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Effect of Row Spacing and Weed Management Practices on Growth and Yield of Summer Maize (*Zea mays* L.)

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ABSTRACT

A field experiment was conducted during summer 2014 at the College Farm, Navsari Agricultural University, Navsari to study the effect of row spacing and weed management practices on growth and yield of maize (Zea maize L.). Experiment result revealed that the growth and yield parameters viz., plant height, number of leaves per plant, dry matter production per plant, number of cobs per plant, cob weight and grain weight per cob were influenced significantly due to row spacing. Significantly higher values of these parameters were recorded under 60 cm (S_2) row spacing. However, grain and stalk yield were significantly higher under 45 cm (S_1) row spacing. From economic point of view, the maximum net realization of Rs. 44911/ha and B:C ratio 1:3.66 were accrued under spacing 45 cm (S_1) as compared to 60 cm (S_2) spacing. Weed management treatments influenced significantly various growth and yield attributing characters viz., plant height, number of leaves per plant, dry matter production per plant, number of cob per plant, cob weight, grain weight per cob and 100 grain weight which caused significant effect on grain and stalk yield of maize. In most of the cases, treatment weed free (W_2) was found superior than rest of the treatments, but remained at par with atrazine 1.0 kg/ha as pre-emergence + HW and IC at 30 DAS (W_3) and atrazine 0.5 kg + pendimethalin 0.25 kg/ha tank-mix pre-emergence fb 2,4-D (SS) 0.5 kg/ha at 20 DAS (W_6). The highest net realization of Rs. 48631/ha was obtained from weed free (W_2) treatment followed by treatments W_3 (Rs. 48342/ha) and W_6 (Rs. 46559/ha). The highest B: C ratio (1:3.79) was observed in treatment W_3 followed by treatment W_6 (1:3.72) and W_4 (1:3.52).

Key words: *Row spacing, Weed management, Tank-mix herbicide, Atrazine, Pendimethalin and 2, 4-D.*

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INTRODUCTION

In India, maize is the third important food crop after rice and wheat. It is one of the most versatile emerging crops having wider adaptability. Maize is known as "**Queen of cereals**" because of its highest genetic yield potential. It is the only food cereal crop that can be grown in diverse seasons, ecologies and uses. Being a C_4 plant, it is capable to utilize solar radiation more efficiently even at higher radiation intensity. Besides this, maize has many types like normal yellow/white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, quality protein maize, etc. Apart from this, maize provides important industrial raw material and large opportunity for value addition. Though it is mainly cultivated in *kharif* season, it is also grown as *rabi* and summer crop, due to its photo-insensitive nature.

Plant spacing/density plays an important role in the competitive balance between weeds and maize. The narrow row spacing limites the weed growth and increase crop yield. Close spacing leads to overcrowding and more plant competition for growth factors whereas, wider spacing reduce the plant population and enhances the vegetative growth and provide favorable condition to weed growth, thereby decreasing the total yield. Optimum spacing allows for easy of field operations and minimizes competition among plants for light, water, and nutrients[9]. Narrow rows make more efficient use of available light and also shade the surface soil more completely during the early part of the season while the soil is still moist[4].

Weeds compete with crop plants for various inputs like water, nutrients, sunlight, space, *etc*. The importance of their management seldom requires any mention especially under the present day high input farming systems. Weed growth throughout the crop growing period caused 43 per cent reduction in grain yield[12]. Herbicides alone or in combination with other weed management techniques reduce weed crop competition and the risk of weeds growing unchecked in initial growing period[1,5].

MATERIAL AND METHODS

A field experiment was conducted during summer 2014 at Navsari. To evaluate the effect of row spacing and weed management practices on growth and yield of maize (*Zea maize* L.). The soil of the experimental field was clayey in texture, low in available nitrogen (230 kg/ha), medium in available phosphorus (38 kg/ha) and fairly rich in available potash (379 kg/ha).

Fourteen treatment combinations consisting of two level of row spacing *viz*., 45 cm (S_1) and 60 cm (S_2) and seven weed management treatments *viz*., un weeded control (W_1), weed free (W_2), atrazine 1.0 kg/ha as (pre-emergence) *fb* HW & IC at 30 DAS (W_3), atrazine 0.5 kg/ha as (pre-emergence) *fb* 2,4-D (SS) 0.5 kg/ha at 20 DAS (W_4), atrazine 0.5 kg/ha as (pre-emergence) *fb* metsulfuron-methyl 4 g/ha at 20 DAS (W_5), atrazine 0.5 kg + pendimethalin 0.25 kg/ha tank-mix (pre-emergence) *fb* 2,4-D (SS) 0.5 kg/ha at 20 DAS (W_6) and atrazine 0.5 kg + pendimethalin 0.25 kg/ha tank-mix (pre-emergence) *fb* metsulfuron-methyl 4 g/ha (W_7) at 20 DAS were evaluated in factorial randomized block design with three replications using maize var. Gujarat Maize-6 sown at 20 cm plant spacing and row spacing as per the treatment. 120 kg N/ha in two equal splits at sowing and 30 DAS was applied uniformly to all the plots and 60 kg phosphorus was applied at sowing.

The seeds of maize variety GM-6 received from Main Maize Research Station, Anand Agricultural University, Godhra (Gujarat) was used for this experiment. It is extra early (75-80 days), drought escaping and white flint grained composite variety for marginal environment of tribal belt of Gujarat, Rajasthan and Madhya Pradesh states of India. The required quantity of seeds was worked out for experimental area and seeds treated with thirum 3 g/kg seed before sowing. Treated seeds were dibbled at 5 cm depth in the same fertilized furrows on 25-2-2014 as per the treatment spacing. Seeds were covered properly with soil and light irrigation was applied in each plot immediately after sowing.

The prominent weed flora observed in the weedy plot of the experiment was *Echinochloa crusgalli* L., *Cynodon dactylon* L. and *Digitaria sanguinalist* L. among the monocot weeds; *Cyperus rotundus* L. among the sedges and *Amaranthus viridis* L., *Alternanthera sessillis*, *Digera arvensis* Forsk, *Convolvulus arvensis* L., *Vernonicinera* Less, *Cassia tora* L. and *Trianthema portulacustrum* among the dicoat weeds during the years.

Method of application of herbicide

The liquid form of pendimethalin was measured by measuring cylinder, while atrazine, 2, 4-D (SS) and Metsulfuron methyl was weighted as per the required quantity at the time of preparation of solution according to treatments. The spraying was done by using knapsack sprayer with flat fan nozzle using 500 liters of water per hectare.

Pre-emergence application of herbicides was done one day after sowing while post-emergence herbicides were applied at 20 days after sowing. The required quantity of trade formulation of each herbicide for gross plots of 27 m^2 was calculated using the following formula.

$$Rh = \frac{Ai \times At}{Ci} \times 100$$

Where,
Rh = Required quantity of trade formulation of herbicide (ha)
Ai = Quantity of active ingredient to be applied (kg)
At = Area to be treated (ha)
Ci = Concentration of active ingredient in the trade formulation

The effectiveness of treatment is observed in growth parameter like plant population per net plot, plant height, number of leaves per plant and dry matter per plant, also study in yield and yield attributing character like seed and/or soil inoculation with fertilizer was assessed in the plant growth parameters like plant height, dry matter per plant, functional leaves per plant, number of internodes per plant and yield attributes viz., cob per plant, cob weight, grain weight per cob, 100 grain weight, grain and fodder yield. The economics of different treatment combinations was worked out in terms of net returns/ha and benefit cost ratio.

RESULTS AND DISCUSSI`ON

Effect of row spacing on growth, yield attributes and yield

Examined data in Table-1 revealed that remarkably higher plant population under 45 cm rows spacing as compared to 60 cm row spacing was due to accommodation of more number of plants per unit area at closer row spacing. It is ascertained from the data that the plant population in all the treatments were different which indicates that variation observed in growth and yield attributes as well as yield was mainly due to plant population. Plant height was maximum under wider row spacing of 60 cm (S_2) and minimum under narrow row spacing 45 cm (S_1). While, in case of number of leaves per plant (Table-1) at 30, 60 and 90 DAS were significantly influenced by different spacing. Spacing of 60 cm (S_2) recorded considerably higher number of leaves per plant compared to 45 cm (S_1). Higher plant height, number of leaves per plant in lower plant density (wider spacing) might be due to greater light interception, efficient utilization of soil moisture under lower degree of inter-plant competition. Significantly the higher dry matter per plant was observed in row spacing of 60 (S_2) as compared to 45 cm (S_1) (Table-1). The probable reasons for the increase in plant dry matter with reducing plant population might be due to increase in plant growth, ultimately lead to production of more photosynthets. These results are in confirmity with the results of Thakur *et al.*[14] and Gollar and Patil[7].

The data showed that 60 cm (S_2) row spacing registered significantly higher number of cob per plant (1.37), cob weight (135.87 g) and grain weight per cob (44.56 g) as compared to 45 cm (S_1) row spacing (Table-2). Higher values of growth and yield parameters in 60 cm (S_2) row spacing might be due to less competition for space, moisture and nutrients which accelerate normal photosynthesis activity owing to more interception of sunlight. It resulted in more accumulation of photosynthets and maximum dry matter production per plant which ultimately reflected in better yield attributes under 60 cm (S_2) row spacing. These findings are sustained with those reported by Bhatt (2012) and Golada *et al.*[6]. Row spacing of 45 cm (S_1) recorded significantly the higher grain yield (3681 kg/ha) than 60 cm (S_2) row spacing (3413 kg/ha). Thus, the results indicated that higher number of cobs per plant and more cob weight recorded under 60 cm (S_2) row spacing did not reflect positive effect on grain yield of maize as compared to 45 cm (S_1) row spacing. Similar observations were also recorded by Mathukia *et al.*[10]. The remarkable increase in stalk yield under 45 cm spacing was mainly due to increased plant population per unit area. The results are in accordance with those of Thakur *et al.*[15], Sukanya *et al.* and Bhatt[3]. The economic analysis of the data given in Table-2 revealed that 45 cm row spacing secured maximum net realization (Rs. 44911/ha) and B: C ratio (3.66) as against net realization of Rs. 39773/ha and B:C ratio of 3.38 in 60 cm row spacing. These results conform to those reported by Arvadiya *et al.*[2] and Mathukia *et al.*[10].

Effect of weed management on growth, yield attributes and yield`

Significantly the higher plant height at 60 DAS and at harvest, number of leaves per plant at 60 DAS and 90 DAS, dry matter production per plant, was observed in under weed free control (W_2) (Table-1), being statistically at par with atrazine 1.0 kg/ha as PE *fb* HW & IC at 30 DAS (W_3), atrazine 0.5 kg + pendimethalin 0.25 kg/ha tank-mix PE *fb* 2,4-D (SS) 0.5 kg/ha at 20 DAS (W_6) and atrazine

0.5 kg/ha as PE *fb* 2,4-D (SS) 0.5 kg/ha at 20 DAS (W_4). This might be due to better availability of moisture, nutrient, light and space to the crop owing to less weeds in these treatments. The lowest plant height and number of leaves per plant in unweeded control might be due to more competition between crop and weed for moisture nutrient, light and space. The results are in conformity with observations of Kotru *et al*[8].

An appraisal of data in (Table-2) indicated that various weed management treatments significantly influenced number of cobs per plant, cob weight and grain weight per cob in maize. Treatment weed free (W_2) resulted in the maximum number of cobs per plant, cob weight, 100 grain weight being statistically at par with W_3, W_6 and W_4. Grain weight per cob was at par with W_3. The lowest cob per plant, cob weight, 100 grain weight and grain weight per cob were noted in unweeded control treatment (W_1). These parameters under various treatments were in the order of $W_2 > W_3 > W_6 > W_4 > W_5 > W_7 > W_1$. This might be due to significant reduction in crop weed competition due to effective control of weeds under these treatments reflected in better growth and development of the crop in term of higher number of cob per plant, cob weight, 100 grain weight and grain weight per cob. The present results are in close confirmity with the findings of Nadiger *et al.*[11] and Mathukia *et al*[10].

The remarkable increase in grain and stalk yield under these treatments (W_2, W_3 and W_6) given in Table-1 might be due to effective control of weeds in terms of reduced weed population and dry weight of weeds, which facilitated the crop to utilize more nutrients and moisture for better growth and development. These findings are in close agreement with those reported by Mathukia *et al.*[10] and Shrinivas *et al.*[13].

The highest net realization of Rs. 48631/ha was obtained from treatment of weed free (W_2) followed by W_3 and W_6 (Table -2). The highest B: C ratio (1:3.79) was observed in treatment W_3 followed by treatment W_6 (1:3.72) and W_4 (1:3.52).

Table 1: Effect of row spacing spacing and weed management practices on growth parameter of summer maize

Treat-ment	Plant population/net plot		Plant height (cm) at		Number of Leaves per plant			Dry matter (g/plant)	
	Initial	Harvest	30 DAS	30 DAS	Harvest	60 DAS	90 DAS	30 DAS	harvest
Row spacing (S)									
S_1	134.06	131.95	99.80	121.07	7.44	10.48	12.37	22.14	147.84
S_2	108.30	106.33	118.3	144.99	8.02	12.12	13.95	23.88	174.99
S.Em	2.76	2.92	2.20	3.09	0.18	0.24	0.24	0.40	3.28
C.D.	8.01	8.49	6.39	8.99	0.51	0.70	0.70	1.17	9.52
Weed management (W)									
W_1	116.56	114.33	100.3	121.04	7.44	10.29	12.16	20.14	146.91
W_2	125.22	123.17	118.7	147.12	7.99	12.34	14.19	25.14	174.41
W_3	123.89	121.83	`115.9	143.11	7.91	12.02	13.88	24.20	170.18
W_4	121.22	119.17	110.3	135.08	7.74	11.39	13.25	23.16	161.72
W_5	119.89	117.83	103.4	124.53	7.65	10.58	12.47	22.64	157.49
W_6	122.56	120.67	113.1	139.09	7.82	11.71	13.57	23.68	165.95
W_7	118.89	117.00	101.6	121.23	7.57	10.77	12.63	22.12	153.26
S.Em	5.15	5.46	4.11	5.79	0.33	0.45	0.45	0.75	6.13
C.D.	NS	NS	11.95	16.83	NS	1.32	1.31	2.18	17.81

Table 2: Yield attribute, yield and economics of summer maize as influenced by various treatments of spacing and weed management

Treat-Ment	no. of cob per plant	Cob weight (g)	Grain weight per cob (g)	100 grain weight (g)	Grain yield (kg/ha)	Stalk yield (kg/ha)	Net realization (Rs./ha)	B:C
Row spacing (S)								
S_1	1.20	119.55	42.45	17.74	3681	10284	44911	3.66
S_2	1.37	135.87	44.56	17.69	3413	8697	39773	3.38
S.Em	0.03	2.90	0.71	0.20	92	201	-	-
C.D.	0.07	8.42	2.06	NS	267	586	-	-
Weed management (W)								
W_1	1.19	114.92	37.77	15.32	2218	8539	23511	2.46
W_2	1.40	139.42	49.35	20.15	4118	10645	48631	3.47
W_3	1.35	135.65	47.16	19.23	3977	9970	48342	3.79
W_4	1.29	128.11	43.30	17.63	3605	9450	42910	3.52
W_5	1.24	122.43	40.01	17.08	3493	9189	41105	3.42
W_6	1.31	131.88	44.97	18.32	3856	9710	46559	3.72
W_7	1.21	120.57	42.00	16.26	3564	8929	41714	3.44
S.Em	0.05	5.42	1.33	0.38	172	377	-	-
C.D.	0.14	15.75	3.86	1.09	499	1095	-	-

CONCLUSION

From the results of one year experimentation, it is concluded that higher profitable yield of summer maize on deep black soil of South Gujarat can be obtained by maintaining row to row spacing of 45 cm and keeping the crop weed free by three hand weeding (20, 40 and 60 DAS) or apply atrazine 1.0 kg/ha as PE *fb* HW & IC at 30 DAS or atrazine 0.5 kg + pendimethalin 0.25 kg/ha tank-mix PE *fb* 2,4-D (SS) 0.5 kg/ha at 20 DAS.

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