Research Article

Weed and Wheat Dynamics Preceding Different Herbicides

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Abstract | Wheat is the main cereal crop and a staple food in Pakistan. It is an important cereal crop of Potohar region. Weeds infestation is a major cause of low wheat yield. Synthetic herbicides are mostly used to control weeds. A field experiment was conducted to investigate the Chemical control of broad-leaved weeds in wheat at the Koont Research Farm, PMAS-Arid Agricultural University, Rawalpindi, during rabbi season, 2014. The experiment was laid out in a randomized complete block design (RCBD) with four replications, with a plot size of 06 x 04 m^2. Four different herbicides were applied as post emergence with three different doses each viz:,Ally max @ 34.58, 46.11 and 23.04 g ha^{-1}, Lihua @ 53.34, 72.4 and 36.23 g ha^{-1}, and Wheat Star @ 370.5, 494 and 247 g ha^{-1} and Buctril super 60% EC @ 741, 988 and 494 ml ha^{-1}. An untreated control and hand weeded plot was also included in the trial. Wheat variety AUR-2009 was sown as a test crop and the herbicide was applied 65 days after sowing. All herbicides were sprayed as post-emergence. The best weed control was accomplished by Wheat star@ 494 gha^{-1} as profoundly lower weed counts m^{-2} (26), and higher percent weed control (27.9%) were noted after 25 days of its spray. Wheat growth parameters like plant height, number of tillers per m^2, spike length and number of spikelets per spike remained statistically at par among various treatments. Significantly higher number of fertile tillers (172), Plant height (93.83 cm), spike length (7.4 cm) were noted with Wheat Star @ 370.5 g ha^{-1}. Although treatments did not differ significantly with respect to wheat grain and biological yields, yet the highest grain yield (3295 kg ha^{-1}) and biological yield (11173 kg ha^{-1}) were produced by Wheat Star @ 370.5 g ha^{-1}. Based on better weed control and wheat yield, Wheat Star @ 370.5 g ha^{-1} and Buctril Super @ 741 ml ha^{-1} are recommended in similar areas where wheat fields are predominantly affected by drought and infested by broad leaved weeds.

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Introduction

Wheat is the leading food grain of Pakistan and being the staple diet of the people and occupies a central position in agricultural policies. Wheat contributes 2.2% to GDP and 10.3% to the value added in agriculture. In 2013-14 area of wheat sowing increased from 8660 to 9039 thousand hectare, which is more than 4.4% over last year. Against the target (FCA) received during 2013-14 which was 25 million tons The production of wheat stood at 25.3 million tons during, which is 1.2% more than the target, compared to last year's production an encouraging growth of 4.4% witnessed over production of 24.2 million tons. The overall increase in area sown is attributed to the attractive market rates and the area was also available due to early maturity of the cotton crop. The production increased due to increase in area cultivated and timely rainfall at regular intervals and favorable weather condition suitable for healthy grain (PES, 2014).

Because of comparable morphology and growth pattern, monocot weeds offer more serious rivalry. There are numerous variables for this decrease, for example, inappropriate seed rate and sowing techniques, late sowing, , lacking plant populace, deficit soils with nutrient and irrigational water unavailable at basic phases of crop yield, weed rivalry bringing about the diminishment in the yield of wheat (Guttieri et al., 2001). Depending on the intensity of weeds reduction in crop yield from 9.5 to 16.05%occur (Jalis and Muhammad, 1980). Commonly weeds represent expensively and limiting factors in crop production, posing threshing and harvesting problems (Noorka et al., 2013). One of the most critical problem is a weed in crops because they contest with crop plants for moisture, light, space and nutrients (Khan et al., 2001).

To achieve the food demand in the world, As compared to other food crops wheat ranks top mostly consumed and grown in almost the whole world (Noorka et al., 2013). Wheat is the leading food grain of Pakistan and being the staple diet of the people and occupies a central position in agricultural policies. Wheat contributes 2.2% to GDP and 10.3% to the value added in agriculture. In 2013-14 area of wheat sowing increased from 8660 to 9039 thousand hectare, which is more than 4.4% over last year. Against the target (FCA) received during 2013-14 which was 25 million tons The production of wheat stood at 25.3 million tons, which is 1.2% more than the target level, reassuring growth of 4.4% observed over production of 24.2 million tons as compared to last year. The overall increment in area sown is credited to the alluring market rates and the zone was additionally accessible because of early ripeness of cotton. Production of wheat increased because of increase in cultivated area and convenient precipitation at regular interims and ideal climate condition appropriate for healthy grains (PES, 2014).

Regardless of the average, the yield of wheat is very low due to the usage of pricey inputs and amended cultural practices. Weeds competition occurs with crop plants for light, air, moisture, space, nutrients and other growth aspects, which decrease yield as well as decay quality of farm production and accordingly decrease its market importance (Qureshi, 1982). There have been reports of crop sensitivity in cereals with some of the herbicides in cereals (Sikkemaet al., 2007). Wheat fields are for the most time pervaded with both monocot and dicot weeds. The major broad leaved weeds are; *Cirsium arvense* (Canada thistle), *Chenopodium album* (common lambs quarters), *Melilotus indica* (Indian sweet clover), *Coronopus didymus* (swine cress), *Fumaria indica* (Fumitory), *Rumex dentatus* (curly dock) and *Convolvulus arvensis* (field bindweed) (Singh et al., 2013). It is true that wheat production may be increased by either increasing the area under wheat crop or maximizing yield per unit area. To increase the area under wheat crop is difficult, because of pressing needs for other agriculture commodities under the existing conditions (Negash et al., 2005).

Weeds are a standout amongst the most significant components which antagonistically influence the yield of the wheat crop. They contend with wheat plants for moisture, light, dampness, light, nutrients and other development necessities. They decrease yields, bring down the nature of the crop and expand the expense of threshing, cleaning and harvesting (Abbas et al., 2009). Weeds represent most costly and limiting factor in crop production, posing harvesting and threshing problem (Noorka and Shahid, 2013). Khalil et al. (1993) revealed that chemical control of weeds is being emphasized in modern agriculture while Khan et al. (1999) stated that in other studies researchers obtained an effective weed control in wheat through chemicals. Herbicides registered in cereals have not changed appreciably in the past 20 years (Ontario, 2013). Post emergence (POST) herbicides such as 2,4- D, MCPA, bromoxynil /MCPA, dicamba / MCPA/ mecoprop, dichlorprop /2,4 -D and thifensulfuron - methyl / tribe nuron- methyl are still being used, either alone or in combination for the control of broadleaved weeds in cereals (Ivany et al., 1990). Keeping in view the above mentioned facts the present study was conducted with an objective to identify herbicides that are more effective in controlling broad-leaved weeds and increasing yield of wheat under moisture deficit conditions as wheat crop faces early season drought for 60-70 days with no or little rainfall after wheat sowing in our agro-ecology.

Materials and Methods

Experimental location

The research study was conducted at University Research Farm Koont, PMAS-Arid Agricultural University, Rawalpindi. The experimental site was in the Pothwar plateau of northern Punjab commonly called as rain-fed potohar region. In summer the mean temperature at the experimental site varies from 36 C° to 42 C° with extremes from time to time as high as 48C° (Nizami et al., 2004).

Experimental design

The experiment was conducted during winter season 2014-15 using Randomized Complete Block Design (RCBD) with four replications. Each experimental plot was consist of sixteen 6 m rows, spaced 22.5 cm apart (4 m and 6 m in dimension).

Experimental procedure

Wheat cultivar "AAUR-2009" was used as test variety for being the latest recommend for rain-fed areas of Pothwar with a seed rate of 120 Kg ha^{-1}. Fertilizer was applied as recommended by the Punjab Agriculture Department for wheat, i.e., NPK @ 90-60-60 kg ha^{-1} in the form of Urea, Di Ammonium Phosphate (DAP) and Potassium sulfate. All the fertilizer was applied as basal dose at the time of wheat sowing with no subsequent application during the crop growth period. Wheat sowing was done using tractor drawn seed-cum fertilizer drill. All other agronomic practices were applied as per standard recommendations. The herbicides were applied at the post-emergence stage to wheat at about 80% weeds emergence using knap sack sprayer equipped with T-Jet nozzle keeping a pressure of 1 bar. The quantity of water for herbicide dilution was 250 liters per hectare to ensure uniform application of the herbicides.

Experimental treatments

Four different herbicides were applied as post emergence with three different doses each viz:, Ally max @ 47.58, 46.11 and 23.04 g ha^{-1}, Lihua @ 53.34, 72.4 and 36.23 g ha^{-1}, and Wheat Star @ 370.5, 494 and 247 g ha^{-1} and Buctril super 60% EC @ 741, 988 and 494 ml ha^{-1}. An untreated control and hand weeded plot was also included in the Table 1.

Experimental soil type

Before sowing of experiments, soil samples were collected from the experimental site and analyzed for physicochemical characteristics. The soil of the experimental field was alkaline in reaction (pH 7.8), low in organic matter (6 g kg^{-1} soil), total N (5 g kg^{-1} soil), AB-DTPA extractable P (7.8 mg P kg^{-1} soil), and high in available K (234 mg K kg^{-1} soil).

Meteorological status of experimental area

The meteorological data was taken from adjacent meteorological station named as Soil and Water Conservation Research Institute, Chakwal (SAWCRI). The meteorological data was including: monthly rainfall Figure 1, mean maximum and minimum air temperatures.

Results and Discussions

Weed density (No. m^{-2})

Species as Lehli (*Convolvulus arvensis L.*), Shahtra (*Fumaria indica L.*), Maina (*Medicago sativa*), Bathu (*Chenopodium album*), Billibooti (*Anagalis arvensis*) and Chatri Dhohdak (*Euphorbia helioscopia*) were the dominant weeds in the experimental area. Statistical analysis revealed significant differences in weed population and biomass reductions among all treatments. Weed density per unit area is an important parameter in finding out the impact of treatments on weed control. The more the weeds the more is the nutrients depletion from the soil and the more is their competition with crop plants. Moreover, the use of herbicides, though discouraged worldwide these days because of environmental and health hazards, is inevitable due to many reasons particularly in terms of economics and the immediate effect. However, the herbicide use should be judicious and properly operated. The data in the experiment regarding weed density m^{-2} of weeds (before and after herbicide application) as shown in (Figure 2) indicated that all the herbicidal treatments convincingly suppressed the growth of the weed.Hand weeding reduced weed density over control by (52) and (96). However, weed density (44 m^{-2} and 45 m^{-2}) at 65 DAS, respectively was achieved in plots where Allay max @ 34.58 g ha^{-1} and Lihua @ 72.4 g ha^{-1} were applied. Whereas, the maximum weed densities (76 m^{-2}) and (71.5 m^{-2}) were recorded in Allay max @ 23.04 g ha-^{1} and Allay max @ 46.11 g ha-^{1} treatments. These results showed that if Allay max was applied at the rate of 23.04 g ha-^{1} is most effective for weed control whereas Lihua @

Table 1: *Detailed list of treatments used in the experiment.*

Sr. No	Treatments/Herbicides Trade Name	Time of Application	Dose of Application
1	Ally max at recommended dose	Post emergence	34.58 g/ha
2	Ally max + 1/3 of recommended	Post emergence	46.11 g/ha
3	Ally max - 1/3 of recommended	Post emergence	23.04 g/ha
4	Lihua at recommended dose	Post emergence	53.34 g/ha
5	Lihua + 1/3 of recommended	Post emergence	72.4 g/ha
6	Lihua - 1/3 of recommended	Post emergence	36.23 g/ha
7	Wheat star at recommended dose	Post emergence	370.5 g/ha
8	Wheat star + 1/3 of recommended	Post emergence	494 g/ha
9	Wheat star - 1/3 of recommended	Post emergence	247 g/ha
10	Buctril super at recommended dose	Post emergence	741 ml/ha
11	Buctril super + 1/3 of recommended	Post emergence	988 ml/ha
12	Buctril super - 1/3 of recommended	Post emergence	494 ml/ha
13	Hand Weeding	65 DAS	
14	Control	-------	------

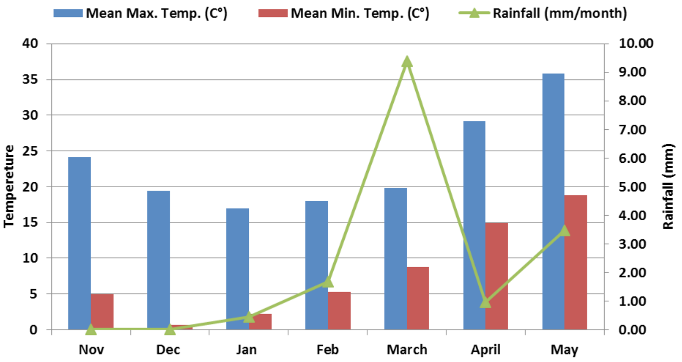

Figure 1: *Meteorological data of experimental site.*
Source: *Soil and Water Conservation Research Institute (SAWCRI) Chakwal.*

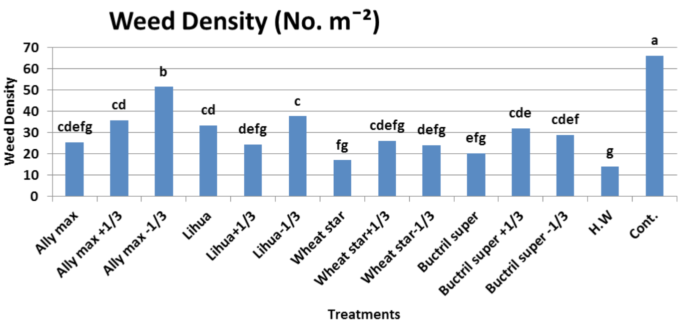

Figure 2: *Effect of different herbicidal treatments on weeds density.*

72.4 g ha^{-1} is less effective. Hand weeding was most effective among all treatments for controlling weeds but this method is labor intensive therefore it is an expensive method and economically not applicable. The results are in line with the findings of Abbas et al. (2008), Khan et al. (2004) and Farooq et al. (2011) who reported a significant decrease in weed density using chemical herbicides.

The dry weight of weeds (gm^{-2})

Data recorded (Figure 3) regarding dry weights weeds at 65 DAS revealed that foliar spray of chemical herbicides significantly reduced fresh and dry weights over the control. However, among the foliar spray treatments of different herbicides, the maximum dry weights (37.5 g) reduction at 65 DAS was observed in Wheat Star @ 494 g ha-^{1} which was followed by Lihua @ 53.34 g ha^{-1} and Buctril super 60% EC @ 494 ml ha^{-1} with dry weight (34 g and 25.25 g). The other foliar treatments were lagging behind with the lowest reduction of dry weights (16.5 g) with Wheat Star application. These decreased dry weights might be because of herbicides were very efficient in suppressing weed biomass compared to weedy check. The results are confirmatory with Abbas et al. (2009), Marwatet al. (2005), Cheema and Akhtar (2005), Arif et al. (2004) and Khan et al. (2004) who observed that herbicides performed better in controlling weeds than weedy check.

Weed control efficiency (%)

Weed control efficiency was suggestively affected by different herbicidal treatments used in this experiment. The density of weed was maximum in control plots. Wheat star @ 370.5 g ha-^{1} showed by lesser weed biomass as well as maximum weed control efficiency among all experimental treatments (Figure 4). Weed control efficiency (WCE) was increased with the increased quantity of herbicide regardless of weed species. In this experiment treatments maximum

(67.65%) weeds were controlled in the plot where Wheat star @ 370.5 g/ha was applied following with Wheat star @ 247 g ha^{-1} and Buctril super 60% EC @ 494 ml ha^{-1} respectively. Sharma and Singh (2012) originate that, a spray of GramoxoneInteon resulted practically fully control efficacy was almost similar as compared to different herbicides. All Gramoxone conduct controlled a maximum of the weeds greater than 80%. On other hand minimum weed control efficiency was recorded as (27.9%) in Wheat Star @ 494 g ha-^{1}in accordance to herbicides. It was evident in the study that the non-selective herbicide Wheat star @ 370.5 g/ha was becoming more operative for controlling broad leaved weed at the inferior amount of that herbicide. Data regarding weed mortality percentage in response to different treatments are given in (Figure 5). The weed free check produces 100% results with respect to controlling broad leaved weeds compared to other treatments. Buctril super 60 % EC @ 988 ml ha^{-1} (72.51%) and Ally max @ 23.04 g ha^{-1} (70.44%) were the next good treatments, respectively. The lowest value was recorded for the weedy check (18.23%) followed by Wheat Star @ 370.5 g ha^{-1} (36.62%) and it may be attributed to weed and crop competition for available resources.

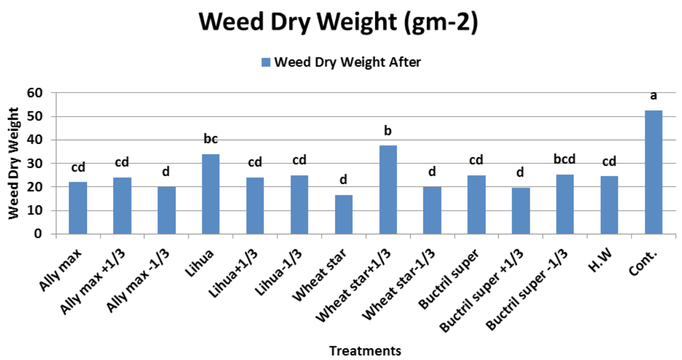

Figure 3: *Effect of different herbicidal treatments on weeds dry weight.*

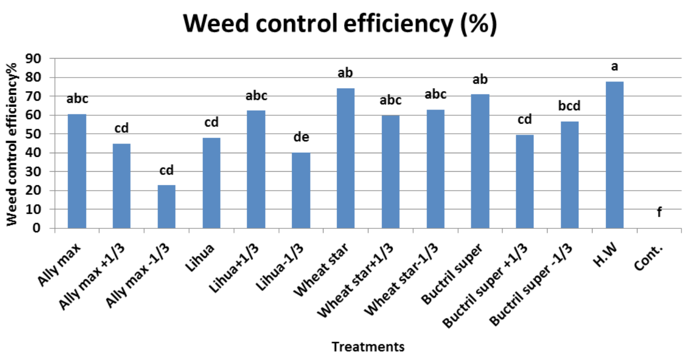

Figure 4: *Effect of different herbicidal treatments on weed control efficiency.*

Weed persistence index

A lower WPI value is essential for effective weed managing. The WPI was deliberate to check the efficiency of any other specific dose of herbicide to eliminate weeds (Figure 6). The maximum value of WPI (0.297) was recorded in Wheat Star @ 494 g ha^{-1} while on other hand minimum value of WPI was founded (0.095) founds in hand weeded plot. These findings are similar to Khaliq et al. (2014) who stated that application of various herbicides resulted in relatively higher WPI than rest of the wheat cultivars. Weed index is an ideal parameter (Figure 7) to describe yield loss caused by weed infestation in comparison with weed free plots (Suria et al., 2011). Application of Wheat Star @ 370.5 g ha^{-1} recorded lowest weed index (-0.7868) than rest of the herbicide treatments. Wheat crop despite its less weed competitive ability and heavy weed infestation showed lower weed index presumably due to lower grain yield in weed free treatment. On other hand maximum weed index (0.3243) was found in Ally max @ 34.58 g ha^{-1} application to plots and was statistically similar (0.1658) to that achieved with Lihua @ 53.34 g ha^{-1}.

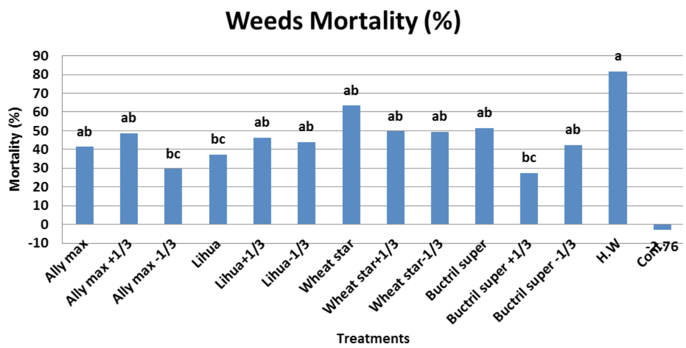

Figure 5: *Effect of different herbicidal treatments on weed mortality.*

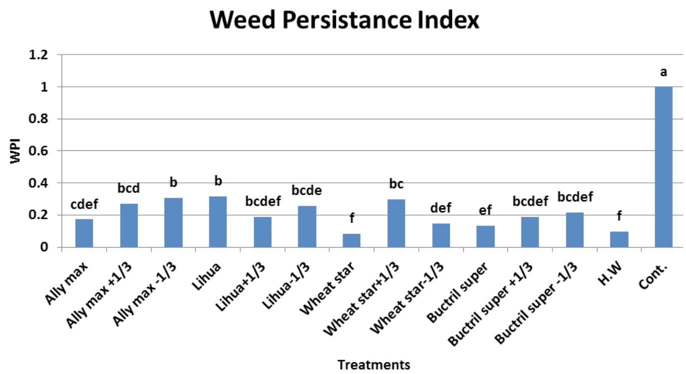

Figure 6: *Effect of different herbicidal treatments on Weed persistence index.*

Wheat dry biomass (kg m^{-2})

Data pertaining to wheat dry biomass at tillering stage was given in (Figure 8) which showed that highest dry wheat biomass (0.24 kg m^{-2}) was recorded in Buctril super 60% EC @ 988 ml ha-^{1} in the line of (0.23 kg m^{-2}) Wheat Star @ 370.5 g ha-^{1} and (0.20 kg m^{-2}) in

Wheat Star @ 247 g ha^{-1}. The minimum value of dry biomass (0.08 kg m^{-2}) was recorded in weedy check control treatment. Similar results were shown in Ally max @ 34.58 g ha^{-1}, Wheat star @ 72.4 g ha^{-1}, Buctril super 60% EC @ 741 ml ha^{-1} and hand weeded treatments. It may be due to mean temperature was quite optimum at all the vegetative growth stages that is why it produced more biomass than any other treatments. The results were alike with those of Marshall (1992) who revealed that average daily temperature significantly affected the biomass accumulation rate.

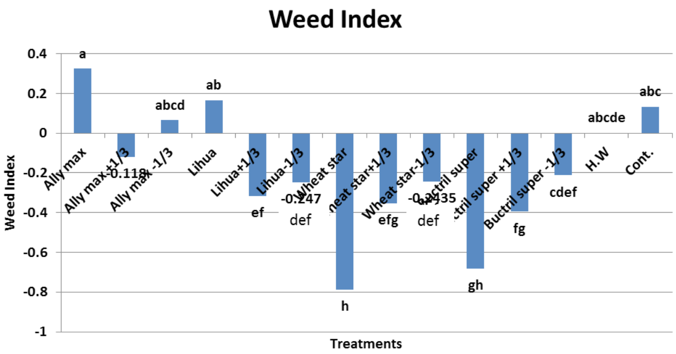

Figure 7: *Effect of different herbicidal treatments on weed index.*

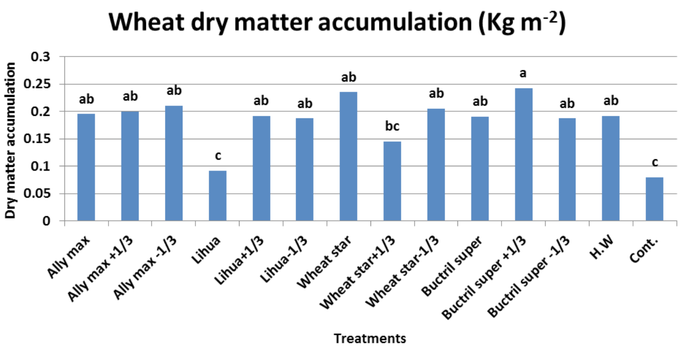

Figure 8: *Effect of different treatments on dry matter accumulation of wheat.*

Wheat crop growth rate (g m^{-2} day^{-1})

Different weed control treatments depicted a positive influence on wheat growth and development. The treated herbicides differed significantly among themselves for crop growth rate at tillering stage (Figure 9). The maximum value of CGR (10.69 g m^{-2} day^{-1}) was recorded in case of Wheat Star @ 370.5 g ha^{-1}. Application of Buctril super 60% EC @ 988 ml ha^{-1} was the second effective treatment in this regard. Crop growth rate was maximum between 75-90 days and showed a sharp decline afterwards. Among herbicide treatments, minimum crop growth rate (4.167 g m^{-2} day^{-1}) was achieved by the application of Wheat Star @ 494 g ha^{-1}. It was closely followed by (4.168 g m^{-2} day^{-1}) by tank mixture of Lihua @ 53.34 g ha-^{1} and (4.165 g $m^{-2}day^{-1}$) in control plot. At the early stage of the crop, CGR was lesser than later phenological stages because low temperature slowed the growth.

Wheat Plant Height (cm)

Plant height, number of tillers and spike length near crop maturity are direct indicators of vegetative growth progress of cereal crops. Plant height is a function of the genetics as well as the environmental conditions which contributes to biomass production of a crop (Figure 10). The maximum plant height (93.82 cm) was noted under the plot treated by Wheat Star @ 370.5 g ha^{-1} which was statistically at par with control (weedy check). Increase in wheat plant height was possibly due to better weed suppression at the proper time in maximum utilization of nutrients and moistures by the crop. Ahmed et al. (1995) also documented similar findings. The maximum reduction in plant height, i.e. (80.39 cm) relative to control was observed when Ally max @ 34.58 g ha^{-1} was applied. This reduced plant height under the treatments of Ally max @ 34.58 g ha^{-1} may be due to crop injury caused by this treatment. Abbas et al. (2009) also reported that herbicides did not cause a significant reduction in plant height of wheat. However, our results are contradictory to those of Cheema and Akhtar (2005), Quimby and Nalewaja (1966) and (Bibi et al., 2008) who noted the significant inhibitory effect of herbicides on plant height m^{-2} of wheat.

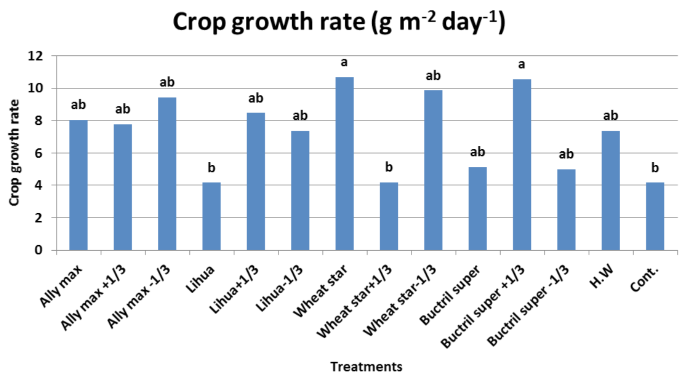

Figure 9: *Effect of different treatments on Crop growth rate of wheat.*

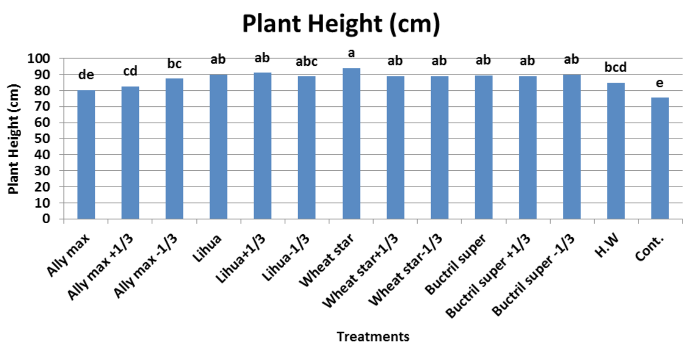

Figure 10: *Effect of different treatments on plant height of wheat.*

Number of fertile tillers of wheat

Comparison of the treatment means showed (Figure 11) that the highest number of fertile tillers (172) were in the plots where Wheat Star @ 370.5 g ha^{-1} was sprayed and (136) in case of Buctril super 60% EC @ 741 ml ha^{-1} applied at 65 DAS. Treatments showing increase in the number of fertile tillers may be due to relatively better weed control which ultimately facilitated relatively more translocation of photosynthates toward reproductive growth due to less weed wheat competition Malik et al. (2009) and Khan et al. (2000) who observed significantly affected fertile tillers m^{-2} by different weed control practices.

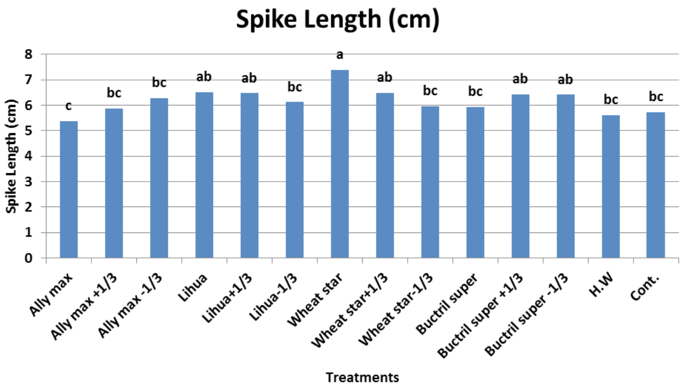

Figure 11: *Effect of different treatments on spike length of wheat.*

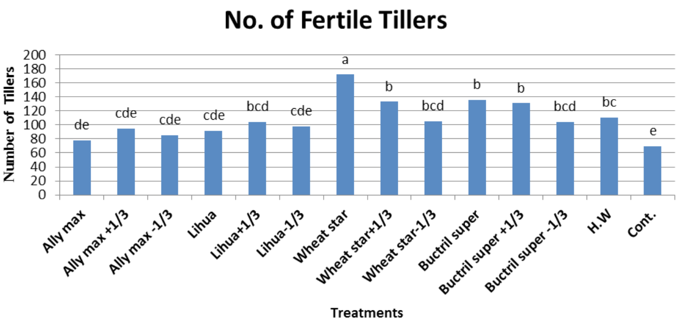

Figure 12: *Effect of different treatments on number of fertile tillers of wheat.*

Spike length of wheat (cm)

Data in (Figure 12) showed that maximum spike length (7.385 cm) was observed with Wheat Star @ 370.5 g ha^{-1} application followed by Lihua @ 53.34 g ha^{-1} (6.50 cm) and Wheat Star @ 494 g ha^{-1} (6.47 cm). Increase in spike length may be attributed to minimum weed-crop competition in treated plots and may be due to more availability of moisture that causes healthy plant growth. The increase in spike length of wheat by weed control methods is well documented by (Ahmad et al., 1989), (Verma and Kumar, 1986) and (Bhan, 1987). Minimum spike length (5.38 cm) was observed in Ally max @ 34.58 g ha^{-1} that was as per with Hand weeded plot (5.60 cm) and in control (5.72 cm), which indicated poor weed control compared to the above mentioned herbicides, as competition for water, light, CO_2, O_2 etc., existed in turn reduced spike length.

Thousand grain weight of wheat (g)

The statistical analysis showed (Figure 13) significant differences among treatments regarding 1000 grain weight. Experimental treatment involving Wheat Star @ 370.5 g ha^{-1} witnessed highest 1000-grain weight (44 g) and were followed by Buctril super 60% EC @ 741 (41.07g) and Buctril super 60% EC @ 988 (38.15 g). As both these herbicides increased grain weight and spike length due to maximum weed controls efficiency. Lihua @ 53.34 g ha^{-1} produced minimum 1000-grain weight (30.22) with respect to Ally max @ 46.11 g ha^{-1} (31.97) and Ally max @ 34.58 g ha^{-1} (32.80). They cause plant injury which produced minimum 1000- grain weight.

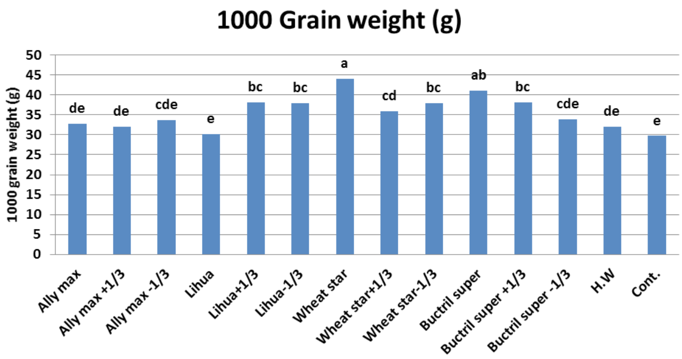

Figure 13: *Effect of different treatments on 1000-grain weight of wheat.*

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

The Maximum biological yield of 11173 kg ha^{-1} was recorded (Figure 14) in Wheat Star @ 370.5 g ha^{-1} followed by (10557 kg ha^{-1}) in Buctril super 60% EC @ 741 ml ha^{-1}. On the other hand the minimum biological yield of 7075 kg ha^{-1} was recorded in Ally max @ 34.58 g ha^{-1}. It may be due to the poor performance of herbicides to control weeds, the effect of environment conditions that favors less germination count per meter square, weed dominance restricted from crop plants from the utilization of natural resources effectively and resulted in lower biological yield as compared to other treatments. Malik et al. (2009), Abbas et al. (2009), Marwat et al. (2008) and Roslon and Fogelfors (2003) also observed that herbicides increased biological yield in wheat.

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

Increase in grain yield in the wheat crop is the most-

Links Researchers

ly required and intended parameter of all agricultural experiments in Pakistan. Among the individually used herbicides, the data from (Figure 15) showed that maximum wheat grain yield (3295 kg ha^{-1}) was observed in Wheat Star @ 370.5 g ha^{-1} followed by (3067.5 kg ha^{-1}) in Buctril super 60% EC @ 741 ml ha-^{1} and (2535 kg ha^{-1}) in Wheat Star @ 494 g ha^{-1}. Higher grain yield in herbicide treated plots may be an outcome of efficient weed control achieved there. The results are also in conformity with the findings of Abbas et al. (2009), Marwat et al. (2005), Tunio et al. (2004) and Hassan et al. (2003) who reiterated the efficacy of herbicide applications having been influential in raising the grain yield of wheat. The negative correlation of wheat yield with weed density and biomass reflects negative implications of weed competition on final yield. Khaliq et al. (2011) and Rinella et al. (2001) reported that wheat negatively correlated with weed growth.

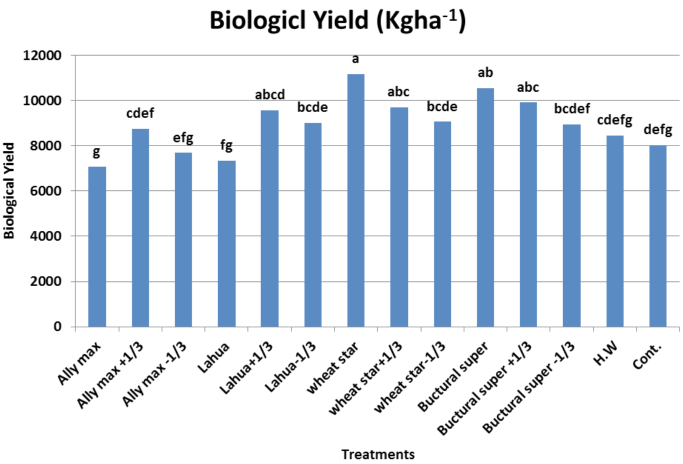

Figure 14: *Effect of different treatments on biological yield of wheat.*

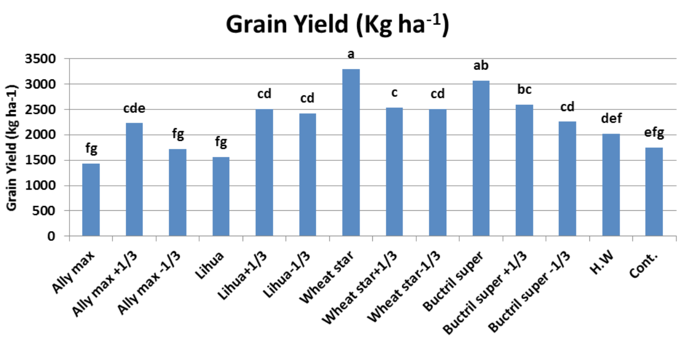

Figure 15: *Effect of different treatments on grain yield of wheat.*

Conclusions

All herbicides significantly affected the weed indices. Wheat growers prefer herbicides for managing weeds. Thus herbicides are the main component for weed administration policies. Our findings lead to the conclusion that hand hoeing is the most effective method for weed management if the crop is grown up on small area but on large scale, application of Wheat Star @ 578.5 g ha^{-1} and Buctril Super @ 474 ml ha^{-1} as post-emergence can be used to minimize the weed infestation under sufficient soil moisture having environmental conditions comparable to the ones considered in this experiment.

Author's Contributions

Muhammad Asad managed experiment, Safdar Ali supervised experiment, Muhammad Ramzan Ansar co-supervised experiment, Ijaz Ahmad, Muhammad Suhaib and Muhammad Khubaib Abuzar helped in writing this article.

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