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# Effect of integrated potassium on weeds fresh weight, weeds dry weight, yield and yield components of maize hybrids

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**Abstract**
Maize (*Zea mays* L.) has high growth rate, produce large quantity of organic matter, and is highly susceptible to weeds presence. An experiment comprised of two factors i.e. hybrids (DK-Garanon, Pioneer-3025, WS-666, and Pioneer-3164) and potassium ratios (Organic vs inorganic) was laid out in randomized complete block design with split plot arrangement in four replicates. Organic source of K was poultry manure (PM) while inorganic source was sulphate of potash (SOP). Potassium (K) was applied from both organic and inorganic source in different ratios to provide a total of 80 kg K $ha^{-1}$. Among maize hybrids lowest weeds fresh weight, weeds dry weight with highest 1000 grains weight, biological yield and grain yield was recorded for DK-Garanon hybrid whereas more grains $ear^{-1}$ was recorded for Pioneer-3164. Regarding potassium ratios, highest weeds fresh weight and dry weight was recorded in plots which received 100% K from organic source. Highest grains $ear^{-1}$, 1000 grains weight, biological yield and grain yield was recorded in plots where 40% K was applied from organic and 60% from inorganic source. Integrated application of 80 kg $ha^{-1}$ K in such an arrangement that 40% K is obtained from organic and 60% from inorganic source results in better yield. More study on combined use of organic and inorganic source of K is recommended to explore more its benefits.

**Keywords:** Poultry manure, sulphate of potash, ratios of organic and inorganic

## Introduction
Maize (*Zea mays L.*), the third important staple crop of Pakistan after wheat and rice. It was sown on 1.14 million hectares with total annual production of 4.93 million tons. Its average seed yield was 4.23 tons $ha^{-1}$. In Khyber Pakhtunkhwa, it was cultivated on 0.46 million hectares that produced 0.91 million tons with mean yield of 1.965 tons $ha^{-1}$ (MNFSR, 2015) [18]. In spite of higher yield potential average yield of maize in Pakistan is less than that of developed countries in the world. Various maize genotypes are planted throughout Pakistan. Their response to different factors like water, nutrients, and weeds vary greatly. This variable response is mainly due to differences in their emergence (Tahir *et al*., 2008) [28], tasseling (Gozubenli, 2001) [10], silking (Luque *et al*., 2006) [15], leaf area (Nawaz *et al*., 2006) [20], leaf area index (Minjian *et al*., 2007) [17], plant height (Umakanth and Satyanarayana, 2000) [30], grain $ear^{-1}$ (Liu *et al*., 2004) [14], 1000 grains weight (Sener *et al*., 2004) [26], biological yield (Ali *et al*., 2012) [1], grain yield (Damon and Rengel, 2008) [6] and harvest index (Bangarwa *et al*., 1988) [4]. Undoubtedly, with increase in maize production life of farming community will improve and sowing of hybrid seed is an opening key for this. Globally hybrids account for 83% in the land under maize cultivation (FSCD, 2005) [9]. Organic manure is a renewable and cheap source for plant nutrients. Positive effects of organic manure on soil health are proved in several studies (Jedidi *et al*., 2004) [13]. Potassium after two major nutrients i.e. N and P has maintained its third position for a tremendous role in plant development. It helps in uptake of water and nutrients (Thomas and Thomas, 2009) [29], protein and carbohydrate synthesis (Patil, 2011) [21], and in increasing crop yield (Rasool *et al*., 2008) [25]. Weeds compete with field crops for natural and synthetic resources hence limits the crop productivity to a greater extent. They also decline the quantity and quality of agriculture produce (Rao *et al*., 2015) [24]. Approximately 32% yield reduces due to the presence of these unwanted plants (Bhan *et al*., 1999) [5]. They also have a negative effect on human, animal and environment health (DWSR 2013) [8]. The losses due to weeds will increase if their indirect effect on nutrient and water depletion, grain quality and cost of their removal are taken into account.

## Material and Methods

Maize hybrids (DK-Garanon, Pioneer-3025, WS-666 and Pioneer-3164) and potassium ratios (100% organic, 80% organic + 20% inorganic, 60% organic + 40% inorganic, 40% organic + 60% inorganic, 20% organic + 80% inorganic, 100% inorganic and control) were taken for a field experiment to document their effect on weeds fresh and dry weight and crop productivity. Hybrids to main plot and potassium ratios to sub plot were allotted in split plot arrangement of randomized complete block design. Poultry manure (PM) as organic while sulphate of potash as inorganic source of K were used to supply a total of 80 kg K $ha^{-1}$ from their combination. Poultry manure was applied to field as required three weeks prior to sowing. The experimental site was Agronomy Research Area of the University of Agriculture Peshawar. A sub plot of 4 m x 3.5 m was used. Sowing was done on ridges in July 2016. Nitrogen as a urea and Phosphorous as a DAP was applied at the rate of 150 and 90 kg $ha^{-1}$ respectively keeping the amount already added from PM into consideration.

## Observations and Measurements

Data regarding weeds fresh weight (g $m^{-2}$) and dry weight (g $m^{-2}$) were determined by randomly throwing three times a 25 cm x 25 cm iron ring in each subplot. Weeds were harvested from each ring, weighed in the field with an electronic balance and averaged to determine weeds fresh weight per iron ring area. The harvested weeds were then kept in sunlight for drying till constant weight which were then weighed and averaged to determine weeds dry weight per iron ring area. The obtained data was converted into g $m^{-2}$. Grains $ear^{-1}$ of maize was calculated by taking five ears randomly in each experimental unit. Grains in these ears were counted manually and averaged to get mean value. Thousand grains were randomly taken after threshing and cleaning the grains in each experimental plot and weighed on a sensible balance in grams. At harvest maturity three central rows in each experimental unit were harvested, sun dried for ten days and weighed on a balance in field for recording biological yield per unit plot area. The data were then converted into kg $ha^{-1}$. Ears from three rows already harvested for biological yield were detached from plants, dehusked, shelled, and weighed to calculate the grain yield and the data were then converted into kg $ha^{-1}$.

The recorded data were statistically analyzed according to analysis of variance techniques recommended for randomized complete block design with split plot arrangement. Least significant difference (LSD) was used at 5% level of significance ($P \leq 0.05$) upon significant F-test through the procedure described by Jan *et al*. (2009) [12].

## Results and Discussion

### Weeds fresh weight and dry weight (g $m^{-2}$)

Hybrids (H) and potassium ratios (K) significantly affected weeds fresh weight and dry weight (Table 1). The interaction between hybrids and potassium ratios was found non-significant. Mean values of hybrids showed that highest weeds fresh weight (351.2 g $m^{-2}$) and dry weight (109.1 g $m^{-2}$) was recorded in plots sown with WS-666 hybrid while lowest weeds fresh weight (271.6 g $m^{-2}$) and dry weight (80.53 g $m^{-2}$) was recorded in DK-Garanon hybrid sown plots. Different hybrids have different potential to compete with weed species for soil and environmental resources, thus affects weeds fresh and dry weight. In case of potassium ratios highest weeds fresh weight (364.2 g $m^{-2}$) and dry weight (114.4 g $m^{-2}$) was recorded in plots which received sole organic potassium while lowest weeds fresh weight (277.3 g $m^{-2}$) and dry weight (82.7 g $m^{-2}$) was recorded in plots which received potassium 40% from organic (poultry manure) and 60% from inorganic (sulphate of potash) source. Similar results are also reported by Jama *et al*. (1997) [11] who documented that application of organic manures resulted in higher weeds biomass. Weeds compete with maize for nutrients in the soil. Shah *et al*. (2016) [27] reported that application of organic manure increases weeds fresh and dry weight due to the presence of essentials nutrients in organic manure.

### Grains $ear^{-1}$

Grains $ear^{-1}$ of maize was significantly affected by hybrids and potassium ratios (Table 1). However, interaction of hybrids and potassium ratio was non-significant. Highest grains $ear^{-1}$ was counted in pioneer-3025 followed by Garanan hybrid while lowest grains $ear^{-1}$ was calculated for WS-666 hybrid. Luque *et al*. (2006) [15] reported that difference in grains $ear^{-1}$ among maize hybrids might be due to the variation in their ear length, ear diameter, and grain size. In case of potassium ratios, highest grains $ear^{-1}$ was recorded in plots which received potassium 40% from organic (PM) and 60% from inorganic (SOP) source while lowest grains $ear^{-1}$ was counted in control plots. It might be due to the synergistic effect of organic and mineral potassium. Ayoola and Adeniyan (2006) [3] reported that integrated use of NP and K fertilizers along with poultry manure performed better than sole use of inorganic and organic sources for grains $ear^{-1}$.

### Thousand grains weight (g)

Hybrids and potassium ratios significantly affected thousand grains weight while interaction of H x K remained non-significant (Table 1). Highest thousand grains weight was recorded for Garanan hybrid while lowest 1000 grains weight was recorded for WS-666 hybrid. Sener *et al*. (2004) [26] reported that differences in thousand grain weight among hybrids could be due to their genetic potential. In case of potassium ratios the highest 1000 grains weight was recorded in plots which received potassium 40% from organic and 60% from inorganic source while lowest 1000 grains weight was recorded in control plots. It might be due to the synergistic effect of organic and inorganic fertilizers which enhanced crop growth and thus produced heavy grains. Davis *et al*. (1996) [7] reported that different potassium levels increased 1000 grains weight.

### Biological yield (kg $ha^{-1}$)

Biological yield was significantly affected by hybrids and potassium ratios (Table 1). Among hybrids highest biological yield was recorded for Garanan hybrid which was significantly different from other hybrids. It might be due to difference in crop growth rate, plant height, and leaves $plant^{-1}$ of hybrids. Ali *et al*. (2004) [2] reported that maize hybrids significantly differed for all parameters including biological yield due to difference in their genetic potential. Highest biological yield was recorded in plots which received potassium 40% from organic and 60% from inorganic source while lower biological yield was recorded in control plots. It might be due to the synergistic effect of organic and inorganic fertilizers which led to enhanced crop growth and thus produced more biological yield. Also, availability of additional nutrients and enhanced nutrient uptake from both organic and inorganic source led to higher biological yield these results are similar with (Munir *et al*., 2007) [19] who

reported that integrated use of fertilizers resulted in higher biological yield. Pettigrew (2008) [22] reported that application of Potassium (K) significantly increased biological yield.

**Grain yield (kg ha$^{-1}$)**

Statistical analysis showed that grain yield was significantly affected by hybrids and potassium ratios (Table 1). However, interaction of hybrids and potassium ratios was non-significant. Highest grain yield was recorded for Garanon hybrid which was significantly different from other hybrids. Pettigrew (2008) [22] concluded that different hybrids react differently for grain yield due to their genetic makeup and potential expressed in terms of difference in ear plant$^{-1}$, number of grains cob$^{-1}$, and 1000 grains weight. Similarly, in potassium ratios the highest grain yield was recorded in plots which received potassium 40% from organic (Poultry manure) and 60% from inorganic (SOP) source while lowest grain yield was recorded in control plots. The possible reason for higher grain yield may be the result of balanced supply of nutrients form organic and inorganic potassium sources. Zafar *et al*. (2011) [32] stated that use of 50% mineral fertilizer in combination with 50% poultry manure outcome in superior maize grain yield. This is also in agreement with the results of Rasool *et al*. (2008) [25] who recorded higher maize grain yield when manure + mineral fertilizers were practiced.

**Conclusion**

Mong hybrids DK-Garanon produced higher grain yield as compared to Pioneer-3025, Pioneer-3164, and WS-666 and also compete well with weeds for soil and environmental resources thus resulted in lower weeds fresh and dry weight. In potassium ratios, highest grain yield was recorded in plots which received potassium 40% from organic (Poultry manure) and 60% from inorganic (sulphate of potash) source. Therefore, application of potassium at the rate of 80 kg ha$^{-1}$ in such an arrangement that 40% K is obtained from organic (poultry manure) and 60% from inorganic source (sulphate of potash) to hybrid DK-Garanon is recommended for minimum weeds fresh weight, weeds dry weight and higher maize yield.

**Table 1:** Impact of integrated potassium on weeds fresh weight (g m$^{-2}$), weeds dry weight (g m$^{-2}$), yield (kg ha$^{-1}$) and yield components of maize hybrids

| Treatment | Weeds fresh weight (g m$^{-2}$) | Weeds dry weight (g m$^{-2}$) | Grain ear$^{-1}$ | 1000 grains Weight (g) | Biological yield (kg ha$^{-1}$) | Grain yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|
| **Hybrids** | | | | | | |
| Garanan | 271.60 c | 80.53 c | 457 b | 291.1 a | 14901 a | 4898 a |
| Pioneer-3025 | 297.50 b | 91.16 b | 496 a | 265.8 b | 14008 b | 4445 b |
| WS-666 | 351.20 a | 109.1 a | 424 c | 241.6 c | 13075 c | 3967 c |
| Pioneer-3164 | 321.40 b | 98.13 b | 488 a | 259.8 b | 13785 b | 4351 b |
| LSD | 24.33 | 10.21 | 29.74 | 7.99 | 590.26 | 181.5 |
| **Potassium Ratios** | | | | | | |
| 100% organic | 364.20 a | 114.4 a | 446 d | 251.8 d | 13316 d | 4038 d |
| 80% organic+ 20% inorganic | 355.30 a | 108.4 a | 445 d | 246.4 d | 13229 de | 3966 d |
| 60% organic+ 40% inorganic | 334.10 b | 100.7 b | 496 b | 282.7 b | 15030 ab | 4992 b |
| 40% organic+ 60% inorganic | 277.30 d | 82.70 d | 517 a | 300.0 a | 15213 a | 5362 a |
| 20% organic+ 80% inorganic | 327.50 b | 99.16 b | 469 c | 268.5 c | 13965cd | 4470 c |
| 100% inorganic | 320.60 b | 97.86 b | 471 c | 271.0 c | 14296 bc | 4653 c |
| Control | 298.40 c | 90.34 c | 421 e | 231.8 e | 12547 e | 3427 e |
| LSD | 19.41 | 7.31 | 20.43 | 11.37 | 752.29 | 256.51 |

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