# RESPONSE OF ONION CROP TO VARIOUS ECO-FRIENDLY WEED MANAGEMENT TECHNIQUES AT PESHAWAR PAKISTAN

Zahid Hussain[1]*, Luqman[1], Muhmmad Ilyas[2], Sadam Hussain[3], Murad Ali[4], Muhammad Saleem Khan[5], Muhammad Saeed[1] and Naushad Khan[6]

## ABSTRACT

*A field experiment was carried out at the Horticulture Research Farm, the University of Agriculture Peshawar, Pakistan in the year 2014 in order to evaluate the effect of different sowing orientations, plant spacing and weed control treatments on onion yield and its infesting weeds. A three factorial RCBD experimental design was used for the experiment replicated three times. Factor A was termed as the sowing direction with two orientations (i.e. North-South and East-West), factor B included plant spacing (10, 15 and 20 cm) while factor C included the treatments of Rumex crispus as mulch, Euphorbia helioscopia as mulch, a hand weeded treatment and a weedy control. Data were taken on weed density $m^{-2}$, weed biomass (fresh) (kg $ha^{-1}$), biological yield (t $ha^{-1}$), and bulb yields (t $ha^{-1}$). Results of the experiment showed that sowing orientation, plant spacing, weed mulches and some of their interactions significantly affetced the studied parameters. Sowing orientation in E-W direction showed significant increase in weed density (113.50 $m^{-2}$), and weed biomass $ha^{-1}$ (1381.90 kg) whereas N-S direction resulted in increased biological yield $ha^{-1}$ (30.09 tons) and bulb yield $ha^{-1}$ (20.07 tons). Plant spacing also significantly affected growth and yield components. Different levels of plant spacing (20 cm) showed significant increase in weed density $m^{-2}$ (119.83) and weed biomass (1405 kg $ha^{-1}$), while plant spacing of 10 cm resulted in increased biological yield (30.44 t $ha^{-1}$), and bulb yields (20.34 t $ha^{-1}$). Whereas minimum weed density $m^{-2}$ (86.42) and weed biomass (1156 kg $ha^{-1}$) were obtained at 10 cm spacing among the seedlings of onion crop. Among the treatments of weed control, weedy check resulted in highest weed density $m^{-2}$ (159.67) and weed biomass (2183.4 kg $ha^{-1}$) while hand weeding resulted in highest biological yield (33.23 t $ha^{-1}$) and bulb yield (22.48 tons $ha^{-1}$) while lowest biological yield t $ha^{-1}$ (18.71) and bulb yield $ha^{-1}$ (11.31 tons) were recorded in weed check. It was thus concluded*

[1]Dept. of Weed Science, [2]Dept. of Horticulture, [4]Dept. of Water Management, [6]Institute of Development Studies, The University of Agriculture Peshawar, Pakistan.
[3]Institute of Chemical Sciences, University of Peshawar, Pakistan
[5]Dept. of Botany, Islamia College Peshawar, Pakistan
*Corresponding author's email: zhussainws@aup.edu.pk

*that sowing in the North-South direction along with 10 cm spacing among onion seedlings and the mulching method of Rumex crispus could be the best environment friendly weed management program for enhancement in onion yield in Peshawar (a lower elevation) of Khyber Pakhtunkhwa Pakistan.*

**Key words:** Mulching, Peshawar, plant spacing, sowing orientation, weeds, yield.

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## INTRODUCTION

Agriculture sectors is the backbone of Pakistan economy. A wide range of crops can be grown in the country as the environmental conditions here are conducive to grow any crop. Still, the yields of all crops are lower as compared to the world's average (Khan, 2004). Infestation of a wide range of weeds is one of the key reasons for sharp decline in the crop yields in the country. Onion is the most important vegetable crop worldwide having about 61 million tons production globally. Out of the 15 vegetables at FAO list, the total production of onion is second after tomato (Pathak, 2000). In Khyber Pakhtunkhwa, it is grown in almost every district, covering irrigated (10157 ha) and un-irrigated (823 ha) areas, with total production of 170629 and 10624 tons, respectively (Anonymous, 2010-11).

Onion plants face strong competition from the associated weeds for the sake of nutrients, space, light, and soil moisture which considerably diminish the onion yield, quality and crop value through increased cost of production and harvesting (Rao, 2000; Kizilkaya *et al*., 2001; Ghaffoor, 2004). The losses due to weeds have always been very higher than the inflicted yield losses by insects and diseases. Hussain (1983) has very early explored that generally weeds infestation reduces the crop yield by 30-60%. The farmers generally do not apply the weed control methods at the early stages of the crop to prevent major weed related damages.

The shallow roots of onion and thin canopy make onion seedlings poor competitors against weeds. In addition, the upright leaves (cylindrical) also have smaller canopy which cannot effectively shade the soil to hamper the emergence and growth of weeds. Factors such as weed species composition, crop variety, crop growth stage, labor availability and costs etc. all play role together.

Ali *et al*. (2007) attributed the lower yields of onion to the limited availability of good quality seeds and improved varieties. Shaikh *et al*. (2002) reported that improved seed varieties would contribute to crop yield up to 30%. Ahmad (1992) attributed the yield gap of 50–60% between potential and actual yield to improper sowing methods and poor weed control practices. Soil moisture is an important factor influencing the onion yield. Ali *et al*. (2007) explored that onion requires many irrigations because the crop sucks very little water from the depths below 5 cm; whereas most of the water is there within the depth of 30 cm of the soil profile. Therefore, upper soil areas should be kept moist in order to stimulate the root growth and provide adequate water to the onion plants.

Nowadays, using the plant residues and synthetic materials as mulch has become a well-established practice for conserving soil moisture and for good plant growth and development (Rhu *et al*., 1990; John, 2000; Kashi *et al*., 2004). Manipulating the sowing directions is another method to maximize the sunlight capture that fall on the crop canopy. No proper research has yet been reported on this aspect.

Keeping in view these reasons, an experiment was planned to figure out the impact of planting spacings, sowing directions, and various mulches on weeds and crop yield components.

## MATERIALS AND METHODS

An experiment was conducted at the Horticultural Research Farm of the University of Agriculture, Peshawar during onion season 2014. The experiment was laid out in a three factorial RCB design with three replications. There were two transplanting directions {north-south (N-S) and east-west (E-W)}. The onion seedlings were placed in rows in two directions i.e. one in north-south and the other one in east-west orientations. The plant spacings (Factor B) were three i.e. 10, 15 and 20 cm. The treatments (Factor C) included biological material of two weeds i.e. *Rumex crispus* and *Euphorbia helioscopia* as mulch, used at the rate of 5 tons $ha^{-1}$ in the field. A hand weeding treatment and a weedy check were included in the factor C treatments for comparison. The size of each individual treatment was 2m x 4m.

Before conducting the experiment, a nursery was raised using the cultivar, SWAT-1. The field was leveled and standard amount of FYM was applied before transplantation. Recommended dose of NPK (90:50:30 kg $ha^{-1}$) was applied just before transplantation and half nitrogen was applied after four weeks of transplantation. The irrigation was made after every week. Mulching was applied in the different plots after one week of transplantation. The data were recorded on weed density $m^{-2}$, weed biomass, biological yield and and bulbs yield (t $ha^{-1}$).

**Statistical analysis**

All the collected data was put to ANOVA technique and was statistically analyzed through MS Excel. In addition the statistical software Statistix 8.1 was also used for confirmation, using the statistical design of 3-factorial RCB. After getting significant F-test results, the LSD test was utilized for comparing the means of the treatments at 5% alpha level (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

**Weed density $m^{-2}$**

The analysis of the data showed that weed density was significantly affected by the sowing orientation, plant spacing, and weed control treatments and their interactions (Table-1). The weed density was significantly lower i.e. 93.31 weeds $m^{-2}$ in plots with onion plants sown in north-south direction as compared to sowing in the east-west direction (113.50 $m^{-2}$). The number of weeds per unit area was significantly lowest (86.42 $m^{-2}$) in plant spacing of 10 cm, followed by plots in which onion plants were sown at a distance of 15 cm with weed density of 103.96 $m^{-2}$ and highest weed population (119.83 $m^{-2}$) was found in onion palnt to plant distance of 20 cm. For the factor C, the weed density was significantly lowest (57.83$m^{-2}$) in hand weeded plots followed by *Rumex crispus* plant biomass used as mulch (94.72$m^{-2}$) and plots with *Euphorbia helioscopia* plant biomass applied as mulch (101.39 $m^{-2}$) as compared to the significantly highest weed density (159.67 $m^{-2}$) in the weed check plots. The significant interactions are given in Fig. 1(a) and 1(b) for S x P and S x T.

**Weed biomass (kg $ha^{-1}$)**

The analysis of the data showed that weed biomass (kg $ha^{-1}$) was significantly affected by the sowing orientation, plant spacing, weed control treatments and their interaction (Table-1). The weed biomass was significantly lower i.e. 1222.9 kg $ha^{-1}$ in plots with onion plants sown in north-south direction as compared to sowing in the east-west direction (1381.9 kg $ha^{-1}$). Weed biomass kg $ha^{-1}$ was significantly lowest (1156.9 kg $ha^{-1}$) in plant spacing of 10 cm, followed by plots in which onion plants were sown at a distance of 15 cm with weed biomass of 1345.0 kg $ha^{-1}$ and highest weed biomass (1405.2 kg $ha^{-1}$) was found in onion plant to plant distance of 20 cm. For the factor C, the weed biomass was significantly lowest (569.4 kg $ha^{-1}$) in hand weeded plots followed by *Rumex crispus* plant biomass used as mulch (1163.2 kg $ha^{-1}$) and plots with *Euphorbia helioscopia* plant biomass applied as mulch (1293.4 kg $ha^{-1}$) as compared to the significantly highest weed biomass (2183.4 kg ha$^{-1}$) in the weed check plots. The significant interaction is given in Fig. 2a for SxP.

Karanja *et al*. (2014) reported higher yields for sorghum crop in north south row orientation due to reduced number of weeds per unit area (Catherine *et al*., 2010). However, Hozayn *et al*. (2012) reported best results for inhibition of weeds growth in wheat crop under East-West crop row direction with 48.5% reduction in weeds. This means that the effect of row orientation on weeds is different in different crops. The spaces between the tomato plants significantly affected the weed density. Narrow spacing of 10 cm in onion plants suffocated weeds number per unit area whereas wider spacing (15 and 20 cm) gave room to the growing weeds with which the number and composition of weeds increased (Ara *et al*., 2007). Mulching enhances the soil moisture retention and improves soil temperature (Mahajan *et al*., 2007; Dalorima *et al*., 2014; John, 2000), which helps boost crop performance making the crop more competitive against the associated weeds. In addition, regardless of what kind of mulch is used, mulching of the soil causes a decrease in the weed density in the beginning of the growing period of vegetables like tomato, potato and onion (Kosterna, 2014).

**Biological yield (t ha$^{-1}$)**

It is evidant from the analysis of the data that biological yield t ha$^{-1}$ was significantly affected by the sowing orientation, plant spacing, weed control treatments and their interactions (Table-2). Onion plants grown in plots of east-west direction resulted in lower (26.35 t ha$^{-1}$) biological yield t ha$^{-1}$ as compared to sowing in the north-south direction (30.09 t ha$^{-1}$). Simillarly wider plant spcing (20 cm) resulted in minimun biological yield ((26.50 t ha$^{-1}$), followed by plots in which onion plants were sown at a distance of 15 cm with t biological yield t ha$^{-1}$ of 27.72 t ha$^{-1}$ and highest biological yield t ha$^{-1}$ (30.44 t ha$^{-1}$) was found in onino palnt to plant distance of 10 cm. Regarding factor C, the biological yield t ha$^{-1}$ was significantly lowest (18.71 t ha$^{-1}$) in weedy check plots followed by *Euphorbia helioscopia* plant biomass used as mulch (29.99 t ha$^{-1}$) and plots with *Rumex crispus* plant biomass applied as mulch (30.94 t ha$^{-1}$) as compared to the significantly highest biological yield t ha$^{-1}$ (33.23 t ha$^{-1}$) in the hand weeded plots.

**Bulb yield (t ha$^{-1}$)**

From analyzing the data, it was cleared that the sowing orientation, plant spacing, weed control treatments all significantly affected the bulb yield of onion. Table-2 indicated the mean values for onion bulb yield. Onion grown in plots of north-south rows resulted in maxiumum yield (20.07 t ha$^{-1}$) row orientation of east-west sowing (17.19 t ha$^{-1}$). Regarding of plant spacing, the bulb yield was significantly highest (20.34 t $ha^{-1}$) in plots of 10 cm spacing between onion plants. The highest bulb yield was followed by 18.25 t $ha^{-1}$ where there was 15 cm spacing between onion plants; while the lowest bulb yield (17.30 t $ha^{-1}$) was achieved in plant spacing of 20 cm. The bulb yield was also significantly highest (22.48 t $ha^{-1}$) in treatments of hand weeding which was followed by the mulching of *Rumex crispus* plants (20.72 t $ha^{-1}$) and mulching of *Euphorbia helioscopia* whole plants (19.99 t $ha^{-1}$) as compared to the significantly lowest bulb yield of 11.31 t $ha^{-1}$ in the control plots.

In conditions of north south row orientation the crop plants receive maxiumn solar radiation as compared to the east west row orientation which is apparently due to the higher distance between rows than the spacing between the crop plants. Also the canopy of individual crop plants overlap with the adjacent plants, consequently rendering the situation favorable for photosynthetic process in plots of north south row sowing. However our results are similar with that of Karanja *et al*. (2014) who reported higher yields for sorghum crop in north south row orientation but lower yields for cowpea crop as compared to the row orientation in east west. In contrary of our results, Hozayn *et al*. (2012) provided best results for wheat yields under East-West row sowing. In conclusion, the row sowing orientation results differently in different crops. Similarly, plant spacing in the onion plants also had a significant effect on the bulb yield. Decreasing the plant spacing from 20 cm to 10 cm decreased the per plant yield because of intra specific competition among the crop plants but the gross yield was highest in the in close plant spacing. The per hectare yield however decreased with increasing the plant spacing from 10 to 20 cm. Kahsay *et al*. (2013) recorded highest total bulb yield at the closest intra-row spacing (5 cm) followed by 7.5 cm. Among the weed control treatments hand weeding resulted in the best fruit yield as a result of efficient weed control. Hand weeding was followed by the mulches of the selected weeds. The mulching factor enhanced the moisture retention capacity of the soil which optimized the soil temperature (Dalorima *et al*., 2014). Ramalingam *et al*. (2013) reported that Un weeded control accounted for lower bulb yield which in turn reflected through higher weed index of 60.6 and 56.1 per cent, respectively during both the years, due to heavy competition of weeds for nutrients, space and light. The mulching of plant biomass of *Rumex crispus* enhanced the yield of tomato because of shading of the emerging weeds. The mulching of *Euphorbia helioscopia* was also better than the weedy check in significsntly improving the onion bulb yield per hectare.The interaction effect of S x T and P x T are important in increasing bulb yield in onion grown at lower elevation of Peshawar, Khyber Pakhtunkhwa, Pakistan

**Table-1.** Effect of sowing orientation, plant spacings and weed control treatments on weed density $m^{-2}$ and weed biomass (kg $ha^{-1}$) in onion crop during 2014 at lower elevation of Peshawar, Khyber Pakhtunkhwa, Pakistan

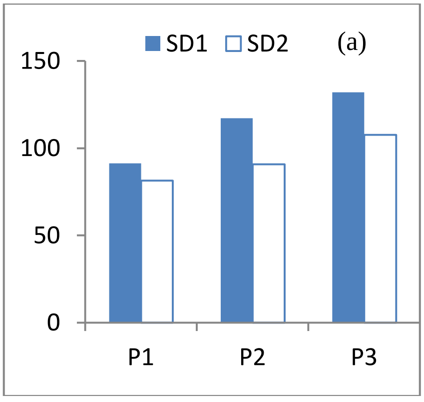
| **Treatments** | **Parameters** | |
|---|---|---|
| | **Weed density ($m^{-2}$)** | **Weed biomass (kg $ha^{-1}$)** |
| **Sowing orientation ( S)** | | |
| East west sowing | 113.50 a | 1381.9 a |
| North south sowing | 93.31 b | 1222.9 b |
| Significance level | * | * |
| **Plant spacing (P)** | | |
| 10 cm | 86.42 c | 1156.9 c |
| 15 cm | 103.96 b | 1345.0 b |
| 20 cm | 119.83 a | 1405.2 a |
| LSD (0.05) | 3.95 | 24.28 |
| **Treatments (T)** | | |
| *Rumex crispus* biomass as mulch | 94.72 c | 1163.2 c |
| *E. helioscopia* biomass as mulch | 101.39 b | 1293.4 b |
| Hand weeding | 57.83 d | 569.4 d |
| Weedy check | 159.67 a | 2183.4 a |
| LSD (0.05) | 4.38 | 64.04 |
| **Interactions** | **Significance level** | |
| S x P | * | * |
| S x T | * | NS |
| P x T | * | NS |
| S x P x T | NS | NS |

Means in the same column with different letters are significantly different at α=0.05 using LSD test; * = Significant, NS = Non-Significant

**Table-2.** Effect of sowing orientation, plant spacings and weed control treatments on biological yield (t ha$^{-1}$) and bulbs yield (t ha$^{-1}$) of onion crop during 2014 at lower elevation of Peshawar, Khyber Pakhtunkhwa, Pakistan

| **Treatments** | **Parameters** | |
|---|---|---|
| | **Biological yield (t ha$^{-1}$)** | **Bulb yield (t ha$^{-1}$)** |
| **Sowing orientation ( S)** | | |
| East west sowing | 26.35 b | 17.19 b |
| North south sowing | 30.09 a | 20.07 a |
| Significance level | ** | ** |
| **Plant spacing (P)** | | |
| 10 cm | 30.44 a | 20.34 a |
| 15 cm | 27.72 b | 18.25 b |
| 20 cm | 26.50 c | 17.30 c |
| LSD (0.05) | 0.38 | 0.30 |
| **Treatments (T)** | | |
| *Rumex crispus* biomass as mulch | 30.94 b | 20.72 b |
| *E. helioscopia* biomass as mulch | 29.99 c | 19.99 c |
| Hand weeding | 33.23 a | 22.48 a |
| Weedy check | 18.71 d | 11.31 d |
| LSD (0.05) | 0.44 | 0.34 |
| **Interactions** | **Significance level** | |
| S x P | NS | NS |
| S x T | * | * |
| P x T | * | * |
| S x P x T | NS | NS |

Means in the same column with different letters are significantly different at α=0.05 using LSD test; * = Significant, NS = Non-Significant



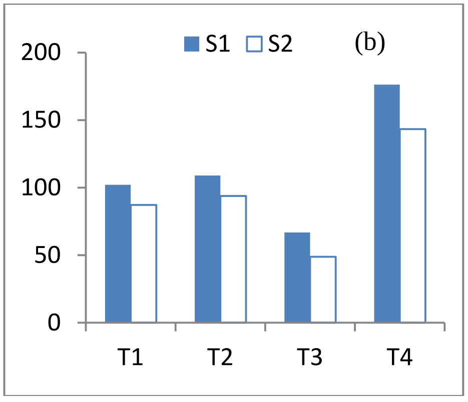




**Figure 1.** Interaction effect of (a) sowing orientation and plant spacing (S x P) and (b) sowing orientation and weed control treatments (S x T) for weed density m$^{-2}$ of onion crop at lower elevation of Peshawarl Pakistan during 2014

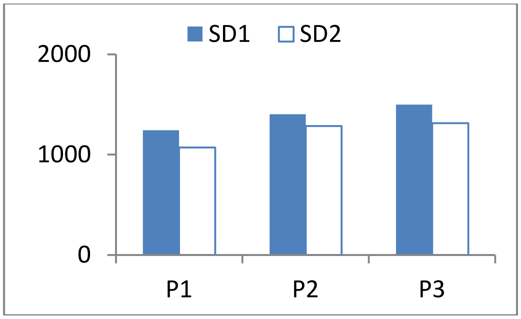



**Figure 2.** Interaction effect of sowing orientation and plant spacing (S x P) for weed biomass (kg ha$^{-1}$) in onion crop at Peshawarl Pakistan during 2014

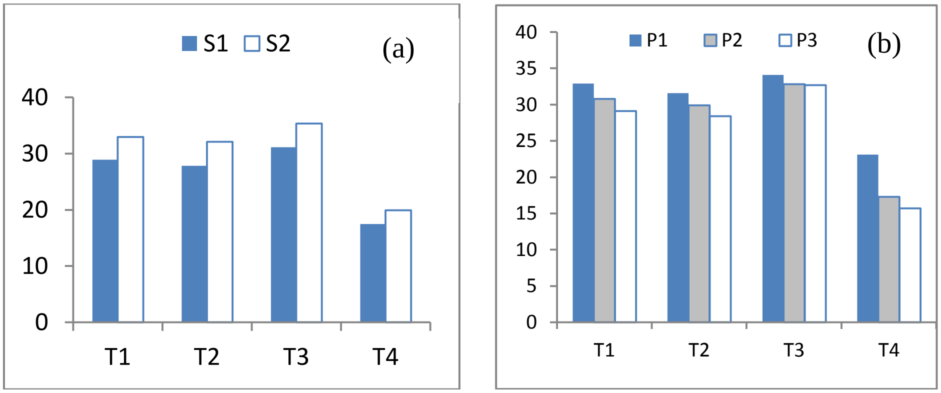



**Figure 3.** Interaction effect of (a) sowing orientation and weed control treatments (S x T) and (b) plant spacing and weed control treatments (P x T) for biological yield (t ha$^{-1}$) of onion crop at Peshawarl during 2014

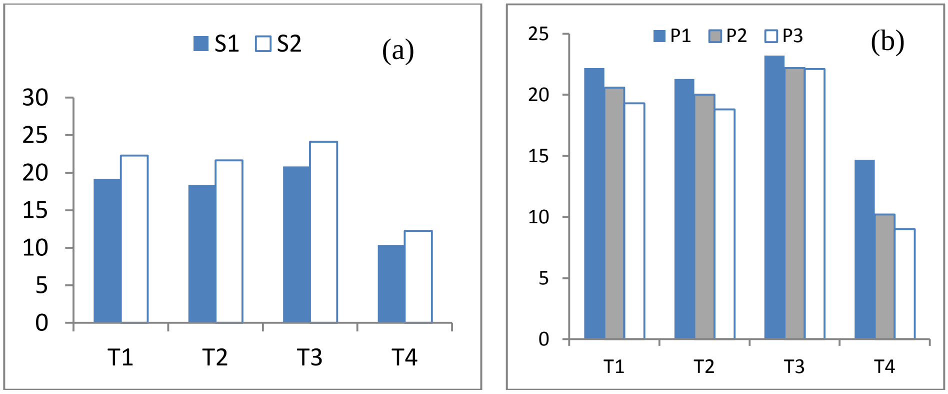



**Figure 4.** Interaction effect of (a) sowing orientation and weed control treatments (S x T) (b) plant spacing and weed control treatments (P x T) for bulb yield (t ha$^{-1}$) of onion crop at lower elevation of Peshawarl during 2014

## CONCLUSION

Row sowing in north south direction produced promising results as compared to that in east west direction in the agroecological conditions of Peshawar in terms of onion bulb yield and weed control. Keeping a distance of 10 cm among the onion seedlings generated best results in terms of weed control and bulb yield per hectare as compared to plant spacing of 15 and 20 cm. The plant biomass of *Rumex crispus* and *Euphorbia helioscopia* as mulch gave best results in comparison with control plots (weedy check) in Peshawar region. However, mulching of *R. crispus* was better than *E. helioscopia* in all respects.

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