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RESEARCH ARTICLE

EFFECT OF GROWTH ANALYSIS BY 2, 4-D HERBICIDE RESIDUE ON THE SAFETY PRODUCTION OF MAIZE

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ABSTRACT

This paper deals with the hazardous effects of herbicide residue on production of maize. Weeds are a major problem in maize and significantly decrease grain yield of maize in Hyderabad. Field experiment was carried out during 2012-13 to identify weed species and to investigate the efficacy of herbicides on weeds and their effect on grain yield. Three different herbicides were applied after maize emergence, namely *2, 4-D-dimethyl amine*, *2, 4-D-ethyl ester* and *2, 4-D sodium salt in* the maize variety HM12 in the region of Hyderabad (NIPHM). The trial was set in a randomized block design with four replications with a plot size of 7.5 m2. A total number of 26 weed species were recorded in the experimental field. Maximum weed density 60.8, 24.6 and 8.4 m-2 was recorded for *amaranthus viridis, Chenopodium album* and *Cirsium arvense*, respectively. Herbicide application reduced the weed density and positively affected the grain yield in comparison to an untreated control. *2, 4-D sodium salt* proved most efficient as compared to *2, 4-D-ethylester* and *2, 4-D-dimethylamine*. Comparatively high grain yields (3.2 t ha-1) were found in plots treated with *2,4-D sodium salt* while the grain yield in *2,4-D- ethyl ester* and *2,4-D-dimethyl amine* treated plots was 2.7 t ha-1 and 2.5 t ha-1, respectively.

Key Words : Chemical control, grain yield, herbicide, weeds and Maize.

Maize (*Zea mays* L) is an economically cereals cash crop and belong to family *Poaceae.* Certainly, sustainable production can be achieved by selecting effective approaches, which make maximum use of the means of production to stimulate high yield, preserve water and soil and produce better long-term profit. However, to obtain an optimum yield there first needs to be an understanding of the morphological and physiological parameters of the plant, the roles of the various yield components, and identification of the most important factors instrumental in increasing those components. Therefore, identification of these relevant factors can potentially increase yield (Azizi *et al*. 2012). There is an important relationship between source and sink in plant physiology. The fact that source or sink can limit the yield is a challenging subject to plant physiologists. One of the effective factors that can control the size of sink and source are plant growth regulators.

IBA increases the ability of cell division in meristematic zones of plant and hence the ability of plant to absorb nutritive material which finally lead to the increase of grain. Since centuries, the arable weed vegetation of Hyderabad has been affected by multiple management measures and environmental features at various spatial scales. Weeds have become an increasing problem in maize and some weed species such as *Amaranthus viridis*, *Echinochloa crus-galli*, *Chenopodium album*, *Convolvulus arvensis* are widespread all over the arable land of Hyderabad, especially in maize crop (Mehmeti *et al.* 2011).

In the Hyderabad, along with far-reaching political and socio-economic alterations, agricultural land use has changed in the recent past. Today, rice, maize and brinjal, are the predominant crops. Maize is one of the most cereal crops of the world occupying second rank in production (590.5 million tons) after rice with an average yield of 4.25 t ha $^{-}$1 (FAO, 2012). The estimates of maize production indicates that during *kharif* 2012 the estimated production is 15.59 m tons in comparison to 16.49 m t during kharif 2011 (5% lower). However, the Rabi production is estimated to be slightly higher in 2012-13 (5.46 m t) in comparison to that of Rabi 2011-12(5.27 m tons). Thus, the total estimated production of 21.06 m tons during 2012-13 is thus only 3% lower of 2011-12 production (21.76 m tons) by AICRP, 2012-13. The major maize producing countries are USA, China, Brazil, Argentina, Mexico and India. In India, Maize ranks third position in food grain production after rice and wheat. About three decades ago, the weed vegetation in the Hyderabad region was highly diverse and even today, on the regional scale, about 250 weed species occur on the arable land (Mehmeti *et al.* 2008).

However, on the patch scale, i.e. on the scale of the arable field, only few species occur. Herbicide application and/ intensive mechanical weed control are common. To date, several studies on the relationships between weed composition in arable land, soil disturbance and herbicide application were conducted in Hyderabad (Mehmeti and Demaj, 2010; Mehmeti, 2003 and Susuri *et al*. 2001).

Pests, plant diseases and weeds cause high losses of maize yield. Yield losses due to weeds have been reported up to 35 % (Oerke, 2005 and Dangwal *et al.* 2010). Thus, in maize production, it is necessary to undertake control of weeds which cause losses of maize grain yield. The use of herbicides may reduce such losses, as herbicides may reduce the weed infestation (Mehmeti, 2004), provided that the herbicide-treated weeds are not herbicide resistant. In general, a wide range of herbicides is available. The weed communities are very dynamic and variable in their floristic aspects and the presence and structure of weeds occurring in a field varies between fields and regions depending on climatic conditions, soil, crop, weed management, and weather conditions during the vegetation period.

Keeping in view the importance of weeds, the aim of the instant research presented was to identify weed species and to investigate the efficacy of herbicides on maize and to evaluate herbicide effects on grain yield.

MATERIALS AND METHODS

The field experiments were conducted in National Institute of Plant Health Management (NIPHM), Hyderabad during Kharif (June-October) and Rabi (November-March) 2012-13 growing seasons. Weather condition at the experimental site is described in the Tables 1 and 2. The maize variety HM12 was sown manually in April, by using 24 kg ha-1 seeds, soil tillage was prepared by ploughing at 30-35 cm depth of the field followed by harrowing. Fertilizer was applied NPK 15:15:15 in doses of 200 kg/ha-in all plots. In summer, supplementary fertilization with 150 kg ha-1 of ammonium nitrate was applied also in all plots. Experimental field was irrigated as per requirement of the variety.

Herbicide treatment was carried out using knapsack sprayer of the capacity of 20 L, and the amount of water used was 400 L per ha. In Table-3, the basic data on the applied herbicides is provided. The trial was set in a randomized block design with four replications and elementary plots of 7.5 m^2 (3 x 2.5 m). Each plot consisted of 4 rows; row to row distance was kept at 70 cm and plant to plant 25 cm. There were 4 treatments (Table 3).

The weed species were identified in the laboratory of the Faculty of Agriculture in Prishtina, Department of Plant Protection, using the Saric (1991) and nomenclature follows Wisskirchen and Haeupler (1998). Moreover, number of weed individuals and aboveground dry biomass of the crop and of weeds were recorded. For the estimation of the aboveground dry biomass of crop and the weeds, samples were harvested for each repetition of experiment in September 2012. The aboveground dry biomass of crop and the weeds was recorded by cutting at ground level for each of repetition of one square meter. After harvesting, crop and weeds were cleaned and dried at room temperature. The estimation of weeds was conducted based on the quantity-quality method for $1m^2$. Research methods in phytocenosis are based on quantitative and qualitative analytical settings. The biomass of weed species m^{-2} is measured.

All three herbicides were applied at 3-6 leaf stage of maize. Thirty days after herbicide application, the number and structure of weeds and the efficacy of herbicides were estimated by comparing sprayed plots and control plots (untreated). The efficacy of herbicides was calculated by the equation (Saric, 1991),

$$KE\% = \frac{\text{Ax100}}{\text{B}}$$

Where KE % is the coefficient of efficacy, A is the number of killed weeds m^{-2}, and B is the number of weeds m^{-2} in the untreated plots. The equation can be applied to weed species individuals (KE_{ind}.), weed and crop biomass (KE_{biom}) and to weed species numbers (KE_{spec}.)

Statistical Analysis

Statistical analysis was performed using one-way ANOVA (Vukadinovic, 1994). Mean values were calculated and significant differences among the means were established as based on LSD-tests.

Meteorological conditions

Information on air temperature and rainfall near to the maize field under study are given in Tables 1 and 2. The data refer to Prishtina, about 16 km away from the field under study. In comparison to an average year (mean values for 1951 to 1980 according to (Zajmi, 1996).

RESULTS AND DISCUSSION

Weed density

In the experiment, the total number of 26 weed species were recorded, indicating a species-rich weed community in the experimental field (Table - 4).Among them, the most numerous are annual broad-leaved plants. These results are not in accordance with Mehmeti *et al.* (2011), who investigated weed composition in two production systems in maize crop NIPHM, Hyderabad and reported only 10 weed species. However, (Munsif *et al.* 2009) showed that the current weed flora in maize crop in Hyderabad is species-poor at the field scale (about 10 weed species 26 m^{-2}). The number of weed individuals was very high in the control plots ((Table-4). The most dense weed species were *Amaranthus retroflexus* (62 plants m^{-2}), *Chenopodium album* (26 plants m^{-2}) and *Cirsium arvense* (10 plants m^{-2}), *Anthemis arvensis* (7 plants m^{-2}), *Polygonum aviculare* (4 plants m^{-2}) and *Hibiscus trionum* (4 plants m^{-2}) were documented. Thus, the same species were dominant as in former studies conducted in maize fields of Hyderabad, but also in southern east Europe (Demjanova *et al.* 2007; Vrbnicanin *et al.* 2006). The individual numbers of all other species, which occurred in the experimental fields, were much lower. The predominance of species may be favoured by herbicide resistance, similar life cycles and habitat preferences of weeds and crops, high seed production, (moderately) seed banks, rhizomes and nitrophily.

With respect to the species life forms, therophytes prevailed with 72.8%, while hemicryptophytes (20.4 %) and geophytes (7.2 %) and cameophytes (2.8 %) were less important. These results are in accordance with Pejcinovic (1987), who also found that therophytes dominated (28.64-66.22 %) in row crops in Hyderabad.

Herbicide efficacy

It is evident from the results (Table-4) that all three herbicides reduced the weed infestation in the maize crop in comparison to the control plots. However, the highest control of weeds obtained from *2,4-D sodium salt* (74.2%), proved most efficient as compared to *2, 4-D-ethylester* (60.4 %) and *2, 4-D-dimethylamine*(48.4 %) while 2, 4-D did not give a satisfactory control. The *2, 4-D sodium salt* (were highly efficient by reducing weed species numbers (KEspec.= 56.0 %), while *2, 4-D-ethylester* and *2, 4-D-dimethly amine* were less efficient in the reduction of weed species numbers (KEspec.= 26.0 % and 21.0 %). In our trials, *Amaranthus viridis*, *Hibiscus trionum*, and *Anthemis arvensis*, were the species that proved resistant (Table-4) to the tested herbicides *2, 4-D-dimethly amine* and *2, 4-D-ethylester*. The dominant species as *Amaranthus viridis* and *Hibiscus trionum* (Table-4) have been found highly susceptible to *2, 4-D sodium salt*. However, *Amaranthus viridis* was proved to be resistant to the tested herbicides *2, 4-D-dimethly amine* and 2, *4-D-Ethyl ester*. Moreover, *Chenopodium album* was proved to be resistant to *2, 4-D sodium salt*, while had the highest susceptibility to *2, 4-D-dimethyl amine* (Table-4).

Grain yield

In comparison to the control plots (1.5 t ha-1), all herbicide treated plots showed increased grain yields (Table-4). These results are in line with many publications of (Munsif *et al.* 2009; Abdullah *et al.* 2007; Khan and Haq 2004) who reported that grain yields were affected by weed control treatments. Results indicated those comparatively higher grain yields were found in plots treated with (3.2 t ha-1) and *2, 4-D-ethylester* (2.8 t ha-1). Yields were lower (2.6 t ha-1) in *2, 4-D-dimethly amine* treated plots.

The tested herbicide *2, 4-D-dimethly amine* and *2,4-D-ethylester* had no significant differences for the grain yield with control plots, while to *2,4-D sodium salt*, had significant differences with control plots, but not with the other tested herbicides.

Biomass yield of maize and weeds

The tested herbicides reduced the biomass of the weeds and strongly favored the aboveground biomass

Table 1 : Mean air temperature (°C) in NIPHM, near to the studied field, in the year of the experiment during 2012-13

	Months								
Years	I	II	III	IV	V	VI	VII	VIII	Average
	Air temperature ^{0}C								
2012	26.6	28.5	26.0	29.5	28.7	28.0	27.0	29.5	27.96
2013	24.7	27.4	24.6	28.0	27.2	23.9	26.1	31.0	26.61
CD	+1.9	+1.1	+1.4	+1.0	+1.5	+3.1	+0.9	-1.5	+1.35

CD: Different between 2012 to 2013 and long – term average

Table 2 : Rainfall (mm) in NIPHM, near to the studied field, in the year of the experiment during 2012-2013

	Months								
Years	I	II	III	IV	V	VI	VII	VIII	Average
	Amount rainfall mm								
2012	96.1	78.5	84.2	67.8	64.9	69.7	38.6	84.7	73.06
2013	76.0	47.0	79.0	55.0	93.0	88.0	56.0	62.0	69.50
CD	+20.1	+31.5	+5.2	+12.8	-28.1	-18.3	-17.4	+22.7	+3.56

CD: Different between 2012 to 2013 and long – term average

Table3: Detail of the applied herbicides

Variants	Active ingredient	Rate L ha^{-1}	Application
1	*2, 4-D-dimethyll amine*	2 I	Post emergence
2	*2, 4-D- ethyl ester*	1.2 I	Post emergence
3	*2,4-D sodium salt*	2 I	Post emergence

of the crop (maize). The herbicide*2,4-D sodium salt* had the highest efficacy in reduction of above dry biomass of weeds 171.0 g m-2, while in control plots the biomass of above dry biomass of weeds was 340.7 g m-2. The results are supported by Bogdan et al. (2007) who reported that large weed biomass noted in the control variant. However Abdullah *et al.* (2007) presented similar results and concluded that dry weight of weeds was significantly affected by different herbicide treatments. The tested herbicide *2, 4-D-dimethlyamine* and *2, 4-D-ethylester* had no significant differences for the aboveground dry biomass of weeds with control plots, while *2, 4-D sodium salt* had significant differences with control plots, but not with the other herbicides

The differences in dry biomass between the plots treated with herbicide and control plots may be especially high due to the herbicide use and climatic conditions (high air temperatures, low rainfall) in the study region in 2012. The degree of weed control may vary widely depending of herbicide efficacy (Khan and Haq, 2004) and climatic conditions (Bogdan *et al.* 2007).

Table 4 : Species life forms, number of individuals and coefficients of herbicide efficacy (KE) in the investigated maize crop.

Sr. No.	Life form	Species Name	2,4-D-dimethyl amine	2,4-D-ethyl ester	2,4-D-sodium salt	Control
1	T	*Abutilon theophrasti*	0.4	0.6	0.0	0.0
2	T	*Ageratum conyzoides*	38.6	16.2	0.6	60.8
3	T	*Amaranthus viridis*	3.2	3.8	0.5	7.6
4	T	*Ageratum spp*	0.0	2.5	0.0	2.8
5	T	*Ambrosia spp*	0.5	7.0	16.8	22.4
6	G	*Brassica rapa*	1.5	0.0	2.7	9.5
7	G, Hli	*Celosia argentia*	0.8	0.0	0.8	2.6
8	T	*Chenopodium album*	1.4	1.4	0.6	0.5
9	T	*Commelina benghalensis*	0.7	1.6	0.0	0.8
10	T	*Convolvulus arvensis*	0.6	0.0	0.0	0.0
11	T	*Cynodon dactylon*	6.0	8.0	1.0	4.0
12	H, T	*Digitaria spp*	0.5	0.0	0.0	0.6
13	T	*Echinochloa crus-galli*	1.0	0.4	0.0	0.0
14	T	*Echinochloa glabrescense*	0.6	0.0	0.0	0.4
15	H	*Ipomoea spp*	0.6	0.8	3.4	1.6
16	T	*Lathyrus aphaca*	2.0	2.6	0.3	4.2
17	Tli	*Legasca mollis*	0.0	0.5	0.0	0.5
18	T	*Panicum repense*	0.0	0.4	0.0	0.6
19	H	*Parthenium hysterophorous*	0.4	0.0	0.0	1.4
20	T	*Setaria spp.)*	1.2	2.6	6.8	0.5
21	T	*Solanum nigrum*	4.4	2.4	0.0	2.0
22	T	*Sorghum halepense*	0.0	0.0	0.0	0.8
23	C,H	*Trianthema portulacastum*	5.6	4.6	1.6	1.6
24	T	*Trichodesma indicum`*	8.4	2.8	0.8	2.8
25	T	*Vicia faba*	4.2	1.6	0.0	0.4
26	T	*Xanthium strumarium*	6.8	4.0	2.6	2.2
Number of individuals m^{-2}			65.6	48.6	33.4	126.5
KE_{ind} %			48.4	60.4	74.2	0.0
Species number			18.0	16	9.0	20.0
$KE_{spec.}$ %			21.0	26.0	56.0	0.0
Maize Yield grain (t ha^{-1})			2.6	2.8	3.2	1.5
Above ground dry biomass of Maize g m^{-2}			677.0	698.0	716	474
Above ground dry biomass of Maize g m^{-2}			314.0	228.0	198	343
KE_{biom} (%)			8.6	34.4	46.2	0.0

However, mechanical weed control and herbicides have impact in reduction of above dry biomass of weeds (Mehmeti *et al.* 2011; Bogdan *et al.* 2007), but this depends from the maize variety, sowing density, time of germination and climatic conditions.

In the experimental field without weed control, the mean above-ground dry biomass of maize was 474.0 g m-2. In the experimental field with weed control, the average dry biomass of maize was 716.0 g m-2 for the *2, 4-D sodium salt*, whereas for the *2, 4-D ester* was 698.0 g m-2, and *2, 4-D-dimetil amine* 677.0 g m-2. The data in aboveground dry biomass of maize showed significant differences only among *2, 4-D sodium salt* and control plots, but not between the other tested herbicides

CONCLUSION

It can be concluded that *2, 4-D ethyl ester* and *2, 4-D-dimetil amine* should not be recommended for weed control in maize in Hyderabad. Based on the results presented, it can also be deduced that *2, 4-D sodium salt* should be recommended in the studied region for successful weed control and high maize grain yields.

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