

EFFECT OF DIFFERENT WEED CONTROL PRACTICES AND FERTILIZER LEVELS ON THE WEEDS AND GRAIN YIELD OF WHEAT

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Abstract

A field experiment was conducted to assess the effect of different weed control practices and fertilizer levels on weeds and grain yield of wheat in winter 2002-03 and 2003-04. The experiment comprised of four weed control practices of viz., weedy check, pre-emergence application of pendimethalin, post-emergence application of isoproturon + carfentrazone ethyl and manual weed control (two hoeings) and three fertilizer levels viz., 0+0, 75+50 and 150+100 kg N + P₂O₅ ha⁻¹. Manual hoeing resulted in minimum weed density and dry weight in both the years. The maximum grain yield (5816 and 5071 kg ha⁻¹) was recorded in manual hoeing in 2002-03 and 2003-04 respectively mainly due to more number of fertile tillers, number of grains per spike and 100-grain weight. Weed density 40 days after sowing and weed dry weight increased significantly with each increased fertilizer level. The maximum grain yield was recorded with 150+100 kg N + P₂O₅ ha⁻¹. Manual weed control and application of 150+100 kg N + P₂O₅ ha⁻¹ was found to be the best combination for obtaining higher grain yield of wheat.

Introduction

Wheat is the most important cereal crop because it is the staple food of the people of Pakistan. It was cultivated over an area of 8.22 million hectares in 2004-05. The total production was 19.50 million tones with an average grain yield of 2375 kg ha⁻¹. The average yield is lower than potential yield (Anon., 2005). Among various factors responsible for low yield, weed infestation and nutrient management are of supreme importance. Nitrogen and phosphorus are essential for normal growth and development of plants. Application of phosphorus produces primordia for reproductive stage and enhances root development, thus enable wheat to tolerate drought during period of water shortage (Li *et al.*, 2003). Nitrogen promotes vegetative growth and photosynthetic activity in wheat and increases the water use efficiency of wheat. But our soils are deficient in these nutrients and we have to apply these nutrients in the form of fertilizers. In Pakistan, nitrogen use efficiency is 40-50% and phosphorus use efficiency is 15-20% (Qureshi & Zia, 1998). Among various causes of low nutrient use efficiency, weed crop competition is of supreme importance. The weeds can deprive the crop about 47% nitrogen, 42% phosphorus and 50% potash of their nutrient uptake (Kumar & Singh, 1998). Cultural, mechanical and chemical methods are commonly used for controlling weeds. Chemical weed control is an important alternative. Herbicides have shown to be beneficial and very effective means of controlling weeds in wheat because they are quite effective and efficient (Azad *et al.*, 1997). Herbicide use reduced the N-uptake in wheat (Azad, 1997) and post-emergence application of isoproturon @ 0.94-1.41 kg ha⁻¹ and metoxuron @ 1.40-2.10 kg ha⁻¹ increased the nitrogen uptake in wheat by 38.0, 47.3, 51.1 and 58.1% over control. (Walia *et al.*, 2000). In view of these contrasting reports the present study was conducted to assess the effect of different weed control practices and fertilizer levels on the weeds and grain yield of wheat.

Materials and Methods

A field experiment to assess the effect of four weed control practices and different fertilizer levels on weeds and grain yield of wheat was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan. The experiment comprised four weed control practices viz., weedy check, pendimethalin @ 1031 g a.i. ha^{-1} (Pre-emergence), isoproturon + carfentrazone ethyl @ 750 g a.i. ha^{-1} (Post-emergence) and manual weed control (2 hoeings) and three fertilizer levels of 0 + 0, 75 + 50 and 150 + 100 kg N + $\text{P}_2\text{O}_5 \text{ ha}^{-1}$. The experiment was laid down in a randomized complete block design with split plot arrangement keeping the fertilizer levels in main plots and weed control practices in sub-plot having a net sub plot size of 1.5 x 5.0 m and it was replicated thrice. The most commonly used wheat variety "Inqlab-91" was used as a test crop. The crop was sown manually in 25 cm apart rows with a single row hand drill using a seed rate of 125 kg ha^{-1} on 7th November 2002 and 14th November 2003, respectively. The nitrogen and phosphorus as per treatment were applied in the form of urea and diammonium phosphate (DAP), respectively. All the phosphorus and half of the nitrogen were side-drilled at sowing time and the remaining half of nitrogen was top dressed at tillering with first irrigation. Pendimethalin was sprayed just after sowing before crop emergence while isoproturon + carfentrazone ethyl were sprayed after the first irrigation using a T-jet nozzle fitted knapsack sprayer after calibrating the volume of water. In manual weed control, two hoeings 20 and 40 days after sowing were performed. Data on weed density, weed dry weight, yield components and grain yield of wheat were recorded following standard procedure. The data collected was analyzed statistically using Fisher's analysis of variance technique. The Least Significance Difference (LSD) test at 5% probability level was used to compare the treatments' means following Steel *et al.*, (1997).

Results

Total weed density was significantly affected by different weed control practices (Table 1). In 2002-03 the maximum density (76.76 m^{-2}) was recorded in weedy check (W_1) against the minimum (6.00 m^{-2}) in manual hoeing (W_4) which resulted in 70.67% control over weed check. Fertilizer levels also significantly affected the total weed density. The maximum (29.25 m^{-2}) was recorded at 150 + 100 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ against the minimum (24.00 m^{-2}) in control where no fertilizer was applied in 2002-03. Similar trend was followed in second year. The interaction between weed control practices and fertilizer levels was also significant in both the years. In 2002-03 the maximum weed density (88.00 m^{-2}) was recorded in weedy check at 150 + 100 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ ($W_1 \times F_2$) against the minimum (5.00 m^{-2}) in manual hoeing at 75 + 50 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ ($W_4 \times F_1$). In 2003-04 the maximum density (99.00 m^{-2}) was recorded in weedy check at 150 + 100 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ ($W_1 \times F_2$). The minimum weed density was recorded in manual hoeing at 150 + 100 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ ($W_4 \times F_2$) but was statistically at par with manual hoeing at 75 + 50 kg N and $\text{P}_2\text{O}_5 \text{ ha}^{-1}$ ($W_4 \times F_1$) and manual hoeing without fertilizer application ($W_4 \times F_0$). At each fertilizer level weedy check (W_1) resulted in maximum weed density against the minimum in manual hoeing (W_4) however, both the herbicide treatments (W_2 and W_3) resulted in statistically similar weed density.

The effect of different weed control practices on dry weight of weeds 40 days after sowing was significant (Table 2). All weed control practices produced significantly lower dry weight of weeds and minimum dry weight was recorded in manual hoeing (W₄). The effect of fertilizers on total weight was also significant in both the years. The maximum and minimum was recorded at 150 + 100 kg N and P₂O₅ ha⁻¹ (F₂) and control without fertilizer application (F₀), respectively.

The interaction between weed control practices and fertilizer levels was significant for both the years. In 2002-03 the maximum dry weight (30.64 g m⁻²) was recorded in weedy check at 150 + 100 kg N and P₂O₅ ha⁻¹ (W₁ x F₂) whereas the minimum (0.85 gm⁻²) was recorded in manual hoeing without fertilizer application (W₄ x F₀). The difference between pre-emergence application of pendimethalin (W₂) and post-emergence application of isoproturon + carfentrazone ethyl (W₃) produced statistically similar dry weight at 0 + 0 (F₀) and 75 + 50 kg N and P₂O₅ ha⁻¹ (F₁), however, at 150 + 100 kg N and P₂O₅ ha⁻¹ (F₂) post-emergence application of isoproturon + carfentrazone ethyl (W₃) resulted in higher dry weight than pre-emergence application of pendimethalin (W₂).

The effect of weed control practices on total weed density was significant in both the years (Table 3). In 2002-03 the weedy check (W₁) resulted in significantly maximum weed density at harvest. It was followed by post-emergence application of isoproturon + carfentrazone ethyl (W₂) which gave 66.94% control over weedy check and was statistically at par with pre-emergence application of pendimethalin (W₂). Manual hoeing resulted in significantly minimum weed density (82.42% control over weedy check). In 2003-04 the maximum density was recorded in weedy check (W₁) against the minimum in manual hoeing (W₄) which was statistically at par with both herbicidal treatments. The effect of different fertilizer levels on weed density at harvest was non-significant.

The effect of different weed control practices on total weed dry weight was significant in both the years (Table 2). Significantly maximum dry weight of weeds was recorded in weedy check (W₁) against the significantly minimum in manual hoeing (W₄). The effect of fertilizer levels on total weed dry weight was also significant in both the years. Weed dry weight increased significantly with each increased fertilizer level and the maximum dry weight was recorded with application of 150 + 100 kg N and P₂O₅ ha⁻¹ (F₂). The interaction between weed control practices and fertilizer levels was significant in 2003-04 and was non-significant in 2002-03. The significantly maximum dry weight (287.64 gm⁻²) was recorded in weedy check at 150 + 100 kg N and P₂O₅ ha⁻¹ (W₁ x F₂) against the minimum (43.16 gm⁻²) in manual hoeing with out fertilizer application (W₄ x F₀). The differences between herbicide application treatments (W₂ & W₃) were non-significant at all fertilizer levels. Weedy check resulted in significantly maximum dry weight than all other weed control treatments at all fertilizer levels.

The effect of different weed control practices on number of fertile tillers was non-significant in both the years (Table 3). Different fertilizer levels however, significantly affected the number of fertile tillers. The application of fertilizer resulted in significantly higher number of fertile tillers over control where no fertilizer was applied. The increase in fertilizer level from 75 + 50 kg N + P₂O₅ ha⁻¹ to 150 + 100 kg N + P₂O₅ ha⁻¹ could not reach to level of significance in both the years. The interaction between weed management practices and fertilizer levels was non-significant in both the years.

Effect of different weed control practices on number of grains per spike of wheat was significant in both the years (Table 2). All weed control practices produced significantly higher number of grains over weedy check (W_1) and maximum were produced by manual hoeing (W_4). Number of grains per spike of wheat were affected significantly by different fertilizer levels. The maximum number of grains per spike were recorded in $150 + 100$ kg N and P_2O_5 ha^{-1} (F_2) against minimum in control where no fertilizer was applied (F_0). The interaction between weed control practices and fertilizer levels was also significant in both the years. In 2002-03 the maximum number of grains per spike (56.07) were recorded in manual hoeing at $150 + 100$ kg N and P_2O_5 ha^{-1} ($W_4 \times F_2$) against the minimum (41.77) in weedy check without fertilizer application ($W_1 \times F_0$). Application of pendimethalin and isoproturon + carfentrazone ethyl as pre and post-emergence resulted in statistically similar number at $75 + 50$ and $150 + 100$ kg N and P_2O_5 ha^{-1} but in plots where no fertilizer was applied pre-emergence application (W_2) resulted in significantly higher number of grains per spike than isoproturon + carfentrazone ethyl (W_3). Similarly weedy check resulted in significantly lower number of grains in control (no fertilizer) and $75 + 50$ kg N and P_2O_5 ha^{-1} (F_1). Whereas at $150 + 100$ kg N and P_2O_5 ha^{-1} (F_2) weedy check (W_1) produced significantly higher number of grains than pre-emergence application of pendimethalin (W_2). Similar trend was recorded in 2003-04.

The effect of different weed control practices was significant in both the years (Table 3). In 2002-03 the significantly maximum grain weight (45.17 g) was recorded at manual hoeing (W_4) against the minimum (40.56 g) in weedy check (W_1). Similar trend was observed in second year. Different fertilizer levels also affected the 1000-grain weight significantly. Significantly minimum grain weight was recorded in plots where no fertilizer was applied. Application of fertilizer increased 1000-grain weight significantly with each increase in fertilizer level and $150 + 100$ kg N + P_2O_5 ha^{-1} resulted in maximum grain weight. The interaction between weed control practices and fertilizer levels was non-significant in both the years.

The effect of different weed control practices and fertilizer levels on grain yield of wheat was highly significant in both the years (Table 1). The interaction between weed control practices and fertilizer levels was significant in 2002-03 and non-significant in 2003-04. In 2002-03 the maximum grain yield (7265 kg ha^{-1}) was obtained with manual hoeing at $150 + 100$ kg N + P_2O_5 ha^{-1} ($W_4 \times F_2$) whereas the minimum (3865 kg ha^{-1}) was obtained in weedy check with out fertilizer application ($W_1 \times F_0$). At each fertilizer level all weed control practices produced higher grain yield than weedy check (W_1) and the maximum grain yield was obtained in manual hoeing (W_4). Post emergence application of isoproturon + carfentrazone ethyl produced higher grain yield than pre-emergence application of pendimethalin at all fertilizer levels except at $75 + 50$ kg N + P_2O_5 ha^{-1} where, both these weed control practices resulted in statistically similar grain yield.

Discussion

Decrease in weed density with weed control practices can be attributed to mortality of weed with herbicides application and manual hoeing. The results are in line with Sharma & Chander (1996) and Anil & Bhan (1998) who had reported higher weed density in weedy check. Increase in fertilizer enhanced the availability of nutrients resulting in higher weed population. The results are in line with those of Das & Yaduraju

(1999) and Panwar *et al.*, (2000) who reported significant increase in weed density with increased fertilizer levels. The results are, however, in contrast with those of Toth (1999) who reported decrease in weed density with increased fertilizer level. This contradiction in results can be attributed to difference in fertility status of soil.

Higher weed density and better plant growth had increased the total dry weight of weeds. Application of herbicide and manual hoeing not only reduced the density of weeds but also suppressed the weed growth resulting in lower dry weight. These findings support previous findings of Hooda & Agrawal (1991, 1995) and Das & Yaduraju (1999) who reported maximum dry weight in weedy check. Lower weed dry weight in plots where no fertilizer was applied can be attributed to low fertilizer nutrients. Increase in weed dry weight with increased fertilizer level might be due to more nutrient uptake, better growth and higher density and fresh weight. The results are in line with those of Azad & Singh (1997) and Das & Yaduraju (1999) who had also reported an increase in dry weight with fertilizer application.

A maximum weed density in weedy check can be attributed to unchecked growth, while application of herbicide or hoeing caused mortality of weed resulting in lower weed density at harvest. A maximum weed density in weedy check has also been reported by Hooda & Agrawal (1995) and Khan *et al.*, (2004). Unavailability of nutrients in control and suppression by well developed wheat plants resulted in similar weed density. The results are different from those of Hooda & Agrawal (1995) who reported increase in weed density with fertilizer application.

Higher dry weight of *Chenopodium mural* in weedy check might be due to more density and unsuppressed growth of *C. mural*. The results are in line with those of Hooda & Agrawal (1991, 1995) who had also reported maximum dry weight of weeds in weedy check. Increase in the dry weight with fertilizer application can be attributed to more density of *C. mural* and better growth due to availability of nutrients. Azad & Singh (1997) and Akhtar *et al.*, (2002) had also reported higher dry weight of weeds at higher fertilizer level.

Lower number of fertile tillers in weedy check treatment can be attributed to higher weed density which increased competition for nutrients and other resources. Higher number of fertile tillers could be due to less number of weeds and lower competition which led to favourable environmental conditions and greater availability of essential nutrients resulting in increased fertile tillers. The results are in line with those of Das & Yaduraju (1999) and Anwar *et al.*, (2003) who reported higher number of fertile tillers with herbicide application and manual hoeing. Increase in number of fertile tillers with fertilizer application might have been due to better nutrition which resulted in better plant growth which resulted in more number of fertile tillers. The results are in accordance with those of RonGen *et al.*, (1999). Chaudhry & Mehmood (1998) and Abid *et al.*, (2002) who reported significant increase in number of fertile tillers with increased fertilizer application.

Lower number of grains per spike can be attributed to lower spike length in weedy check treatment. Similar results have also been reported by Das & Yaduraju (1999) and Pandey & Verma (2002). Increase in number of grains per spike can be attributed to availability of nutrients and greater spike length of wheat. The results are in line with those of RonGen *et al.*, (1996) who reported significant increase in number of grains with increased fertilizer level.

The probable reason for higher grain weight in plots where weed control practice was carried out was due to lower weed density which reduced the competition between wheat plants and weeds for nutrients, light, moisture and space relating in maximized utilization of resources by crop plants. Pandey & Verma (2002) have also reported lower 1000-grain weight in weedy check. Availability of nutrients and better plant growth might be the reason for heavier grains in high fertilizer levels. Increase in 1000-grain weight with increased fertilizer application had also been reported by Singh *et al.*, (1998) and Chaudhry & Mehmood (1996).

Lower grain yield in weedy check treatment was mainly due to the lower number of grains per spike, 1000-grain weight and fertile tillers. Significantly lower grain yield in weedy check over chemical and non-chemical weed control had also been reported by Das & Yaduraju (1999). More grain yield with higher fertilizer application was probably due to more nutrients up take by wheat which resulted in better growth and development of crop plants. Thus more number of grains per spike and 1000-grain weight was produced that contributed to higher grain yield. Significantly higher grain yield of wheat due to fertilizer application had also been reported by Singh *et al.*, (1998), Akhtar *et al.*, (2002) and Abid *et al.*, (2002).

Based upon the present studies it can be concluded that manual hoeing gave best weed control (86.09%) and maximum grain yield (5816 kg ha⁻¹). Application of 150 + 100 kg N + P₂O₅ ha⁻¹ resulted in significantly higher grain yield (6776 kg ha⁻¹).

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