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Variations in morpho-physiological traits of sweet corn in response to weed management

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ABSTRACT

A field experiment was conducted in spring 2016 and 2017 at G.B.P.U.A&T, Pantnagar to evaluate the effect of different weed management practices on the morphological and physiological parameters of sweet corn (*Zea mays* L. var. '*Sugar 75*'), which determines the yield directly or indirectly. The experiment was comprised of twelve treatments. Effect of weed management practices were studied over several growth characters *viz*. plant height, crop dry matter accumulation, leaf area index, Fv/Fm value, crop growth rate, leaf chlorophyll content, yield, harvest index and nutrient uptake by crop. At 45 DAS, maximum crop height (57.5 cm), crop dry matter (776.5 g/m^2), CGR (26.1 g/m^2/day), LAI (6.71) and SPAD (60.4) records were obtained from twice hand weeding at 20 and 40 DAS. Fv/Fm value remained unaffected by weed interferences. A significant positive correlation of weed control efficiency was found with all the growth parameters However, weed dry matter accumulation and weed density impacted morpho-physiological characters and ultimate yield in a negative way.

INTRODUCTION

Maize is known as the "Queen of Cereals" due to its omnipresence and versatility in usage. Sweet corn (*Zea mays* L. var. '*Sugar 75*') is a special kind of maize having more than 16% sugar in its kernel. It is mainly grown for fresh consumption purpose and may also be used in industrially processed products. Its taste and nutritional value have made it a valued crop of eminence in all over the world and the scope of corn production is constantly increasing (Olabode and Sangodele 2015). Among the several factors, most critical factor for limiting the yield of maize appears to be the weeds, competing with the crop for nutrients, water, sunlight and space. Maize is highly suffered by the weeds due to wider spacing and slow initial growth, which favour the growth of weeds. Yield losses due to weeds are evident to the extent of 28 to 93%, depending on the type of weed flora, intensity and duration of crop-weed competition (Sharma and Thakur 1998).

Use of herbicides for managing the weeds is not necessarily an economically and ecologically fitting option every time as there are limitations and advantages of every weed control method, therefore integrated weed management is a good option for a sustainable production system (Ehsas *et al.* 2016). In the current study, the effect of different weed control measures on the morpho-physiological determinants of yield was studied. The morphological and physiological traits for yield variations were identified and the effect of weed management on them and how the final yield benefit is derived were investigated.

MATERIALS AND METHODS

The present experiment was conducted during spring season of 2016 and 2017 in N.E.B.C.R.C. of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), India (29 ^{0}N, 79.3 ^{0}E, 243.83 m) with average annual rainfall of 1350 mm. Soil of the experimental site was sandy loam, neutral in pH with high organic carbon (0.79%), medium available nitrogen (314.3 kg/ha), phosphorus (19.8 kg/ha) and potassium (220.3 kg/ha). Sweet corn variety '*Sugar 75*' was grown. The experiment was laid out in a randomized complete block design with twelve different weed management treatments *viz.* intercropping with mung bean, paddy straw mulching at 5 t/ha, atrazine at 1000 g/ha, halosulfuron-methyl at 90 g/ha, tembotrione at 120 g/ha, atrazine at 1000 g/ha with paddy straw mulching, atrazine at 1000 g/ha *fb* halosulfuron-methyl at 90 g/ha, atrazine at 1000 g/ha *fb* tembotrione at 120 g/ha, atrazine at 1000 g/ha *fb* one hand weeding at 40 DAS, twice hand weeding at 20 and 40 DAS, weed free and weedy check,

replicated thrice. Observations on morphological features were taken in field condition while analytical and physiological parameters were evaluated under lab conditions. Morpho-physiological observations include plant height, crop dry matter accumulation, leaf area index, Fv/Fm value (Chlorofluorometer), crop growth rate, leaf chlorophyll content index (SPAD), yield, harvest index and nutrient uptake by crop. Observations on weeds include total weed dry matter accumulation, total weed density and weed control efficiency at 45 DAS.

Data from both the years were pooled for analysis as no significant time to treatment interaction was found (Elsami and Afgani 2009). The weed density and dry matter were transformed using square root transformation ($\sqrt{(x+1)}$) for the purpose of treatment comparison using ANOVA. Effect of the treatments was compared statistically by Fisher's least significant difference method at 5% level of significance (Gomez and Gomez 1984). All statistical analysis were made using IBM SPSS 24.0 software package developed by IBM Corp. (2016).

RESULTS AND DISCUSSION

Weed studies

The major weed species which infested the experimental plots were *Cynodon dactylon* (10.4%), *Echinochloa colona* (4.6%) among grasses, *Alternanthera sessilis* (11.6%), *Celosia argentea* (7.5%) among broad-leaf weeds and *Cyperus rotundus* (57.8%) among sedges at 45 DAS. Weedy plots were recorded with highest total weed dry matter at all the crop growth stages. The effect of different treatments on total weed dry matter accumulation was found significant. The lowest total weed dry matter accumulation was recorded from twice hand weeded plots followed by pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha (**Table 1**). Swetha *et al.* (2015) has also reported similar findings. Efficient control of grassy and non-grassy weeds in maize with post-emergence application of tembotrione has been also reported by Singh *et al.* (2012).

All the weed control treatments reduced the weed density significantly over the weedy check. The lowest weed density was recorded from the twice hand weeded plots up to 45 DAS of the crop and afterwards the lowest total weed density was recorded with pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of halosulfuron methyl 90 g/ha due to effective control of *Cyperus rotundus* which had contributed about 70% of the total weed population at later stages of crop growth (**Table 1**). Similar results were also established in controlling *Cyperus rotundus* effectively in turf grass with halosulfuron-methyl by Desai *et al.* (2017).

At 45 DAS, the highest weed control efficiency was recorded from the twice hand weeded plots at 20 and 40 DAS which was at par with the pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha among the weed control treatments (**Table 1**). Better performance of pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha, may be attributed to good initial control over grassy and broadleaf weeds through pre-emergence application of atrazine 1000 g/ha and the weeds were further taken care by the post-emergence application of tembotrione 120 g/ha at 20 DAS.

Table 1. Effect of weed management practices on weed density, weed dry matter accumulation and weed control efficiency at 45 DAS (pooled data)

Treatment	Weed density (no./m^2)	Weed dry matter accumulation (g/m^2)	Weed control efficiency at (%)
Intercropping with mung bean	13.0 (168.0)	10.3 (105.4)	23.7
Paddy straw mulching 5 t/ha	11.0 (119.3)	8.5 (71.7)	48.0
Atrazine (1000 g/ha)	10.2 (102.7)	7.6 (57.1)	58.7
Halosulfuron-methyl (90 g/ha)	8.1 (65.3)	8.4 (69.2)	49.9
Tembotrione (120 g/ha)	7.8 (60.0)	4.8 (22.4)	83.8
Atrazine + paddy straw mulching (1000 g/ha + 5 t/ha)	9.9 (97.3)	7.2 (50.3)	63.6
Atrazine *fb* halosulfuron-methyl (1000g/ha *fb* 90)	5.9 (33.3)	6.6 (43.0)	68.9
Atrazine *fb* tembotrione (1000 g/ha *fb* 120)	7.0 (48.0)	3.8 (13.4)	90.3
Atrazine *fb* 1 hand weeding at 40 DAS (1000 g/ha)	7.1 (49.3)	4.8 (22.4)	83.7
Two hand weeding's at 20 and 40 DAS	4.3 (17.3)	3.4 (10.4)	92.4
Weed free	1.0 (0.0)	1.0 (0.0)	100.0
Weedy check	15.2 (230.7)	11.8 (138.1)	-
LSD (p=0.05)	0.68	0.14	3.96

*Original values are given in parentheses

Crop studies

The fastest increment in plant height was observed between the knee-high stage and 50% tasseling stage or in the grand growth phase to the tune of 8.63 cm/day in weed-free plots. All the treatments, except intercropping with mung bean, resulted in significantly higher plant height than weedy check. Among the weed control treatments, twice hand weeding at 20 and 40 DAS was found to have maximum plant height which was at par with pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione at 120 g/ha which was as good as weed-free plots, may be due to the efficient weed control of the treatments as evidenced by the higher weed control efficiency and lower weed dry matter accumulation. Effect of weed interference on plant height of maize was also reported by Da Silva *et al.* (2005).

Crop dry matter accumulation is one of the best indicators for predicting the crop yield because the accumulation of dry matter is directly related to effective photosynthesis which is the pre-requisite for obtaining higher yield levels. Among the weed control treatments, twice hand weeding at 20 and 40 DAS was recorded to have maximum crop dry matter accumulation over all the crop stages which was at par with pre-emergence application of atrazine at 1000 g/ha *fb* post-emergence application of tembotrione at 120 g/ha and comparable to weed free plots, may be due to effective weed control which had caused less competition to the crop.

Similar trend was found in Crop growth rate (CGR). The highest CGR at 45 DAS was recorded from twice hand weeding at 20 and 40 DAS (26.10 g/ m^2/day) which was at par with pre-emergence application of atrazine at 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha, alone application of tembotrione 120 g/ha and comparable to that of weed free plots (**Table 2**).

At 45 DAS maximum LAI, SPAD readings were also recorded from twice hand weeding at 20 and 40 DAS (6.71, 60.4) which was at par with pre-emergence application of atrazine at 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha, alone application of tembotrione 120 g/ha and weed free plots (**Table 2**). The effect of weed control on CGR, LAI was also reported by Teymoori *et al.* (2013). However, Fv/Fm value, the indicator of the PS-II activity and photosynthetic efficiency (Murchie and Lawson 2013), was found to remain unaffected by weed interference.

The highest green cob yield was recorded with twice hand weeding at 20 and 40 DAS (15.46 t/ha) which was at par with pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha (15.31 t/ha) among the weed control treatments. Pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha has resulted in highest harvest index (0.34) which was at par with alone post-emergence application of tembotrione 120 g/ha (0.32), pre-emergence application of atrazine 1000 g/

Table 2. Effect of weed management practices on morpho-physiological attributes of sweet corn at 45 DAS and yield (pooled data)

Treatment	Plant height (cm)	Crop dry matter accumulation (g/m^2)	LAI	Fv/Fm	Crop growth rate (g/m^2/day)	SPAD (CCI)	Cob yield (t/ha)	Harvest index (%)	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)	B:C ratio
Intercropping with mung bean	23.3	278.4	4.07	0.804	9.52	32.6	5.33	0.26	160.7	36.2	118.9	1.11
Paddy straw mulching 5 t/ha	28.1	412.0	3.86	0.809	11.16	31.4	6.88	0.30	178.5	40.4	125.6	1.37
Atrazine (1000 g/ha)	33.1	492.2	4.40	0.846	12.31	31.4	8.81	0.31	215.1	48.7	143.3	1.80
Halosulfuron-methyl (90 g/ha)	28.2	433.3	3.83	0.799	11.82	30.8	6.96	0.30	177.0	40.1	117.8	1.34
Tembotrione (120 g/ha)	47.8	700.3	5.93	0.842	22.21	54.7	13.36	0.32	307.0	69.6	196.6	2.59
Atrazine + paddy straw mulching (1000 g/ha + 5 t/ha)	38.0	516.8	5.06	0.797	14.67	46.8	9.21	0.28	251.3	56.7	180.4	1.78
Atrazine *fb* halosulfuron-methyl (1000g/ha *fb* 90)	42.8	601.4	4.96	0.816	17.81	49.0	10.81	0.31	272.7	61.7	191.5	2.02
Atrazine *fb* tembotrione (1000 g/ha *fb* 120)	56.7	766.9	6.12	0.875	24.53	59.2	15.31	0.34	343.2	77.9	216.3	2.87
Atrazine *fb* 1 hand weeding at 40 DAS (1000 g/ha)	46.3	691.9	5.51	0.842	20.78	52.7	13.13	0.32	312.9	70.8	211.5	2.49
Two hand weeding's at 20 and 40 DAS	57.5	776.5	6.71	0.836	26.10	60.4	15.46	0.31	369.2	83.7	233.7	2.75
Weed free	59.3	789.9	6.66	0.872	26.36	61.8	15.92	0.32	378.2	85.5	240.2	2.55
Weedy check	23.3	253.6	3.69	0.781	8.54	29.9	5.13	0.27	149.8	33.7	110.7	1.08
LSD (p=0.05)	3.45	39.6	1.19	NS	5.85	6.6	1.42	0.03	44.4	8.5	68.7	-

ha *fb* one hand weeding at 40 DAS (0.32) and twice hand weeding at 20 and 40 DAS (0.31) (**Table 2**).

The maximum nitrogen (369.2 kg/ha), phosphorus (83.7 kg/ha) and potassium (233.7 kg/ha) uptake by the crop were recorded in twice hand weeding at 20 and 40 DAS which was at par with pre-emergence application of atrazine at 1000 g/ha *fb* post-emergence application of tembotrione at 120 g/ha among the weed control treatments owing to lesser competition faced by crop from weeds due to superior control over weeds.

Growth characters of sweet corn which are the direct or indirect determinants of yield are significantly affected by the weed management practices. Especially, the treatments having higher weed control efficiency are found to have higher plant height, crop dry matter, crop growth rate, LAI and final yield. Twice hand weeding and pre-emergence application of atrazine 1000 g/ha *fb* post-emergence application of tembotrione 120 g/ha were found best among the weed control treatments with respect to all growth parameters due to higher weed control efficiency, lower weed density and lower weed dry matter accumulation. Better understanding of these morphological and physiological characters may help in the selection of better agrotypes and weed management practices for achieving a higher productivity.

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