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STUDIES ON PLANTING TECHNIQUE-CUM-IRRIGATION METHODS UNDER VARIED LEVELS OF NITROGEN ON GROWTH AND DEVELOPMENT OF WINTER MAIZE (*Zea mays* L.)

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Abstract: The experiment entitled, "Studies on planting technique-cum-irrigation methods under varied levels of nitrogen on growth and yield of Winter Maize (*Zea mays* L.)" was conducted at PAU, Ludhiana on loamy sand soil. Different planting techniques-cum-irrigation methods and nitrogen rates were compared to evaluate the performance of winter maize. The trial was laid out in factorial RBD with six planting techniques-cum-irrigation methods (1 Row FIRBS/EF, 2 Row FIRBS/EF, 1 Row FIRBS/AF, Conv.-FIRBS/EF, Conv.-FIRBS/AF and Conv./S) and two nitrogen rates (N_{175} and N_{250}) in four replications. Under these treatments the manipulation of soil particles provided better soil aeration and moisture conditions resulted in vigorous plants which maintained their superiority in growth indicated through taller plants, LAI and dry matter accumulation (g/plant). The more dry matter accumulation and its partitioning which helped to attain larger sink capacity and sink strength (number of grains/cob, 1000-grain weight) to accommodate more photosynthates and thus, kept an edge in grain yield. The planting techniques-cum-irrigation methods (1 Row FIRBS/EF, Conv.-FIRBS/EF) resulted 66.65 and 66.75 q/ha grain yield which was significantly higher than (2 Row FIRBS/EF and 1 Row FIRBS/AF) with 51.45 and 43.35 q/ha grain yield. Thus, furrow irrigated raised bed-till system (FIRBS) with each furrow (EF) irrigation method showed the better growth with optimum source-sink relation. Similarly, the plants supplied with N_{250} maintained their superiority over the plant supplied with N_{175} in growth, source size, sink capacity and its strength which resulted in significant increase in grain yield 11.7 per cent over lower dose of nitrogen.

Key words: EF, AF, Conv./S, Dry matter, FIRBS and Sink capacity.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crop which contains about 70.7 per cent carbohydrates, 10 per cent proteins, 4 per cent oil, 13.5 per cent moisture, 1.4 per cent ash and 0.4 per cent other substances. In India, out of total production, 35 per cent is being used for human consumption, 25 per cent each in poultry feed and cattle feed and 15 per cent in food processing (corn flakes, pop corn etc.) and other industries mainly starch, dextrose, corn syrup, corn oil etc. (Singhal 1999). In Punjab, maize ranks third in acreage and production after wheat and rice, occupying 133 thousand hectares, with a production of

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491 thousand tonnes (Anonymous 2013). The rice-wheat cropping system largely adopted by the farmers in Punjab has adversely affected the ground water table and soil health, increased pest and disease problems and has created ecological imbalance. So, winter maize by virtue of its high yield potential, low incidence of insect-pest and diseases, lodging tolerance coupled with its wider adaptability at aerial environment especially to low temperature conditions as compared to main season crop, is a viable choice in diversification (Lal *et al* 2001). The water table in Punjab on an average is declining @ 23 cm/year (Taneja 2002). Thus, there is a great need to try various irrigation methods in order to reduce its water requirement without reduction in yield. Irrigation frequency, its methods of application and nitrogen management significantly influenced the nutrient uptake and may ultimately increase the yield of maize. Nitrogen is another key input for obtaining the potential yield of crops. Winter maize has been observed to be highly responsive to fertilization, results in healthy crop and also helps in protecting against cold damage which is a pointer towards using higher doses of nitrogen to explore the yield potential in winter maize. Keeping these considerations in view, the present study has been planned with the following objective:

1. To evaluate the effect of different planting techniques-cum-irrigation methods under varied levels of nitrogen on the growth and yield attributes in winter maize.
2. To study the interactional effect of different planting techniques-cum-irrigation methods under varied levels of nitrogen on the yield in winter maize.

MATERIALS AND METHODS

The present investigation entitled, "Studies on planting technique-cum-irrigation methods under varied levels of nitrogen on growth and yield of Winter Maize (*Zea mays* L.)" was conducted at Students' Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana on loamy sand soil. Different planting techniques-cum-irrigation methods and nitrogen rates were compared to evaluate the performance of winter maize. The trial was laid out in factorial RBD with six planting techniques-cum-irrigation methods (1 Row FIRBS/EF, 2 Row FIRBS/EF, 1 Row FIRBS/AF, Conv.-FIRBS/EF, Conv.-FIRBS/AF and Conv./S) and two nitrogen rates (N_{175} and N_{250}) in four replications. A common basal dose of 60 kg P_2O_5/ha through single super phosphate (16% P_2O_5) and 30 kg K_2O/ha through muriate of potash (60% K_2O) was applied at the time of sowing. The crop was fertilized with 175 kg N/ha and 250 kg N/ha treatment wise was applied through urea (46% N). One-third N was applied at the time of sowing, one-third was top dressed in mid January and the

remaining one third at pre-tasseling stage. The winter maize cv. Sheetal The sowing was done with dibbling method by using 3 seeds per hill.

RESULTS AND DISCUSSION

Growth and Development

Different planting techniques have not shown significant effect on plant height (Table 1). However, significant difference was observed in plant height under both the levels of nitrogen viz. N_{175} and N_{250}. The plants under N_{250} showed an edge in final plant height over those under N_{175} by attaining 165.1 cm plant height. The FIRBS/EF planting techniques-cum-irrigation methods helped in maintaining better aeration, more conservation of soil moisture and for a longer period facilitated better root growth which favoured vigorous plants in the better anchorage against lodging to attain more plant height. Such a favourable effect of FIRBS/EF planting techniques-cum-irrigation methods has also been advocated by Debebe (1999) and Kaur (2002). The more plant height under bed and ridge plantings might be due to better physical conditions for root development.

Maximum LAI to the tune of 7.01 was observed under 2 Row FIRBS/EF planting techniques-cum-irrigation method which was significantly higher than rest of the planting techniques-cum-irrigation methods. A significant difference in maximum LAI was observed under both the levels of nitrogen, where plants supplied with 250 kg N/ha maintain their superiority in source size over the plants where the N was applied 175 kg/ha which is well depicted through an increment of 0.28. The period of favourable aerial environment (optimum air temperature coupled with clear sky conditions for more influx of solar radiation) with non-limiting nitrogen supply conditions had a direct bearing on the growth of source size of winter maize has been reported by Govil and Pandey (1998) and Kaur (2002).

The maximum number of cobs per plant (1.35) were observed under 1 Row FIRBS/EF and Conv.-FIRBS/EF planting techniques-cum-irrigation methods which were significantly higher than that observed under 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods Table (2). But these planting techniques-cum-irrigation methods were significantly higher than rest of treatments viz. 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF, where the number of cobs/plant remained at par with each other. Kaur (2002) has also reported significantly more number of cobs/plant in one row of maize crop raised on bed, ridge and trench than bed-2 R, trench-2 R and flat sown crop. A non-significant difference was observed under both the levels of

nitrogen application. Interactional effects of planting techniques-cum-irrigation methods and N rates were found to be non-significant.

The maximum cob length (15.5 cm) was observed under 1Row FIRBS/EF which was significantly higher than 2 Row FIRBS/EF, 1Row FIRBS/AF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods. The planting techniques-cum-irrigation method 2 Row FIRBS/EF was at par with Conv.-FIRBS/AF and 1 Row FIRBS/AF planting techniques-cum-irrigation methods. The cob length under Conv./S, Conv.-FIRBS/AF and 2 Row FIRBS/EF was found to be at par. 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods were also at par with each other. During both years, a non-significant difference in cob length was observed under both the levels of nitrogen. Interactional effects of planting techniques-cum-irrigation methods and N levels were found to be non-significant.

The plants under 1 Row FIRBS/EF showed maximum cob girth of 12.3 cm followed by Conv.- FIRBS /EF (12.1 cm), Conv./S (11.7 cm), 2 Row FIRBS /EF(10 cm), Conv.-FIRBS /AF (9.85 cm) and 1 Row FIRBS /AF (9.1 cm). The plants supplied with 250 kg N/ha maintained their superiority in cob girth over the plants supplied with 175 kg N/ha. The interactional effects of planting techniques-cum-irrigation methods and N levels were found to be non-significant.

A non-significant difference in number of grains per cob were observed under 1Row FIRBS/EF, Conv.-FIRBS/EF and Conv./S planting techniques-cum-irrigation methods, but it was significantly higher than those of the 2 Row FIRBS/EF, 1Row FIRBS/AF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods. The plants under 2 Row FIRBS/EF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods were at par as for as the number of grains/cob is concerned except 1 Row FIRBS/AF planting technique-cum-irrigation method during 1st year of study where it was significantly lesser than the other treatments. The plants supplied with 250 kg N/ha gave significantly higher number of grains per cob over the plants where N was applied 175 kg N/ha. The increase in number of grains/cob with higher dose of nitrogen over the lower dose was to the tune of 11.1 per cent. The interactional effects of planting techniques-cum-irrigation methods and N levels were found to be non-significant.

A non-significant difference in 1000-grain weight was observed under all the planting techniques-cum-irrigation methods are presented in Table (1). The 1000-grain weight under

various planting techniques-cum-irrigation methods and nitrogen rates ranged from 237.4 to 262.8.

Grain yield

The grain yield under 1 Row FIRBS/EF, Conv.-FIRBS/EF and Conv./S planting techniques-cum-irrigation methods was to the tune of 66.6 , 66.7 and 63.0 q/ha respectively, which was found to be at par with each other but it remained significantly higher than the grain yield observed in rest of the planting techniques-cum-irrigation methods viz. 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF. The grain yield under 2 Row FIRBS/EF and Conv.-FIRBS/AF planting techniques-cum-irrigation method was at par, which was significantly higher than 1 Row FIRBS/AF planting technique-cum-irrigation method (Table 1). The plants supplied with nitrogen 250 kg N/ha gave significantly higher grain yield over the plants, where N was supplied 175 kg N/ha.

The perusal of data in Table (2) revealed that maximum grain yield was observed under Conv.-FIRBS/EF (63.6 q/ha) which was at par with 1 Row FIRBS/EF and Conv./S planting techniques-cum-irrigation methods when the plants were supplied with 175 kg N/ha, but produced significantly higher grain yield than rest of planting techniques-cum-irrigation methods viz. 2 Row FIRBS/EF, 1Row FIRBS/AF and Conv.-FIRBS/AF. With the increment of 75 kg N/ha, the maximum grain yield (72.4 q/ha) was observed in 1 Row FIRBS/EF planting techniques-cum-irrigation method which was at par with Conv.-FIRBS/EF and Conv./S planting techniques-cum-irrigation methods. But produced significantly higher grain yield than 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF planting techniques-cum-irrigation methods. At both the levels of nitrogen application, the planting techniques-cum-irrigation methods 1 Row FIRBS/AF and Conv.-FIRBS/AF were at par with each other even where with the increment of 75 kg N/ha produced a non-significant increase in grain yield, but rest of the planting techniques-cum-irrigation methods produced a significant difference in grain yield with higher dose of 250 kg N/ha over lower dose of 175 kg N/ha. Thomas and Kasper (1997) observed that practice of ridging was beneficial for root development and grain yield.

Stover Yield

The data presented in Table (1) revealed that maximum stover yield was observed to the tune of 154.2 and 173.2 q/ha under 175 kg N/ha and 250 kg N/ha respectively under the 2 Row FIRBS/EF planting technique-cum-irrigation method, which was significantly higher than the rest of the planting techniques-cum-irrigation methods. The significant higher stover

yield under 2 Row FIRBS/EF than all other planting techniques-cum-irrigation methods might be due to double number of rows as compared to other planting techniques-cum-irrigation methods. These results are in line with the results of Kaur (2002) who obtained 73.3 per cent more stover yield in bed-2R over bed-1R. Similar results have also been reported by Debebe (1999). They reported that ridge planting produced significantly higher stover yield over flat planting.

The data given in Table (2) indicate that during stover yield of (154.2-173.2 q/ha) was observed under 2 Row FIRBS/EF planting techniques-cum-irrigation method when N varies from 175 kg N/ha to 250 kg N/ha respectively, which remained significantly higher than those observed under rest of the planting techniques-cum-irrigation methods. The stover yield under 2 Row FIRBS/EF was followed by 1 Row FIRBS/EF and Conv.-FIRBS/EF planting techniques-cum- irrigation method which were at par with each other. But gave significantly higher stover yield than 1 Row FIRBS/AF, Conv.-FIRBS/AF and Conv./S planting techniques-cum-irrigation methods. The optimum physical and aerial environment conditions provided to the crop with above mentioned methods of irrigation than alternate furrow irrigation method provides more nutrients and their uptake through better physiological process. The more photosynthetic activities with better source-sink relation which is well depicted through more plant height and LAI which harvest more solar radiation through more dry matter accumulation (g/plant) during the crop season. Thus, helps in better partitioning of the photosynthates under turgid canopy conditions in furrow irrigated raised till bed system (FIRBS) with irrigation to each furrow, thus, resulted higher sink capacity which is well depicted through more cobs per plant, cob length and cob girth coupled with higher sink strength indicated through significantly higher number of grains/cob and ultimately more grain and stover yield. Guar *et al* (1992) observed that with the application of 120 kg N/ha increased 10.8 per cent grain yield and 11.1 per cent stover yield over the lower dose of 80 kg N/ha.

CONCLUSIONS

The results revealed that 1Row FIRBS/EF, Conv.-FIRBS/EF produced significantly higher grain yield than observed than rest of the planting techniques-cum-irrigation methods viz. 2 Row FIRBS/EF, 1 Row FIRBS/AF and Conv.-FIRBS/AF. The winter maize crop supplied with nitrogen 250 kg N/ha gave significantly higher grain as well as stover yield over the plants, where nitrogen was supplied with 175 kg N/ha.

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Table 1: Effect of different planting techniques-cum-irrigation methods and nitrogen rates on growth and development of Winter maize

Treatment	Final plant height (cm)	LAI 160 DAS	Cobs/ plant (No.)	Cob length (cm)	Cob girth (cm)	Grains/ cob (No.)	1000 grain wt. (g)	Grain Yield (q/ha)	Stover yield (q/ha)
Planting techniques-cum-irrigation methods									
1 Row FIRBS /EF	166.0	4.08	1.35	15.5	12.3	424.1	262.8	66.6	118.45
2 Row FIRBS /EF	165.2	7.01	1.1	14.0	10	335.6	246.1	51.4	163.7
1 Row FIRBS /AF	155.0	3.45	0.95	12.9	9.1	285.4	237.4	43.3	83.8
Conv.- FIRBS /EF	162.5	3.97	1.35	15.4	12.1	419.7	257.6	66.7	117
Conv.- FIRBS /AF	156.2	3.67	1.1	13.8	9.85	356.4	244.2	50.1	86.1
Conv./S	153.4	3.98	1.25	15.0	11.7	405	255.4	63.0	102.9
CD (0.05)	NS	0.49	0.1	1.3	1.0	42.4	NS	3.3	4.0
Nitrogen rates (kg/ha)									
N_{175}	154.3	4.22	1.1	14.1	10.3	355.9	246.8	53.7	106.9
N_{250}	165.15	4.50	1.2	14.7	11.3	395.4	253.1	60.0	117.1
CD (0.05)	9.2	0.24	NS	NS	0.5	23.6	NS	2.1	2.2
Interaction	NS	NS	NS	NS	NS	NS	NS	4.8	5.6

Table 2: Interactional effect of different planting techniques-cum-irrigation methods and nitrogen rates on grain and stover yield of winter maize

Planting techniques-cum-irrigation methods	Nitrogen rates (kg/ha)	Grain yield		Stover yield	
		175	250	175	250
1 Row FIRBS /EF		60.9	72.4	113.3	123.5
2 Row FIRBS /EF		48.1	54.9	154.2	173.2
1 Row FIRBS /AF		42.7	44.0	82.4	85.1
Conv.- FIRBS /EF		63.6	69.8	114.3	119.7
Conv.- FIRBS /AF		49.7	50.6	85.4	86.9
Conv./S		57.4	68.7	90.6	115.1
CD (0.05)		4.8		5.6	