use lower herbicide dose in combination with the higher seeding rate and closer row spacing.

Weed Density (m^{-2}) at 60 days after sowing

Data in the Table-2 showed that seed rate had non-significant while row spacing and their interaction had significant effect on the weed density m^{-2} at 60 days after sowing. Among row spacing, maximum weed density (30.44 m^{-2}) was recorded in 30 cm row spacing and minimum weed density (18.11 m^{-2}) was recorded in 24 cm row spacing. Means of the seeding rate indicated that highest weed density (28.29 m^{-2}) was observed in 140 kg ha^{-1} and lowest (22.25) was observed in 120 kg ha^{-1}. However, the values were statistically at par with each other. Among interaction between seed rates and row spacing, maximum weed density (36.33 m^{-2}) was recorded in seed rate of 140 kg ha^{-1} with 30 cm row spacing and lower weed density (15.00 m^{-2}) was recorded in 120 kg $ha-^{1}$ with 24 cm row spacing. Similar results were reported by Rasmussen (2004). He reported that with the decreasing row spacing the weed density decreased. These results showed that the weeds were suppressed by the increasing seed rate of wheat and decreasing row spacing. Higher seeding rate and closer row spacing not only cover the soil but also prevent the sunlight reach the underneath weeds. Thus wheat seedlings prevent the sunlight to reach the weeds and thus weeds become weaker due to lack of photosynthesis. Light plays an important role in yield of crop, solar radiation is an essential determinant of crop yield in many ways (Ballare and Casal 2000).

Table-1. Effect of seed rates and row spacing on weed density at 30 days after sowing.

Row spacing	Seed rates (kg ha^{-1})			Means
	100	120	140	
40 cm	6.00 e	6.00 de	5.33 cde	5.78a
30 cm	5.67 cde	7.00 de	3.33 cde	5.33a
24 cm	3.33 bed	4.33 ab	3.67 a	3.78b
20 cm	3.00abc	3.67 ab	2.33 cde	3.00b
Mean	4.50	5.25	3.67	

LSD 0.05 for row spacing = 0.9809
LSD 0.05 for interaction = 0.8495

Table-2. Effect of seed rate and row spacing on weed density at 60 days after sowing.

Row spacing	Seed rates (Kg ha^{-1})			Means
	100	**120**	**140**	
40 cm	24.33 be	26.67 b	35.33 a	28.78a
30 cm	27.33 b	27.67 b	36.33 a	30.44a
24cm	17.67ef	15.00 f	21.67 d	18.1 lb
20cm	2 1.00 cde	19.67 de	22.33 cd	21. 0b
Mean	22.58 b	22.25 b	28.92 b	

LSD 0. 05 for seed rate = 6.823
LSD 0.05 for row spacing = 4.345
LSD 0.05 for interaction = 3.770

Fresh weed biomass (g m^{-2}) at 100 days after sowing

Statistical analysis of the data showed that seed rates had non-significant effect while row spacing and their interaction had a significant effect on fresh weed biomass at 100 days after sowing (Table-3). Means of row spacing exhibited that maximum fresh weed biomass (743.29 g m^{-2}) was recorded in 40 cm row spacing and minimum fresh weed biomass (585.43 g m^{-2}) was recorded in closer row spacing (20 cm). Among seed rates, maximum fresh weed biomass (670.83 g m^{-2}) was recorded in 120 kg ha^{-1} and minimum fresh weed biomass (651.45 g m^{-2}) was observed in 140 kg ha^{-1}. The means of the seeding rate were statistically at par with each other. Interaction between seed rate and row spacing showed that the highest (779.37g m^{-2}) was observed in seed rate of 120 kg ha^{-1} with 40 cm row spacing and lowest (543.60 g m^{-2}) was recorded in 140 kg ha^{-1} with 20 cm row spacing. Similar results were reported by Jena and Behera (1998). They reported that weed density and biomass at harvest were higher with wider row spacing, lower wheat sowing rate and higher fertilizer rates. Similar results were also reported by Malik *et al.* (1993). They reported that decreased row spacing resulted in only a modest reduction in weed biomass and weed losses. They claimed that the sowing of crops in narrow row spacing would result in the most efficient exploitation of space by crop plants and in the least amount of space available for weed growth. Like the weed density, the weeds fresh biomass was also decreased significantly by row spacing and non-significantly by seed rate. This may be due to the fact that at lower seed rate, the tillers compensated. Similarly Shinggu *et al.* (2009) in their result showed that both spacing and seed rates had the ability of suppressing weeds. Higher seed rate and narrow spacing had strong and negative effects on weed biomass and positive effects on crop biomass and yield.

Leaf area tiller^{-1} (cm^2)

Data presented in Table-4 showed that row spacing had non-significant effect while seed rate and their interaction had significant ($P<0.05$) effect on leaf area tiller^{-1}. Means of the data exhibited that maximum leaf area (36.78 cm^2) was recorded in 40 cm row spacing and minimum leaf area tiller^{-1} (33.1 cm^2) was recorded in 20 cm row spacing. However, all the values were statistically at par with each. Among means of seeding rate, it was noted that maximum leaf area (38.25 cm^2) was recorded in 120 kg ha^{-1} and minimum leaf area (29.92 cm^2) was observed in 100 kg ha^{-1}. Among interaction between seed rate and row spacing, the highest leaf area (40.00 cm^2) was observed in seed rate of 120 kg ha^{-1} with 40 cm row spacing and lowest (26.667) value was recorded in 100 kg ha^{-1} with 24 cm row spacing. Similar results were reported by Monsi *et al*. (1973). They reported that the crop's spatial distribution does not affect its total leaf area index (LAI), rows will result in much more spatial variation in the distribution of this LAI than a uniform distribution of the crop. As leaf area plays a vital role in manufacturing of photosynthetic materials therefore higher leaf area can greatly affect the overall crop production.

Table-3. Effect of seed rates and row spacing on weeds fresh weight (g m^{-2}) at 100 days after sowing

Row spacing	Seed rates (kg ha^{-1})			Means
	100	**120**	**140**	
40 cm	730.27 ab	779.37 a	720.23 ab	743.29a
30 cm	689.67 be	715.23 b	724.33 ab	709.74a
24 cm	634.80 cd	573.97 ef	617.63 de	608. 80b
20 cm	597.93def	614.77 de	543.60 f	585.43b
Means	663. 17	670.83	65 1.45	

LSD 0.05 for row spacing=69.25
LSD0.05 for interaction=59.97

Table-4. Effect of seed rates and row spacing on leaf area (cm^2) tiller^{-1}

Row spacing	Seed rates (kg ha^{-1})			Means
	100	**120**	**140**	
40 cm	35.00abcd	40.00 f	35.33 a	36.78
30 cm	30.00 cd	38.67 ef	34.67 abc	34.44
24 cm	26.667abcde	39.67 f	38.67 ab	35.00
20cm	28.00 de	34.67 f	36.67bcde	33.10
Mean	29.92 b	38.25 a	36.33 a	

LSD 0.05 for seed rate =1.949
LSD0.05 for interaction= 5.058

1000 grain weight (g)

Statistical analysis of the data shows that seed rate and row spacing had non-significant effect while their interaction had a significant effect on 1000 grain weight (Table-5). Data exhibited that maximum heavier 1000-grain (39.82 g) was recorded in 30 cm row spacing however, all other values were statistically at par with each other. Similarly, mean values recorded for the seeding rates were also statistically at par with each other. Interaction showed that the heavier 1000 grain weight (40.00 g) was observed in seed rate of 100 and 120 kg ha^{-1} with 30 cm row spacing and lowest (38.00 g) was recorded in 120 kg ha^{-1} with 20 cm row spacing. These findings were in agreement with the work of Shaukat *et al.* (1999) who reported that row geometry has significant effects on 1000 grain weight. While in similar studies, Husrev *at al.* (2005) showed that wheat grain yield increased with seeding rate. Overall data indicated that seed rate of wheat was not important in term of physiological and yield related traits of wheat. Marwat and Khan (2007) reported that higher seeding rate is recommended to suppress the weeds and getting higher grain yield.

Table-5. Effect of seed rate and row spacing on 1000 grain-weight (g)

	Seed rates (kg ha^{-1})			
Row spacing	**100**	**120**	**140**	**Means**
40cm	38.28 ab	39.27 ab	39.83 ab	39.13
30 cm	40.00 ab	40.00 ab	39.47 ab	39.82
24 cm	38.67 ab	38.47ab	38.20 b	38.44
20 cm	41.33 a	38.00 b	38.63 ab	39.32
Mean	39.57	38.93	39.03	

$LSD_{0.05}$ for interaction=3.064

Grain yield of wheat (kg ha^{-1})

Statistical analysis of the data showed that seed rate and row spacing had non-significant effect on the grain yield while their interaction was significant ($P<0.05$). Means data presented in Table-6 exhibited that maximum grain yield (3637.89 kg ha^{-1}) was recorded in 24 cm row spacing and minimum grain yield (3509.00 kg ha^{-1}) was recorded in 20 cm row spacing. Among seed rates, maximum grain yield (3609.75 kg ha^{-1}) of wheat were recorded in 100 kg $ha^{-1}$and minimum grain yield (3562.92 kg ha^{-1}) was observed in 120 kg ha^{-1}. Interaction of seed rate and row spacing showed that highest grain yield (3646.67 kg ha^{-1}) was observed in seed rate of 120 and 140 kg ha^{-1} with 24 cm row spacing and lowest (3456.33) value was recorded in 140 kg ha^{-1} x 20 cm row spacing. Similar results were reported by

Ahmad *et al.* (1999) who reported that seed rate and row spacing interacted to affect biological and grain yield significantly. Similar results were also reported by Christensen (1995) and Lemerle (1996). They reported that when weed pressure is high reduced weed biomass translates directly into yield. By the end of the growing season most of the available resources were consumed, so there was a simple negative linear relationship between yield and weed biomass when weed pressure was high. Similar results were shown by Tompkins *et al*. (1991) reported that increased seed rate and decreased row spacing interacted positively to increase grain yield so optimum seed raet increase as row spacing decreased. Malik *et al.* (2009) observed that delayed sowing decreased grain yield due to decrease in germination count m^{-2}, number of grains $spike^{-1}$ and 1000-grain weight whereas increase in seed rate did not affect grain yield. Overall the experimental results indicated that row spacing of wheat was more important than seeding rate.

Table-6. Effect of seed rate and row spacing on grain yield ($kg\ ha^{-1}$)

Row spacing	Seed rates ($kg\ ha^{-1}$)			Means
	100	**120**	**140**	
40cm	3577.33abc	3533.00abc	3566.33abc	3558.89
30 cm	3638.67ab	3604.00abc	3604.00abc	3615.56
24cm	3620.33abc	3646.67a	3646.67a	3637.89
20cm	3602.67abc	3468.00bc	3456.33c	3509.00
Mean	3609.75	3562.92	3568.33	

LSD0.05 for interaction= 172.8

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