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RESPONSE OF MAIZE AND THREE PERENNIAL WEEDS TO DIFFERENT COMBINATIONS OF MACRO-NUTRIENTS

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ABSTRACT

Pot experiment was conducted in the Department of Weed Science, The University of Agriculture, Peshawar, Pakistan in July 2009 investigating the response of three perennial weeds and maize to different combinations of macro-nutrients. The experiment was laid out in Completely Randomized Design and each treatment being replicated three times. There were eight treatments comprising the control (no macro-nutrients), nitrogen (N), phosphorous (P), potassium (K) and the combinations of NP, NK, PK and NPK. The doses of NPK each alone and in mixture were 300, 200 and 100 mg Kg^{-1} soil. Five seeds of maize and three rhizomes/stolons of Cyperus rotundus, Cynodon dactylon and Sorghum halepense were planted in pots. Analysis of the data revealed that all the fertilizers significantly increased the growth parameters of the weed species and the crop studied. However combine use of the macro-nutrients were more effective in promoting the plant height, fresh plant biomass, dry plant biomass and the plants root weight as compared using them alone. The present findings revealed that macro-nutrients (fertilizer) application in maize not only favour the crop growth but also promote the growth of the three perennial test weeds. Thus band application of the macro-nutrients may show advantages over the broadcast application as NPK is shared equally by weeds and maize as well.

Keywords: Maize, NPK, perennial weeds, combination.

INTRODUCTION

Maize *(Zea mays* L.) is the third most important cereal crop after wheat and rice in Pakistan and mostly consumed as human food and animal feed. Maize provides raw material for food industry. According to estimation, 75% of the total production of maize is used as food by the farming community and remaining finds its way in starch manufacturing industry, poultry feed and food grain sales (Muhammad, 1979). Like other crops, the average yield of maize is low in Pakistan as compared to other maize growing countries. Various factor are responsible for this low production, among them severe weed infestation, poor weed management practices and improper

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planting method are common problems. Weed infestation is important and usually ignored by the farming community. It has been reported that weeds reduce crop yield from 20%-40% depending upon weed species and density (Ashique *et al.,* 1997)

Weeds reduce crop yield and deteriorate the quality of produce and hence reduce the market value of turn out (Arif *et al.*, 2006). Weeds use soil fertility available moisture, nutrient and compete for space and light with crop plant, which results in yield reduction (Khan *et al.*, 2002). Many weeds are hosts of plant disease organisms or of insect pests. If left uncontrolled, weeds are capable of reducing yield by more than 80% (Karlen *et al.*, 2002).

Nitrogen, phosphorus and potassium are major nutrients that are needed for plants in higher amount. Nitrogen is required to synthesis protein, chlorophyel, nucleic acid metabolism and proper function of enzymes system. While Phosphorus is essential for the general health and vigor of all plant. Potassium (K) is required for photosynthesis, osmotic regulation and the activation of enzyme systems. Potassium deficiency in cereal crops results in reduced and stunted growth. Weed infestation of maize crop is a serious problem in our country. All types of weeds i.e. grassy, broadleaf, annual and perennial weeds infest the maize crop in Khyber Pakhtunkhwa. However the most troublesome weeds like *Cyperus rotundus, Sorghum halepense, and Cynodon dactylon* are the major weeds that greatly affect the maize crop throughout the province. It has been reported that N application can increase nitrophilous species such as common lambsquarters (*Chenopodium album* L.) (Haas and Streibig, 1982)

Keeping in view the importance of maize, increasing prices of fertilizers and other inputs, weed infestation and increasing cost of production, the present study was conducted with the following objectives. The study was initiated to study the effect of N, P and K alone and in combination on maize and weed for future weed management programs.

MATERIALS AND METHODS

Pot experiment was conducted in the Department of Weed Science, Agricultural University Peshawar during the month of July 2009 to assess the response of three perennial weeds and maize to different combinations of macro-nutrients. Rhizomes of three perennial weeds (*Cyperus rotundus* L.*, Sorghum halepense* L. and *Cynodon dactylon* L. were collected from Agricultural Research Farm, The University of Agriculture, Peshawar. Seed of maize hybrid "32T78" (Pioneer) were obtained from the laboratory of Weed Science, The University of Agriculture, Peshawar.

After collection, the rhizomes/stolen were placed in refrigerator to prevent them from drying because it was not sown on the same day. Soil was collected from Horticulture Nursery, Agricultural University Peshawar and then brought to the Lab. Pots having 21.7 cm diameter and 17 cm height were filled with the soil leaving one inch space at the top. Fertilizer doses at the rate of 300, 200 and 100 mg Kg^{-1} soil of N, P, K, respectively and combinations of fertilizer (NP, NK, PK, and NPK) were weighed and mixed with the soil in each pot in each replication. One pot in each treatment and replication remained untreated as control.

There were eight treatments in experiment comprising control (0), nitrogen (N), phosphorous (P), potassium (K), NP, NK, PK and NPK. Completely randomized block design was use in experiment. The pots were placed in the open space so that they were exposed to sunlight.

Five seeds of maize and three rhizome or stolon of each *Cyperus rotundus* L., *Cynodon dactylon* and *Sorghum halepense* were planted in the pots separately. Pots were then irrigated with tap water soon after sowing and then watered with equal amount of water whenever needed.

Data on germination was taken 25 days after sowing by visually observing the number of weeds and maize hybrid per pot. Plant height (cm) data was recorded 40 days after sowing by measuring height of each weed and maize hybrid per pot with the help of measuring tap and then average was calculated.

After 40 days of sowing the plants were harvested and fresh weight (g $plant^{-1}$) data was taken by using electric balance. Then plants were placed in oven for 48 hours at 65 °C for drying. After 48 hours, they were taken out and dry weight (g) data was recorded by using electric balance. At the same time roots were taken out and roots weight (g) data was recorded and then the average was calculated. The data recorded was subjected to statistical analysis by using MSTATC software and treatment means were separated using LSD test at 5% probability level.

RESULTS AND DISCUSSION

Maize's plant height (cm)

Statistical analysis of the data revealed that fertilizer application significantly ($p<0.05$) affected the plant height of maize (Table-1). Maximum plant height (84.67 cm) was recorded in NPK treated plots which was statistical similar to the plant height recorded in P, NP, NK, and PK treated plots. Minimum plant height (53.18 cm) was recorded in control, which was statistically similar to the plant height recorded in N and K treated plots. Overall data indicated that fertilizer application increased the plant height of maize. However, using N and K alone were less effective in increasing the plant height of maize. Both nitrogen and phosphorus fertilization increased the straw and grain yields of rice plant significantly (Brohi *et al.,* 1998).

Fresh biomass (g plant^{-1})

Data presented in Table-1 indicated that application of N, P and K alone and in combinations significantly affected the fresh biomass of maize. Data revealed that higher values for fresh biomass (38.35 g) was recorded in application of NPK, which was statistically at par with the value recorded in P treated pots. Lower fresh biomass (6.26 g) was recoded in control. Thus control was statistically similar to all other treatments except P and NPK. Overall data represents that except NPK and P, all other treatments were less effective to increase the fresh biomass of maize. These findings revealed that combinations of fertilizer may show promising results in increasing the crop biomass as compared to the use of a single use of NPK. Iftikhar-ud-Din *et al.* (2011) reported that the number of leaves per plant was significantly affected by different levels of phosphorus. The number of leaves per plant was significantly higher in phosphorus treated plants.

Dry biomass (g plant^{-1})

Table-1 showed that fertilizer application significantly affected dry biomass of maize. Maximum dry biomass was recorded in NPK (4.27 g) which was similar to P, and NP, whereas lower dry biomass was recorded in control plots (0.96 g). This value was at par with all plots except NPK, K and NP. Data indicated that NPK, K and NP were effective to increase the dry biomass of maize probably due the availability of macro nutrients that were required for maize growth. In a similar study, Yin *et al.* (2006) reported that in NK treatment, maize suffered from P deficiency and its growth and light transmittance were similar to the control. Crop growth reduction under NP was not as severe as under NK and PK. Maize yield was high when N, P, and K nutrient were applied together.

Root weight (g plant^{-1})

Root growth of plants play a vital role in absorbing nutrients and moisture from the soil. Thus root system is a useful study in determining the competitive ability of a plant species. Statistical analysis of the data presented in Table-1 indicated that root weight of maize was significantly affected by fertilizer application. Maximum root weight of maize (3.16 g) was recorded in application of PK, which was statistical at same level with NPK (2.96 g). Minimum root weight (0.62 g) was recoded in control plots which were similar to all plots except PK and NPK. Data shows that PK and NPK treatments increased the root weight of maize. Overall data indicated that application of fertilizers increased the growth parameters of maize. However, N, P and K combinations were more effective to increase the growth instead of using alone.

Table 1. Effect of N, P, K alone and in combinations on the growth of maize.

Treatment	Plant height (cm)	Fresh biomass (g plant^{-1})	Dry biomass (g plant^{-1})	Root weight (g plant^{-1})
Control	53.18 c	6.26 c	0.96 c	0.62 d
N	63.67 bc	10.52 c	1.46 bc	1.15 bc
P	77.03 ab	27.67 ab	3.29 ab	1.55 bc
K	64.75 bc	11.47 bc	1.58 bc	1.25 bc
NP	73.42 ab	17.33 bc	2.52 abc	0.69 d
NK	75.08 ab	17.48 bc	2.21 bc	1.70 bc
PK	70.40 ab	17.38 bc	2.27 bc	3.16 a
NPK	84.67 a	38.35 a	4.27 a	2.96 ab
LSD	16.71	16.57	1.91	1.55

Means in columns followed by different letters are significantly different at P<0.05.

Cyperus rotundus plant height (cm)

Analysis of data showed that the plant height of *Cyperus rotundus* was significantly affected by the application of fertilizers (Table-2). Maximum plant height (53.66 cm) was recorded in pots received NPK, which was statically at par with all pots except N, NK and control. Minimum plant height (32.25 cm) was recorded in control pot (Table-2). Plant height showed significant increase to fertilizer application due to the fact that the application of NPK enhances the growth of plants and uptake of micronutrients, which enhanced the plant growth. Interestingly, all weeds showed positive response to added fertilizers. Thus fertilizer application in maize production will directly stimulate the growth of *Cyperus rotundus.* Thus band application of fertilizer should be adopted in maize because *Cyperus rotundus* is a major weed of maize in Peshawar and other parts of our country.

Fresh biomass (g plant^{-1})

Biomass of weed is always directly related to its competitive ability; bigger the vegetative growth, higher will be the competition of that weed with the crop plants. Statistical analysis of the data indicated that the fertilizer application significantly affected fresh biomass of *C. rotundus*. Maximum fresh biomass of *C. rotundus* (1.87 g) was recorded in application of NP, which was statistical at same level with NPK, PK, K and K. Minimum fresh biomass (0.79 g) was recoded by control which was at par with N and NK. Data depicted that NP significantly increase the fresh biomass of *Cyperus rotundus* as compared to control. In a similar study, Backshaw *et al.* (2003)

reported that at the highest N dose, 17 of 23 weed species took up similar or greater amounts of soil N than did wheat, and 6 weed species took up N in amounts similar to that taken up by canola.

Dry biomass (g plant^{-1})

Mean values depicted in Table-2 showed that application of fertilizer significantly affected dry biomass of *Cyperus rotundus.* Higher dry biomass (0.62 g) was recorded in pots supplemented with application of K (0.62 g) which was not significantly different from application of NP and NPK. Lower dry biomass was recorded in control (0.26 g), which was statistically at with per with N and P applied pots. It can be concluded from the data that *Cyperus rotundus* responded to all the fertilizers. Thus application of fertilizer to maize crop will also benefit the *C. rotundus* by sharing the resources. Chamanabad *et al.* (2009) reported that NPK application can strongly affect and reduce weed density in spring barley.

Root weight (g plant^{-1})

Data pertaining root weight of *C. rotundus* is shown in table 2. Statistical analysis of the data indicated that root weight was significantly ($p<0.05$) affected by fertilizer application. Maximum root weight was recorded in NP (0.75 g), which was similar to PK and K, whereas lower root weight was recorded in pots where sole NK was applied (0.29 g), which was at par with control N, P and NPK. Data shows roots of *C. rotundus* can be greatly affected by NPK application. As *C. rotundus* is a perennial weed therefore in cropping system it must be considered to apply fertilizer in a judicious way; to benefit the crop and deprive the weeds. It is suggested in light of the present studies that band application of fertilizers will benefit the crop more and thus weeds growth can be suppressed. Blackshaw *et al.* (2003) claimed that at the highest N dose, 17 of 23 weed species took up similar or greater amounts of soil N than did wheat, and 6 weed species took up N in amounts similar to that taken up by canola.

Table-2. Effect of N, P and K alone and in combinations on the growth of *Cyperus rotundus.*

Treatment	Plant Height (cm)	Fresh biomass (g plant^{-1})	Dry biomass (g plant^{-1})	Root weight (g plant^{-1})
Control	32.25 c	0.79 d	0.26 c	0.35 d
N	42.20 abc	1.00 cd	0.31 bc	0.34 d
P	51.25 ab	1.55 abc	0.37 bc	0.46 bcd
K	48.67 ab	1.74 ab	0.62 a	0.58 abc
NP	47.00 ab	1.87 a	0.42 abc	0.75 a
NK	39.67 bc	1.07 bcd	0.31 bc	0.29 d
PK	49.75 ab	1.69 abc	0.51 ab	0.63 ab
NPK	53.66 a	1.79 a	0.39 bc	0.39 cd
LSD	12.83	0.71	0.21	0.19

Means in columns followed by different letters are significantly differ at $P<0.05$.

Cynodon dactylon plant height (cm)

Data presented in Table-3 showed that application of fertilizer significantly affected plant height (longest shoot) of *Cynodon dactylon*. Maximum plant height (57.33 cm) was recorded in pots received NK followed by PK (44.23 cm). Minimum plant height (29.17 cm) was recorded in K treated pots, followed by control (29.42 cm). Data revealed that application of K in combination with either P or N enhanced the shoot length of *C. dactylon*. This weed being a runner; reproduce vegetatively therefore the enhanced growth of this weed due to fertilizer application might be proved more harmful for the crop. Analogous results were reported by Yin *et al.* (2006). They reported that omission of N, P, and K applications decreased weed diversity and/or inhibited the presence of many weed species.

Fresh biomass (g plant^{-1})

Table-3 shows the response of *Cynodon dactylon* to fertilizers (NPK) as alone and in combinations. It was observed in the present studies that fertilizer application significantly ($p<0.05$) affected the fresh biomass of *C. dactylon*. Maximum fresh biomass plant^{-1} (2.76 g) was recorded in pots received NPK, which was statistical at the same level with NK and PK. Minimum fresh biomass (0.51 g) was recoded in N treated pots, which was at par with control, P, K, and NP. Overall data indicated that fertilizer application increased the fresh biomass. However, using NPK and NK alone were more effective in increasing the fresh biomass of *C. dactylon*. In light of the present results, it could be concluded that application of NPK to maize will make the growth of weeds faster and thus will compete for the above ground and below ground resources.

Dry biomass (g plant^{-1})

Data in Table-3 presents the dry biomass of *Cyperus rotundus*, where higher dry biomass (0.91 g plant^{-1}) was recorded in pots received NP which was not significantly different from the values obtained in the pots where NK and NPK was applied. Lower dry biomass was recorded by K (0.13) followed by P and control. Application of NP, NK and NPK enhanced the fresh biomass of *C. dactylon*. It was observed in the present study that the fertilizers used in this experiment were not effective to enhance the growth of weeds when used alone. However, using fertilizers in combinations accelerate the growth of the weeds studied. Chamanabad *et al.* (2009) reported that despite the fact that many weed species are more responsive to fertilizer than crops are, the phenomenon is not universal. their study showed that combined fertilizer application substantially reduced weed density.

Root weight (g plant^{-1})

Data presented in Table-3 depicts that fertilizer application significantly ($p<0.05$) affected the root weight of *Cyperus rotundus.*

Data revealed that maximum root weight (0.66 g plant^{-1}) was recorded in NP treated pots followed by NPK, whereas lower root weight was produced by plots where sole K was applied (0.13 g), which was statistically similar to P, N, NK and PK and control pots. It can be concluded that NP and NPK were effective to increase the root weight of *Cynodon dactylon* as compared to other fertilizers when used alone or in mixture. Usually farmers use only N and P alone and in combinations in maize in our province. Thus the use of these fertilizers accelerate the weeds problem in maize which ultimately decrease the crop yield.

Table-3. Effect of N, P and K alone and in combinations on the growth of *Cynodon dactylon.*

Treatment	Plant height (cm)	Fresh biomass (g plant^{-1})	Dry biomass (g plant^{-1})	Root weight (g plant^{-1})
Control	29.42 c	0.59 b	0.23 bc	0.16 c
N	32.25 bc	0.51 b	0.34 bc	0.19 bc
P	39.90 bc	0.86 b	0.18 c	0.17 bc
K	29.17 c	0.66 b	0.13 c	0.13 c
NP	35.02 bc	0.77 b	0.91 a	0.66 a
NK	57.33 a	2.42 a	0.68 ab	0.18 bc
PK	44.23 ab	1.36 ab	0.36 bc	0.17 bc
NPK	30.33 c	2.76 a	0.53 abc	0.38 b
LSD	13.34	1.41	0.46	0.22

Means in columns followed by different letters significantly differ at P<0.05.

***Sorghum halepense* plant height (cm)**

Sorghum halepense is among the world's worst weeds therefore studying the response of this weed will give useful information to modify the fertilizer application in maize. Statistical analysis of the data shown in Table-4 indicated that effect of fertilizer application on plant height of *Sorghum halepense* was significant ($p<0.05$). The data revealed that maximum plant height (78.83 cm) was recorded in application of NP, which was statistically at same level with N, P, K, NK and NPK. Minimum plant height (44.00 cm) was recoded in control pots. It was observed that application of all fertilizers whether used alone or in mixture increased the plant height of all the species including *S. halepense*. Thus it is possible to control weeds in the continuous crop with the management of fertilizer application (Chamanabad *et al.,* 2009).

Fresh biomass (g plant^{-1})

Statistical analysis of the data presented in Table-4 indicated that the fresh biomass of *Sorghum halepense* was significantly

($p<0.05$) affected by fertilizer application. Maximum fresh biomass of *S. halepense* was recorded in application of NPK (9.87 g), which was statistical at same level with N, P and NP. Thus N and P played a major role in increasing the fresh biomass instead of K. Minimum fresh biomass (2.97 g) was recoded in K treated pots which was statistically at par with NK, PK and control pots. Overall data shows that N, P, NP and NPK were effective to increase the fresh biomass of *Sorghum halepense*. There is excessive use of nitrogenous and phosphorus fertilizers in the irrigated zones of our province and that might be the reason that *S. sorghum* has become a problem in the maize growing areas.

Dry biomass (g plant^{-1})

Table-4 showed that fertilizer application affected the dry biomass of *Sorghum halepense*. Maximum dry biomass was recorded in K treated pots (1.24 g) which was similar to N and P whereas lower dry biomass was recorded by control (0.51g), which was similar to NP, NK, PK and NPK. Data revealed that combinations of fertilizers reduce the dry biomass of *Sorghum halepense* as compared to N, P and K. The application of three major nutrients (NPK) individually and/or together maintain, growth, yield and quality of plants. In a similar study, Vivek *et al.* (2010) reported that NPK uptake by weeds was significantly influenced by different weed management practices.

Root weight (g plant^{-1})

Table-4 showed that fertilizer application affected the root weight of *Sorghum halepense*, maximum root weight (3.64 g) was recorded in N, followed by NK, PK, K and control whereas lower root weight (1.45 g) was produced in plots where sole NP was applied, which was similar to P and NPK. It was noted that all fertilizers significantly increased the biomass of roots. However, applying these fertilizers alone had minimum effect on the root weight of *Sorghum halepense*. Brohi et al, (1998) reported that different rates of N and P applied to rice plant under greenhouse conditions have significantly increased the uptake of macro and micro-nutrients in rice grain. Thus it can be concluded from the instant results that macr-nutrients could change the uptake of mirco-nutrients and thus the issue of weeds management needs to be addressed.

CONCLUSION

Three perennial weeds were studied during the instant study. These weeds are the major weeds of maize in the country. As maize is grown in the irrigated areas therefore fertilizer application encourage these weeds to grow and propagate. Our results showed that combine use of NPK increased the growth of the weeds. Thus band application of the fertilizers may show advantages over the broadcast application as NPK is shared equally by weeds and maize as well.

Table-4. Effect of N, P and K alone and in combinations on the growth of *Sorghum halepense.*

Treatment	Plant height (cm)	Fresh biomass (g plant^{-1})	Dry biomass (g plant^{-1})	Root weight (g plant^{-1})
Control	44.00 c	4.01 b	0.51 c	2.37 bc
N	73.50 ab	6.65 ab	1.24 ab	3.64 a
P	60.78 abc	6.18 ab	1.14 ab	1.70 bc
K	75.08 ab	2.97 b	1.42 a	2.20 bc
NP	78.83 a	6.66 ab	0.79 bc	1.45 c
NK	66.00 ab	4.43 b	0.90 abc	2.88 ab
PK	54.67 bc	4.72 b	0.79 bc	2.21 bc
NPK	64.10 abc	9.87 a	0.90 abc	1.99 bc
LSD	20.89	3.93	0.61	0.26

Means in columns followed by different letters significantly differ at $P<0.05$.

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