Mycopath (2014) 12(1): 43-51 **Research Article**

The relative performance of weed control practices in September sown maize

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Abstract

Influence of weed control practices on growth and yield of September planted maize (*Zea mays* L.) was studied in a field trial at the experimental station of Agronomy, UAF, Faisalabad, Pakistan. Experiment comprised of eight treatments, viz., weedy check (control), manual hoeing, bentazon @ 720, 840, 960, 1080 and 1200 g ha^{-1}, (as post-emergence), and pendimethalin @ 1031 g ha^{-1} (as pre-emergence). All the weed control practices decreased weed density by 46-93%, weeds fresh weight by 39-98% and weeds dry weight by 42-88%. The highest grain yield was obtained with manual hoeing followed by the treatment with pendimethalin. Higher doses of bentazon were found inefficient to control weeds, however; it showed satisfactory results @ 960 g ha^{-1}.

Keywords: Performance, September sown, weeds control, *Zea mays*.

Introduction

Maize is an important cereal of the world, known for its food and feed value. In Pakistan, it ranks third after wheat and rice. Pakistan produces 4.8 million tons of maize annually from an area of 1.2 million hectares resulting average yield of 4000 kg ha^{-1}. Its grains contain 72% starch, 10% proteins, 4.8% oil, 8.5% fiber, 3% sugar and 1% ash (Chaudhry, 1983). Due to a lack of resources and non-adaptation of modern agro-technology, the inherent yield potential of domestic varieties has not been exploited yet. Resultantly, major emphasis has been laid down on the use of high inputs like fertilizers for the purpose to gain high yield. Although, there is a great potential to increase maize yield since high yielding varieties are under cultivation, yet the average yield is far below as compared to the achievable potential of varieties. Amongst various factors responsible for the low yield in maize, weeds are of prime importance which usually causes around 40% yield losses. Weeds result in increased cost of production by reducing crop yield through competition for light, water and nutrients. Weed control practices in maize resulted in around 85% higher yield in comparison with that of control (Khan *et al.,* 1998). Infestation of weeds may result in crop growth suspension, yield reduction, and delayed harvesting. Weeds, when not adequately controlled, may reduce grain yield in maize by as much as 50% (Chikoye *et al.,* 2001).

Cultural, mechanical and chemical controls are commonly used weed control practices; however, the latter two are laborious, time consuming and expensive. The farmers of poor resource or developing countries like Pakistan usually adopt chemical measures due to the fact of being quick and cost-effective. Increased grain yield with a decreased weed density, growth and dry weight due to herbicide application has been reported by many scientists (Khan and Haq, 2004; Salarzai, 2001). However, such studies, through the available scientific literature, are rare at Pakistan level. Therefore, keeping in view the importance of the crop and role of herbicides in combination of other measures in increasing maize yield, the present study was planned with the objectives to: 1) compare the effectiveness of pre- and post-emergence herbicides for weed control in September sown maize, 2) evaluate the different weed control practices in maize, and 3) standardize the dose of bentazon (Basagran-48 SL) herbicide for September planted maize.

Materials and Methods

Study area and crop husbandry

Research study was conducted at an experimental field situated at 31^{O}- 26' N, 73^{O}- 06' E at an altitude of 184.4 m. The experiment was carried out at the experimental station of agronomy, UAF, Pakistan to compare the efficiency of different weed control practices in September planted maize. Single cross maize hybrid R-2315 was sown in 5 m × 3 m plots randomized in randomized complete block design (RCBD) with three replicates. The crop was sown in 75 cm apart rows with an intra row distance of 25 cm maintained by thinning at the early growth stage. The crop was fertilized with nitrogen and phosphorous at 200 and 150 kg ha^{-1}, respectively. The following treatment combinations were compared in the present study:

W_1 = Weedy check (Control), W_2= Manual hoeing (two at 15 and 30 days after sowing), W_3= Bentazon (Basagran-48 SL) @ 720 g ha^{-1}, W_4 = Bentazon @ 840 g ha^{-1}, W_5 = Bentazon @ 960 g ha^{-1}, W_6 = Bentazon @ 1080 g ha^{-1}, W_7 = Bentazon @ 1200 g ha^{-1}, and W_8 = Pendimethalin (Stomp-330 E) @ 1031 g ha^{-1}. Pre-emergence herbicides were applied after the sowing of the crop, whereas post emergence herbicides were applied two weeks after sowing of the crop and completion of 50% germination of the maize crop. First and second manual hoeing(s) were done at two and four weeks after sowing of maize crop, respectively.

Data collection and analyses

An area of one square meter was selected randomly at two places in each plot for weed count at 20 and 40 days after spray and at harvest, and the average was worked out. Weeds were harvested at ground level to calculate the fresh weight (g m^{-2}) of individual weeds at above mentioned time intervals and area. Harvested weeds were cleaned and their fresh weight was recorded with an electronic balance and average was worked out. The biomass of each weed harvested for fresh weight was sun-dried for 10 days and then to a constant weight in a drying oven at 70 ºC and the average for dry matter (g m^{-2}) were calculated.

Height (cm) of ten randomly selected plants from every experimental unit was measured from base to the apical growing point with a meter rod. Ten randomly selected cobs from each plot were shelled for the purpose to calculate average grains per cob. The average 1000 grain weight (g) was recorded by weighing three different samples each of 1000 grains by means of balance and the average was worked out.

Ten sun-dried cobs were randomly selected, shelled mechanically and grain and pith weight was recorded separately from each plot to calculate the grain pith ratio as under;

Grain pith ratio = grain weight/pith weight

Grain yield was calculated by harvesting and sun drying all the plants form the net experimental area. The cobs were separated from plants, shelled and weighed to have grain yield per plot (kg), which was further converted into tons per hectare. Harvest index (%) was calculated by the formula;

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

All the collected data on different weed and crop parameters were subjected to Fisher's analysis of variance technique and the means were separated by the least significant difference (LSD) test at 5% level of significance (Steel *et al*., 1997).

Results and Discussion

Weed density after 20 days of spray

Total weed density (m^{-2}) at 20 days after spray was significantly affected by all weed control practices when compared with that of weedy check (Table 1). Weedy check (W_1) resulted in significantly maximum weed density (236.7) followed by that of bentazon @ 1200 g ha^{-1} (W_7). Manual hoeing (W_2) lead to maximum weed control (93.2%) followed by the treatment application of pendimethalin (W_8) as pre-emergence herbicide (89.4%). The differences between non-chemical (W_2) and chemically controlled plots (W_{3-8}) were significant. The non-chemical weed control practice resulted in lower weed density than chemical weed control treatments. Comparison of pre-emergence herbicide (W_8) with post-emergence herbicide (W_{3-7}) differed significantly. The pre-emergence herbicide provided better control (89.4%) than that of herbicides applied at post-emergence stage. Comparison of post-emergence herbicide (W_{3-7}) showed that where bentazon was applied at different concentration the differences were highly significant. The bentazon application @ 960 g ha^{-1} (W_5) had better control (51.9%) and was followed by bentazon @ 840 g ha^{-1} (W_4) which was statistically at par with bentazon @ 1080 g ha^{-1} (W_6).

The lowest weed population in manual hoeing might be a result of more mortality due to uprooting and mechanical injury of weeds. The treated plots results in a highly significant reduction in density of weeds when compared with that of weedy check due to mortality of weeds by weed control practices. These results are in line with that of Pandey *et al.* (2000) and Chikoye *et al.* (2001) who described significant differences in weeds density of several weed control treatments.

Weed fresh weight after 20 days of spray

All weed control treatments significantly decreased wed fresh weight as compared to that of control at 20 days after spray (Table 1). The minimum fresh weight of weeds (7.9 g) (99.1 % reduction) was recorded in manually hoed plots (W_2) and was significantly same with the pre-emergence application of pendimethalin (W_8) (98.3% reduction). The significantly maximum fresh weight (853.7 g) of weeds was recorded in the plots where no weed control practices were used (W_1). The comparison of non-chemical (W_2) and chemically controlled plots (W_{3-8}) for weeds fresh showed significant differences. Manual hoeing resulted in lower fresh weight of weeds than chemically controlled plots. Highly significant differences were recorded for the fresh weight of weeds between the comparison of pre- (W_8) and post-emergence (W_{3-7}) herbicides. The pre-emergence herbicide treatment resulted in higher fresh weight reduction (98.3%) than post-emergence herbicide. Among post-emergence herbicide (W_{3-7}) treatments where bentazon was applied at different rates, the differences for fresh weight of weeds were significant and minimum fresh weight of weeds was obtained with bentazon @ 960 g ha^{-1} (W_5) and was followed by the treatment bentazon @ 840 g ha^{-1} (W_4).

Weed control practiced plots resulted in a highly significant reduction in fresh weight of weeds in comparison with that of weedy check. The fresh weed biomass decreased in weed control treatments as a result of less number of weeds or suppressed growth and development of weeds. In contrast, maximum fresh weight of weeds in weedy check plots was due to excessive weed density and undisturbed growth of weeds (Table 1). These findings support the results of Skrzypczak *et al.* (2002) and Chikoye *et al.* (2005) who reported maximum fresh weight of weeds in weedy check.

Weed dry weight after 20 days of spray

The data pertaining to dry weight of weeds at 20 days after spry revealed that weed control practices decreased weed dry weight significantly (Table 1). The lowest dry weight (4.9 g) (98.3% reduction) of weeds was recorded in case of manual hoeing (W_2) that was statistically at par with that of pendimethalin (W_8) application. Significantly maximum wed dry matter (287.2 g) was obtained in control plots (W_1). The comparison of non-chemical (W_2) and chemically controlled plots (W_{3-8}) showed significant differences. The non-chemical weed control practice resulted in lower weeds dry weight. The comparison of pre (W_8) and post-emergence (W_{3-7}) application of herbicides also showed highly significant differences. Pre-emergence application of herbicides resulted in the lower weeds dry weight than that of post-emergence herbicide treatments. The post-emergence herbicide (W_{3-7}) treatments application at different rates produced significant differences for weed dry weight. Minimum weed dry matter was recorded in bentazon @ 960 g ha^{-1} (W_5).

Weed control practices resulted in decreased weed dry weight. It might be due to less number of weeds and lower fresh weight (Table 1). It may also be described that weedicides reduced the moisture content of the weed leaves. The minimum dry weight of weeds in manually weeded plots could be attributed to uprooting of weeds or mechanical injury of weeds. Maximum weed dry weight in weedy check was perhaps due to excessive weed density and undisturbed or vigorous growth and development of weeds in that treatment. Variation in dry weight of weeds among different weed control treatments might be due to the varying effect of herbicide and hoeing on the number of weeds and their growth. These results confirm the findings of Ali *et al.* (2003) and Chikoye *et al.* (2005) who reported decreased weed dry weight in weed control and maximum in check (W_1).

Weeds density after 40 days of spray

The data regarding weed population in maize arranged in Table 2 reveals that total weed mass at 40 days after spray was significantly affected by all weed control practices when compared with that of weedy check (W_1). Weedy check (W_1) produced significantly maximum weed density (224) followed by bentazon @ 720 g ha^{-1} (W_3), and significantly similar with that of bentazon @ 1080 g ha^{-1} (W_6) and bentazon @ 1200 g ha^{-1} (W_7). Highest weed control (88.7% control) was obtained with manual hoeing (W_2) followed by pre-emergence application of pendimethalin (W_8) (84.52% control). The differences among non-chemical (W_2) and chemically controlled plots (W_{3-8}) were significant. The non-chemical weed control practice resulted in the lower density of weeds than chemical weed control treatments. Comparison of pre-emergence herbicide (W_8) with post-emergence herbicide (W_{3-7}) differed significantly. Pre-emergence herbicide provided better weed control (84.5% control) than that of post-emergence application. Among the post-emergence herbicides (W_{3-7}) where bentazon was applied at different concentrations, the differences were highly significant. The treatment where bentazon was applied @ 960 g ha^{-1} (W_5) had better control (61.8% control) and was followed by bentazon @ 840 g ha^{-1} (W_4).

Minimum weed density in manual hoeing might be a result of higher mortality caused by complete uprooting and mechanical injury of weeds. Treated plots resulted in markedly significant decline in weed density when compared with that of weedy control perhaps due to mortality of weed by weed control practices. These results confirm the findings of Sarpe and Mihalcea (1999), Chikoye *et al.* (2001) who concluded significant differences in weeds densities among various weed control treatments.

Weed fresh weight after 40 days of spray

All weed control treatments significantly decreased fresh weight of weeds in comparison with that of the weedy check at 40 days after spray (Table 2). The minimum fresh weight of weeds (15.5 g) (98 % reduction) was recorded in plots where manual hoeing (W_2) was done followed by the treatment where pendimethalin (W_8) (96.8% reduction) was applied as pre-emergence herbicide. The significantly maximum fresh weight (826.8 g) of weeds was observed in weedy check plots (W_1). The comparison of non-chemical (W_2) and chemically controlled plots (W_{3-8}) for weeds fresh weight showed significant differences. Manual hoeing resulted in lower fresh weight of weeds than that of chemically controlled plots. Highly significant differences were recorded among the comparison of pre-emergence (W_8) and post-emergence herbicide (W_{3-7}). The pre-emergence herbicide treatment resulted in higher fresh weight reduction (96.8% reduction) than that of post-emergence herbicide. Among post-emergence herbicide application (W_{3-7}),where bentazon was applied at different rates, differences for fresh weight of weeds were significant and minimum fresh weight of weeds was obtained with bentazon @ 960 g ha^{-1} (W_5), followed by bentazon @ 840 g ha^{-1} (W_4).

Weed control treatments resulted in a marked reduction in fresh weed biomass in comparison with that of weedy control (W_1). Decreased fresh weed biomass in weed control treatments might be related to reduced weed density or suppressed growth and development of weeds (Table 2). Maximum fresh weight of weeds in weedy (control) was probably due to high weed density and their undisturbed growth. These outcomes are strongly supported by Skrzypezak *et al.* (2002) and Chikoye *et al.* (2005) who reported maximum fresh weight of weeds in weedy check.

Weed dry weight after 40 days of spray

Weed dry matter at 40 days after herbicide application reveals that all weed control practices decreased weed dry weight significantly. The minimum dry weight (7.03 g) (97.1% reduction) of weeds was noted in manual hoeing (W_2) that was statistically similar with the application of pendimethalin (W_8). Statistically highest weed dry matter (241.5 g) was obtained in weedy check (W_1). The comparison of non-chemical (W_2) and chemically controlled plots (W_{3-8}) showed significant differences. Non-chemical weed control practice resulted in lower weed dry matter than that of chemically controlled ones. The comparison of pre-emergence (W_8) and post-emergence herbicides (W_{3-7}) showed highly significant differences. The pre-emergence herbicide weed control practice resulted in the lower weeds dry weight in comparison with that of post-emergence herbicide treatments. Among the post-emergence herbicide (W_{3-7}) treatments the differences for dry weight of weeds were significantly different among each other. The minimum weed dry matter was noted for bentazon @ 960 g ha^{-1} (W_5) (Table 2).

Weed control practices lead to decreased dry weight of weeds due to less number of weeds and lower fresh weight (Table 2). The minimum weed dry matter in manual weed control could be attributed to uprooting or mechanical injury of weeds. Highest weed dry weight in weedy check was probably due to higher weed density (Table 2) and undisturbed or vigorous growth and development of weeds. Varied weed dry weight among weed control treatments might be related to the varying effect of herbicide and hoeing on the number of weeds and their growth. Our present findings are in accordance with those of Ali *et al.* (2003), and Chikoye *et al.* (2005) who reported a decreased weed dry matter in weed control treatments and maximum dry weight in check.

Plant height at harvest

Plant height is a function of the vegetative growth of crop plants achieved as a result of applied inputs. Data arranged in the Table 3 indicates that the height of maize plants was affected significantly by various weed control practices. The Highest plant height (188.77 cm) at harvest was documented with mechanical hoeing (W_2) that was significantly similar with the application of Pendimethalin (W_8) and Bentazon @ 960 g ha^{-1} (W_5). Significantly lowest plant height was observed in check plots (W_1). The comparison of mechanical (W_2) and chemical controlled plots (W_{3-8}) showedstatistically significant differences among each other. The non-chemical weed control practice (W_2) resulted in higher plant height than that of chemical weed control treatments. Comparison of pre-emergence (W_8) and post-emergence herbicides (W_{3-7}) showed significant differences. The pre-emergence herbicide weed control practice resulted in higher plant height at harvest than that of post-emergence herbicides. Among post-emergence herbicides (W_{3-7}) Bentazon applied at different rates showed significant differences for plant height where height was observed in Bentazon @ 960 g ha^{-1} (W_5) and was significantly similar with that of Bentazon @ 840 g ha^{-1} (W_4).

The lowest plant height in check (W_1) may be the result of increased weed density which suppressed plant growth by competing for light, moisture, and nutrients (Table 1 and 2). Variations in height of maize plants among different weed control handlings might be the result of varying competition effects offered by different weed densities. Our present findings second the outcomes of Singh and Singh (2003) and Khan *et al.* (2002) who narrated increased plant height by different weed control practices. Contrarily these results differ with the findings of Stefanovic *et al.* (2004) who reported maximum plant height in control. These contradictory outcomes may be a result of differences in environmental conditions, the species prevalence and height of weeds.

Grains per cob in response to weed control practices

Grains per cob pertain to an important yield determining component of maize. Data given in the table 3 shows that various weed control practices affected grains per cob markedly. Maximum grains per cob (407.9) were obtained with manual hoeing (W_2) and was followed by pendimethalin (W_8). Statistically lowest grains per cob (284.1) were recorded in the weedy check (W_1). Treated plots (W_{2-8}) resulted in highly significant addition in the number of grains per cob compared with that of weedy check (W_2). Comparison of manual hoeing (W_2) and chemically controlled plots (W_{3-8}) showed significant differences. The manual weed control practice (W_2) resulted in more number of grains per cob than chemical weed control treatments. Pre-emergence herbicide (W_2) had more number of grains per cob as compared to the post-emergence application of herbicides (W_{3-7}). Among post-emergence herbicide (W_{3-7}) treatments where bentazon was applied at different rates showed significant differences. The maximum number of grains per cob was found with bentazon @ 960 g ha^{-1} (W_5) that was statistically similar with bentazon @ 840 g ha^{-1} (W_4).

The lowest grains per cob in weedy check might be due to less number of grain rows per cob which was due to more weed density (Table 1 and 2) and weed crop competition in check (W_1) which probably suppressed plant growth by competition. Variation in grains per cob among weed control practices might be a combined effect of varying weed competition offered by different weed densities. Maximum grains per cob in manual hoeing were probably due to minimum weed density and ultimately lead to availability of more photosynthates for plant growth and development. These results can be supported by the previous findings of Khan *et al.* (2002), and Sinha *et al.* (2001). They found that weed control practices resulted in increased grain rows and grains per cob.

1000-grain weight as affected by various weed control practices

1000-grain weight is an important parameter of the final crop yield. Data presented in the Table 3 shows that significantly lowest 1000-grain weight (200.9 g) was documented in check (W_1). Maximum 1000-grain weight (276.1 g) was noted in manual hoeing (W_2) which was statistically same with that of pendimethalin (W_8) (275.6 g) and followed by 1000-gran weight with the application of bentazon @ 960 g ha^{-1} (W_5). Comparison of non-chemical (W_2) and chemically controlled plots (W_{3-8}) for 1000-grain weight were significant and more 1000-grain weight was obtained in non-chemical treatment (W_2). Comparison of pre-emergence (W_8) and post-emergence herbicides (W_{3-8}) showed significant differences. The pre-emergence herbicide weed control practice resulted in higher 1000-grain weight than that of post-emergence herbicides. Among the treatments where bentazon was applied as post-emergence herbicide at different rates, differences for 1000-grain weight were significant with maximum 1000-garin weight observed in case of the application of bentazon @

960 g ha^{-1} (W_5) followed by that of bentazon @ 840 g ha^{-1} (W_4).

Increase in 1000-grain weight in treatments practiced with weed control in comparison with that of weedy check was probably due to enhanced growth and development of maize plants, which results in more photosynthates assimilation in grains. Increased grain weight may lead to the hypothesis of excessive resource availability to maize crop. Minimum 1000-grain weight in check (W_1) which was due to the presence of weeds in crop resulting in smaller grains, whereas, more 1000-grain weight by weed control practices as a result of bigger, well-defined and heavy grains. Present results are in line with the findings of Sharma and Gautam (2003) and Singh and Singh (2003) who concluded that 1000-grain weight was greater for mechanical and chemical weed control treatments in comparison with that of untreated control in maize.

Grain pith ratio as affected by various weed control practices

The grain pith ratio for maize crop shows how much part of the cob is converted to grain and how much to the pith. Results revealed that the grain pith ratio was markedly affected by various weed control exercises (Table 4). The maximum grain pith ratio (4.5) was obtained with the herbicide application of pendimethalin (W_8) which was statistically similar with that of manual hoeing (W_2) and followed by bentazon @ 960 g ha^{-1} (W_5). The lowest grain pith ratio (2.9) was observed in check (W_1). Comparison of non-chemical (W_2) and chemically controlled treatments (W_{3-8}) showed significant differences. The chemical weed control practices resulted in lower grain pith ratio than that of manual hoeing. Comparison of the pre- (W_8) and post-emergence (W_{3-7}) herbicides for the grain pith ratio showed significantly higher grain pith ratio in case of pre-emergence application of herbicides than that of the post-emergence application. Among post-emergence herbicide (W_{3-7}) treatments bentazon was applied at different rates showed non-significant response to the grain pith ratio. The minimum grain pith ratio in weedy check may be a result of maximum weed density (Table 1 and 2) that probably suppressed growth and development of plants by competing for light, moisture and nutrients. Variation in the grain pith ratio among weed control treatments might be an effect of the varying competition imposed by different weed densities. More grain pith ratio in weed control treatments was perhaps due to higher grain yield in these treatments.

Grain yield (t ha^{-1}) in response to weed control practices

Grain yield is a combined effect of various yield components. These components show differential response to differential environmental conditions and agronomic practices. Grain yield is the ultimately goal of growing a crop like maize. The results (Table 4) indicates that the significant response of grain yield to various weed control practices over weedy check. Manual hoeing (W_2) gave significantly highest grain yield (6.12 t ha^{-1}) followed by the application of pendimethalin (W_8) and bentazon @ 960 g ha^{-1} (W_5). Statistically lowest grain yield (3.65 t ha^{-1}) was documented in weedy check treatment (W_1). Comparison of non-chemical (W_2) and chemically treated plots (W_{3-8}) significantly affected the grain yield. The non-chemical weed control practice resulted in higher grain yield than that of chemically controlled plots. Pre-emergence herbicide (W_8) yielded comparatively more grain yield (5.96 t ha^{-1}) in comparison with that of post-emergence herbicide (W_{3-7}) application. Among the post-emergence herbicide treatments (W_{3-7}) where bentazon was applied at different rates, the differences for grain yield were significant and topmost grain yield (5.87 t ha^{-1}) was attained with bentazon @ 960 g ha^{-1} (W_5). Minimum grain yield (4.85 t ha^{-1}) in post-emergence treatments was recorded with bentazon @ 1200 g ha^{-1} (W_7) which was significantly not different with bentazon @ 1080 g ha^{-1} (W_6).

Increase in grain yield over check (W_1) was different in different weed control practices and ranged from 20.75-40.35%. It was probably due to more grain rows per cob, the number of grains per cob and 1000-grain weight. Minimum grain yield in check (W_1) might be a result of maximum weed density (Table 1 and 2) which led to suppression of growth and development of maize by competition for space, light, water and food. Lower grain yield in response to the highest dose of bentazon might be related to its phytotoxic effect on maize. Efficiency of weed control by use of chemicals and other weed control practices for the increased grain yield had previously been elaborated by Khan *et al.* (2002), Singh and Singh (2003) and Khan and Haq (2004).

Harvest index (%) as affected by various weed control practices

Functional efficiency of a crop to segregate the biomass into its commercial (grain) yield is referred as harvest index. It reflects the efficiency of the crop in partitioning higher dry matter to its economic portion and result in higher grain yield. Different weed control treatments affected harvest index (%) significantly in comparison with that of weedy check. Manual hoeing (W_2) resulted in maximum harvest index (28.4%) which was statistically same with that of pendimethalin (W_8), bentazon @ 960 g ha^{-1} (W_5) and bentazon @ 840 g ha^{-1}(W_4). Minimum harvest index (25.4%) was recorded with bentazon @ 1200 g ha^{-1} (W_1) which is statistically similar to W_6, W_3 and W_1. Comparison of non-chemical (W_2) and chemically treated plots (W_{3-8}) significantly affected the harvest index. Non-chemical weed control practice resulted in higher harvest index than that of chemically controlled plots. Pre-emergence herbicide (W_8) yielded comparatively more harvest index than that of the post-emergence herbicide (W_{3-7}) application. Among the post-emergence herbicide treatments (W_{3-7}) bentazon applied at different rates showed significant differences for harvest index with maximum harvest index obtained by bentazon @ 960 g ha^{-1} (W_5) and was statistically similar with its lower dose i.e. 840 g ha^{-1} (W_4). The lower harvest index with a higher dose of bentazon might have been a result of its phytotoxic effect on maize plants. Variation in harvest index among weed control treatments might be due to varying weed competition.

It can be concluded that none of the weed control treatments completely eliminated the weeds but manual hoeing and pendimethalin controlled the weeds more than that of other treatments. Among the treatments where bentazon was applied as post-emergence herbicide bentazon @ 960 g ha^{-1}proved best over other concentration of bentazon. Manual hoeing proved more effective for control of weeds and to increase grain yield than other weed control treatments however, if there is a labor problem pendimethalin @ 1031 g ha^{-1} would be applied for weed control and producing higher grain yield.

Table 1: Weed density, weeds fresh weight and weed dry weight as affected by different weed control practices 20 days after spray.

Treatments	Weed density (m^{-2})	Weeds FW (g m^{-2})	Weeds DW (g m^{-2})
W_1 = Weedy check	236.7 a	853.7 a	287.1 a
W_2 = Manual hoeing (two hoeing)	16.0 g	7.9 g	4.9 d
W_3 = Bentazon (Basagran-48 SL) @ 720 g ha^{-1}	134.7 c	241.3 d	78.9 bc
W_4 = Bentazon (Basagran-48 SL) @ 840 g ha^{-1}	124.3 d	232.1 e	66.6 bc
W_5 = Bentazon (Basagran-48 SL) @ 960 g ha^{-1}	113.6 e	213.1 f	57.3 c
W_6 = Bentazon (Basagran-48 SL) @ 1080 g ha^{-1}	126.0 d	248.8 c	88.3 b
W_7 = Bentazon (Basagran-48 SL) @ 1200 g ha^{-1}	149.3 b	262.1 b	80.4 bc
W_8 = Pendimethalin (Stomp-330 E) @ 1031 g ha^{-1}	25.0 f	14.8 g	6.4 d
LSD	4.9	7.5	28.8

Means sharing same letters in a column differ insignificantly at $P \leq 0.05$ as determined by LSD method.

Table 2: Weed density, weeds fresh weight and weed dry weight as affected by different weed control practices 40 days after spray.

Treatments	Weed density (m^{-2})	Weeds FW (g m^{-2})	Weeds DW (g m^{-2})
W_1 = Weedy check	224.0 a	826.8 a	241.5 a
W_2 = Manual hoeing (Two hoeing)	25.3 f	15.5 g	7.0 f
W_3 = Bentazon (Basagran-48 SL) @ 720 g ha^{-1}	108.7 b	179.9 b	68.4 c
W_4 = Bentazon (Basagran-48 SL) @ 840 g ha^{-1}	101.0 c	165.8 d	61.8 d
W_5 = Bentazon (Basagran-48 SL) @ 960 g ha^{-1}	85.7 d	139.7 e	51.1 e
W_6 = Bentazon (Basagran-48 SL) @ 1080 g ha^{-1}	109.3 b	175.1 c	63.6 d
W_7 = Bentazon (Basagran-48 SL) @ 1200 g ha^{-1}	111.3 b	180.1 b	72.6 b
W_8 = Pendimethalin (Stomp-330 E) @ 1031 g ha^{-1}	34.7 e	26.6 f	8.7 f
LSD	4.4	3.9	2.6

Means sharing same letters in a column differ insignificantly at $P \leq 0.05$ as determined by LSD method.

Table 3: Plant height, number of grains per cob and 1000-grain weight as affected by different weed control practices.

Treatments	Plant height (cm)	No. of grains per cob	1000-grain weight (g)
W_1 = Weedy check	153.2 d	284.1 e	200.9 e
W_2 = Manual hoeing (Two hoeing)	188.8 a	407.8 a	276.1 a
W_3 = Bentazon (Basagran-48 SL) @ 720 g ha^{-1}	174.8 c	342.9 d	246.3 d
W_4 = Bentazon (Basagran-48 SL) @ 840 g ha^{-1}	179.5 bc	355.7 c	255.2 c
W_5 = Bentazon (Basagran-48 SL) @ 960 g ha^{-1}	182.9 ab	364.2 c	268.1 b
W_6 = Bentazon (Basagran-48 SL) @ 1080 g ha^{-1}	173.9 c	339.8 d	245.3 d
W_7 = Bentazon (Basagran-48 SL) @ 1200 g ha^{-1}	174.9 c	334.9 d	241.9 d
W_8 = Pendimethalin (Stomp-330 E) @ 1031 g ha^{-1}	187.6 a	394.5 b	275.6 a
LSD	6.5	9.2	6.2

Means sharing same letters in a column differ insignificantly at $P\leq0.05$ as determined by LSD method.

Table.4: Grain pith ratio, grain yield (t ha^{-1}) and harvest index (%) of maize as affected by different weed control practices.

Treatments	Grain pith ratio	Grain yield (t ha^{-1})	Harvest index (%)
W_1= Weedy check	2.9 d	3.7 f	25.8 b
W_2= Manual hoeing (Two hoeing)	4.3 ab	6.1 a	28.4 a
W_3= Bentazon (Basagran-48 SL) @ 720 g ha^{-1}	3.8 c	5.1 d	25.9 b
W_4= Bentazon (Basagran-48 SL) @ 840 g ha^{-1}	3.9 c	5.4 c	27.6 a
W_5= Bentazon (Basagran-48 SL) @ 960 g ha^{-1}	4.1 bc	5.9 b	28.2 a
W_6= Bentazon (Basagran-48 SL) @ 1080 g ha^{-1}	3.9 c	4.9 de	25.6 b
W_7= Bentazon (Basagran-48 SL) @ 1200 g ha^{-1}	3.9 c	4.8 e	25.4 b
W_8= Pendimethalin (Stomp-330 E) @ 1031 g ha^{-1}	4.5 a	5.9 b	28.9 a
LSD	0.36	0.15	1.22

Means sharing same letters in a column differ insignificantly at $P\leq0.05$ as determined by LSD method.

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