PERFORMANCE OF MAIZE TO NITROGEN PLACEMENT METHODS AND ROW SPACING ON ITS YIELD ATTRIBUTES AND WEED DYNAMICS

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ABSTRACT

An experiment having four replications was designed in Randomized complete block design with split plot arrangements (RCBD in split plot) and conducted at Research Farm of Agronomy, The University of Agriculture Peshawar, during kharif 2015. Row spacing (45, 55, 65 and 75 cm) were allotted to main plots while nitrogen placement methods (control, single side of the row, between the rows and both sides of the row,) were assigned to sub plots. Maximum cob height from ground (81.1 cm), ear weight at silking (166.2 g), grain yield (2226.2 kg ha^{-1})and thousand grain weight (194.5 g) were obtained from row spacing of 65 cm and biological yield (15058.1 kg ha^{-1}) was observed at row spacing of 45 cm while maximum weeds dry weight (90.5g m^{-2}) was examined at row spacing of 75 cm. Similarly maximum cob height from ground (81.6 cm), ear weight at silking (1661.8 g), grain yield (2184.9 kg ha^{-1}), biological yield (14821.9 kg ha^{-1}) and thousand grain weight (199 g) were obtained from applying nitrogen to both sides of the row while maximum weeds dry weight (79.2 g) was noted in control plots. All the interactions (RS×NP) were found non-significant for all the parameters. It is concluded that maize should be sown at 65 cm row spacing with nitrogen applied to both sides of the rows to get maximum yield in Peshawar, Pakistan.

Keywords: Fertilizer application, row spacing, side dressing, Zea mays.

Citation:Khan, Z., B. Ahmad, H. Akbar, M. A. Khan, S. Ahmad, Hafeezur Rahim, B. Ali and L. Zada. 2018. Performance ofmaize to nitrogen placement methods and row spacing on its yield attributes and weed dynamics. 2018. Pak. J. Weed Sci. Res. 24 (1):31-38.

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INTRODUCTION

Maize (Zea mays L.) is an imperative and leading crop and considered third in world production of cereals after wheat and rice. It is broadly cultivated in all climates like temperate, subtropical and tropical areas of the world. Its grain provides nutritive raw materials for various edible products and human consumption. It is also used in animal and poultry feed manufacturing industries (Witt and Pasuquin, 2007). In 2015-16, cultivated area of maize was about 1,144 thousand ha with a production of 4,920 thousand tons in Pakistan (MNFSR.2015-16). The average grain yield of maize (4,301 kg ha^{-1}) is very low when compared with the potential capability of the cultivars. Response of maize to different environments is varying under different agronomic management practices and thus the yield can be enhanced by providing best management practices and improved inputs.

Cultivating maize with appropriate row spacing has great contribution towards its production. It is necessary to adopt proper methods in maize growing to ensure best utilization of nutrients and minimize various crop losses. The unavailability of modern production technology and high prices of inputs are major hurdles for attaining high yield of maize in Pakistan (Farhadet al., 2009). The similar row spacing for all types and varieties of maize is not possible due to different environmental factors viz., soil factors, management and agronomic practices hence the maize yield varies (Luis, 2001). Very dense plant population causes more interference between plants and decrease yield by increasing intra-specific competition while too low plant population enhances vegetative growth and enhances weed density due to more available space. Yield contents of maize such as number of ears, number of kernels ear^{-1} and kernel mass were significantly enhanced due to positive effects from various row spacing (Maqboolet al., 2006). Row spacing in maize has great effect on grain yield. Very close row spacing results in barren plants, small ear and grain size and plants are susceptible to lodging and various pest attack and thus decreased grain yield, however more plant population can bring about an expanded number of cobs per unit, with possible increment in grain yield and its components.

Nitrogen (N) holds an essential role in chlorophyll, photosynthesis and formation of protein. Plant metabolic processes like enzymatic, biochemical and physiological reactions need nitrogen for their processing (Balasubramaniyanand Palaniappan, 2001). Comparatively application of nitrogen fertilizer through side dressing/side placement enhances grain yield of maize hybrids (Chaudhary andPirhar, 2002;Cerettaet al., 2002) than broadcast due to increment in yield components of yield, number of rows and grains per cob and 1000- grain weight (Lehrschet al., 2000). Nitrogen applied with side placement is efficiently utilized and promote biochemical processes and utilize soil moisture more easily than other methods (Lehrschet al., 2000). Application of nitrogenous fertilizer in band placement method as compared to broadcast method is an effective strategy for better nutrients uptake, utilization and nitrogen transformation and it uses farm resources and moisture more efficiently to enhance crop productivity (Lehrschet al., 2000). To investigate the growth and development of maize under different row spacing and nitrogen placement this experiment was designed.

MATERIALS AND METHODS

An experiment having four replications was designed in Randomized complete block design with split plot arrangements (RCBD in split plot) and conducted at Research Farm of Agronomy, The University of Agriculture Peshawar, during kharif 2015. Plot size was 2m x 5.25 m and 'Pahari' variety of maize was sown. The experiment consisted of two factors, four nitrogen placement methods and four row spacings was assigned to main plots and N application method were kept it sub plots. Each plot consisted of 7 rows. There were four row spacings (45, 55, 65 and 75 cm) and four nitrogen placement methods (single side banded, double side banded, between the rows and controlled.SSP was applied at the rate of 60 kg ha^{-1}for phosphorus as a basal dose while N was applied from urea at the rate of 120 kg ha^{-1}, half 30 days after emergence and remaining half at knee stage. Recommended irrigation schedule was followed. Weeds were controlled manually by hoeing and irrigations were provided according to schedulewhile the agronomic techniques were done consistently for all the experimental plots throughout the entire growing season.After the appearance of a black abscission layer at the base of grains, the maize was harvested at physiological maturity approximately at (about 30-35% grain moisture content). After harvest, crop plants were sundried, ears were separated from the stalk and further sundried for a few days and thenat 14% seed moisture content shelling was done.

Statistical analysis

Data were statistically analyzed according to the method relevant to randomized complete block design (RCBD split plot). LSD test at 0.05 level of probability was used to compare the means when the F-values significant (Jan et al., 2009).

RESULTS AND DISCUSSION

Cob height from ground (cm)

Statistical results revealed that row spacing and nitrogen placement methods significantly enhancedcob height of maize from ground while their interaction (RS X NP) was found non-significant. Row spacing of 65 cm produced cob with more height (81.1 cm) while row spacing of 75 cm produced cob with low height (77.7 cm). It could be attributed to the proper plant to plant distance, less competition and best utilization of resources. Our outcomes are in accordance with the discoveries of Shafiet al. (2011) who examined that when maize row spacingwas limited from 75 cm to 45 cm, cob height was significantly expanded by 6%. Maximum cob height (81.6 cm) from ground was recorded in the plots where N was double banded. It might be due to the reason that vegetative growth increased with increased N levels. Maize cob height was significantly increased with increased in nitrogen up to 200kg ha^{-1}(Gokmenet al., 2001). This expansion in cob stature could be credited to beneficial outcome of N on overwhelming development in vegetative growth of maize (Warren et al.,2006), greater accessibility of N all throughout the developing time period and enhanced fertility of soil, hence N effective plots had taller plants and cob height from ground when contrasted with control plots (Mitchell and Tu, 2005; Hossainet al., 2004).

Weeds dry weight (g m^{-2})

Statistical findings of the uncovered that various row spacing and different nitrogen placement methods significantly influenced theweeds dry weight while there was no significant effect observed due to their interaction (RS X NP). Higher dry weight (90.5 g m^{-2}) of weeds was acquired from row spacing of 75 cm while least dry weight of weeds (57.9 g m^{-2}) was observed from row spacing of 45 cm. It might be due to more availability of free space for more growth and high infestation of weeds as compared to less space in 45 cm row spacing. Our results are in line with that of Stewart (2001) and Tharp and Kells (2001) who also reported the increase in weeds dry weight with the increase in row spacing in maize. Our results are in accordance with those of by Begnaet al. (2001) who examined concealment in weed biomass by lessening row spacing from 56 to 38 cm. Maximum weeds dry weight (79.2 g m^{-2}) was observed in the plots with no N as there was no nitrogen applied while lower weeds dry weight (67.4 g m^{-2}) was noted in double side banded nitrogen. Lower weeds dry weight in nitrogen efficient plots may be attributed to the beneficial outcome of band placement of N to expandnitrogen supply, which may have advanced formation of new leaves prompted vigorous development in growth (Chatterjee, 2010). Our outcomes are in accordance with Dolan et al. (2006) and Li (2003) who researched that higher supplements accessibility and positive soil conditions may cause vigorous crop growth and decrease weeds infestation.

Ear weight at silking

Statistical perusal of findings demonstrated that various row spacing and different nitrogen placement methods significantly ($p<0.05$) influenced ear weight and interaction of row spacing and nitrogen placement methods had no significant (RS X NP) effect on ear weight at silking stage. Row spacing of 65 cm produced higher ear weight (166.2 g) while row spacing of 75 cm produced lower ear weight (158.2 g). The possible reason for higher ear weight could be due to proper space for growth of plants and less competition for light and nutrients. Comparative investigations were also examined by Shafiet al. (2001) and Shah et al. (2011), who found an expansion in ear weight by declining row spacing from 90 to 75 cm. These outcomes were may be because of better photosynthesis and usage of minerals, nutrients and moisture. These discoveries are also in accordance with those of Saniet al. (2004), who found more vigorous reproductive growth in narrow spaced rows. Similarly maximum ear weight (166.8 g) was obtained from double banded nitrogen placement method while minimum (156.6 g) was observed from control. Similar results were reported by Torbertet al. (2001). Higher nitrogen levels increase grains per row and ear due to more availability of nitrogen and less competition for supplement that enabling the plants to aggregate more biomass with higher ability to change over more photosynthesis into sink to produce more grains per ear. These outcomes are additionally in concurrence with Zeidanet al. (2006) who presumed that the grain number per ear was most extreme at the most higher nitrogen levels.

Table-1. Cob height from ground (cm), weeds dry weight (g m^{-2}) and ear weight at sliking (g) as affected by row spacing and nitrogen placement.

Row Spacing (RS)	Cob height (cm)	Weed dry weight (g m^{-2})	Ear weight at silking (g)
45 cm	79.2 ab	57.9 d	158.4 b
55 cm	80.3 a	67.1 c	159.5 b
65 cm	81.1 a	77.0 b	166.2 a
75 cm	77.7 b	90.5 a	158.2 b
LSD (0.05)	2.1	11.4	5.4
Nitrogen placement (NP)			
Control	76.6 b	79.2 a	156.6 b
Single side the row	80.6 a	75.1 ab	159.2 b
Both sides of the row	81.6 a	67.4 ab	166.8 a
Between the rows	79.9 a	70.8 b	160.5 ab
LSD (0.05)	2.9	7.8	6.7
Interaction			
RS x NP	NS	NS	NS

NS = Non-significant

1000 grains weight (g)

Statistical analysis revealed a significant ($p<0.05$) change in 1000 grain weight due to different row spacing while there was no significant change observed due to various N placement methods and interaction of row spacing and nitrogen placement methods (RS X NP). Row spacing of 75 cm produced most extreme 1000 grain weight (203.2 g)while row spacing of 45 cm produced lower 1000 grain weight (185.9 g). One of the yield components 1000 grain weight mirrors the photosynthetic capability of plant and its ability to transport photosynthates into important plant sinks and organs (Rizwan et al., 2003). These outcomes are in congruity with those of Shah et al. (2001) who quoted 75 cm row spacing produced the most extreme 1000 grain weight. .The purpose behind the higher thousand grain weight in 75 cm row spacing could be because of high light capture and less competition for water resulted in higher accumulation of photosynthates.

Biological yield (kg ha^{-1})

Measurable perusal of the biological yield data demonstrated various row spacing and nitrogen placement methods significantly enhanced biological yield while their interaction (RS X NP) showed no significant effect. Row spacing of 45 cm produced maximum biological yield (15058 kg ha^{-1})while 75 cm row spacing produced minimum biological yield(11756.6 kg ha^{-1}) followed by 55 cm and 65 cm row spacing. Our outcomes concur with those of Gulet al. (2009) who revealed that increasing plant density increased biological yield. Our findings are in accordance with those of Ahmad et al. (2010) who discovered biological yield enhancement through increasing plant population in maize. Correspondingly double banded nitrogen produced greatest biological yield (14861 kg ha^{-1}) while minimum (11901 kg ha^{-1}) was observed from control. The results regarding nitrogen are also in line with Shapiro and Wortmann (2006) who reported that corn biomass increased with applied N. Similarly Alamet al. (2003) demonstrated that development and yield segments in field grown maize were upgraded by nitrogen treatments. Double nitrogen banded fulfills he nutrients requirement of the crop throughout the season and enhance its growth. Similarly Luque et al. (2006) also experienced the same results that decreased light, less nutrients availability and various abiotic stresses resulted in low biological yield.

Grain yield (kg ha^{-1})

Statistical perusal of the data uncovered that effect of various row spacing and nitrogen placement methods was found significant and interaction RS X NP was found non-significant. Row spacing of 65 cm produced highest grain yield (2226.2 kg ha^{-1}) was obtained from 65 cm row spacing and row spacing of 75 cm produced lower grain yield (1805.0 kg ha^{-1}). This may be because of the way that 65 cm row spacing have made better soil conditions for significant root improvement and effective supply of supplements. Our outcomes are in similarity with those of Luquevet al. (2006) found that grain yield per plant is diminished due to less light and other ecological resources availability. Moririet al. (2010) additionally found that more plant population causes pressure and competition in plants and hence reduces plant development in maize. This may be because of the way that wider row spacing gave appropriate condition for efficient root improvement and plant development. The outcomes are in concurrence with Abuzaret al. (2011) who found least grain yield at the most population. Similarly greatest grain yield (2184.9 kg ha^{-1}) was acquired from double side banded united nitrogen arrangement while least (1754kg ha^{-1}) was recorded in controlled. The expansion in grain yield of maize by band arrangement was most likely because of more N availability for uptake and its constant supply to maize plants close plant roots all throughout the developing time frame and enhanced soil physiological characteristics of the plant that prompted better yield characteristics and grain yield. These outcomes are in concurrence with Kaiser et al. (2005) and Ahmad et al. (2002) who discovered more grain yield of maize with band position of nitrogen.

Table-2. 1000-grain weight (g), grain and biological yield (kg ha^{-1}) as influenced by row spacing and N placement.

Row Spacing (RS)	1000-grain weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
45 cm	185.9 c	15058.1 a	1870.5 b
55 cm	190.9bc	12785.5 b	1919.5 b
65 cm	194.5 b	12594.1 b	2226.2 a
75 cm	203.2 a	11756.6 b	1805.0 b
Control	188.7 c	11901.8 b	1754.0 c
LSD (0.05)	8.27	1157.4	255.73
Nitrogen placement (NP)			
Single side the row	194.3	12383.8 b	
Both sides of the row	199.0	14861.9 a	1909.6 bc
Between the rows	192.6	13046.9 ab	2184.9 a
LSD (0.05)	NS	1879.28	1972.6 ab
Interaction			216.3
RS x NP	NS	NS	
			NS

NS = Non-significant

CONCLUSIONS

Keeping in consideration the above findings and arguments it is concluded that maize sown at 65 cm row spacing gave best yield (2226 kg ha^{-1}) which is significantly better than other row spacing. Nitrogen placement of both sides of the rows gave higher yield of (2184 kg ha^{-1}) therefore row spacing of 65 cm along with nitrogen placement to both sides of the row is recommended for pahari variety of maize in Peshawar Pakistan.

REFERENCES CITED

Abuzar, M. R., G. Sadozai, U. Baloch, S. Baloch, A. Shah, H.Javaid.andN. Hussain. 2011. Effect of plant population densities on yield of maize J. Ani. Plant Sci., 21(4): 692-695.

Ahmad, R., A. Mahmood, M. Ikraam and B. Hassan. 2002. Influence of different irrigation methods and nitrogen banding. Afr. J. Agric. Res. 8(44): 5475-5484.

Balasubramaniyan, P. and S. P. Palaniappan. 2001. Nutrient management. In Principles and Practices of Agronomy. Agrobios, India, pp.185-188.

Begna, S.H., R.I. Hamilton, L.M. Dwyer, D.W. Stewart, D. Cloutier, L. Assemat, K. Fortoutan-Pour and D.L Smith. 2001. Weed biomass production response to plant spacing and corn (Zeamays) hybrids differing in canopy architecture. Weed Technol.,15: 647-653.

Ceretta, C. A., C. J. Basso, J. Diekow, C. Aita, P. S. Pavinato, F. C. B. Vieira and E. R. O. Vendrusculo. 2002.Nitrogen fertilizer split application for corn in no till succession to black oats. Sci. Agric. (Prachicaba, Barz.), 59(3).

Chaudhary, M. and S. S. Pirhar. 2002. Comparison of banded and broadcast fertilizer applications in relation to compaction and irrigation in maize and wheat. Agron. J., 66(4): 560-564.

Chatterjee, R. 2010. Physiological attributes of cabbage (Brassica oleracea) as influenced by different sources of nutrients under Eastern Himalayan Region. Res. J. Agric. Sci. 1(4): 318-321.

Dolan, M. S., C. E. Clapp, R. R.Allmaras, J. M. Baker, J. A. E. Molina. 2006. Soil organic carbon and nitrogen in a Minnesota soil as related to tillage, residue and nitrogen management. Soil Till. Res. 89: 221-231.

Farhad, W., M.F. Saleem, M. A. Cheema and H.M. Hammad. 2009. Effect of poultry manure level on the productivity of spring maize (Zea mays L.). J. Anim. Plant Sci.19(3): 122-125.

Gokmen, S. and S. Butzen. 2001. Corn hybrid response to plant population .Crop Insights, 11(6):1-5. Pioneer Hi-Bred Int. Johntialston, IA.

Gul, S, A., A. Amany, A. Bahr and M. F. El-Kramany. 2009.Effect of N-fertilizer and plant density on yield and quality of maize in sandy soil. J. Agric.Biol.Sci., 2(4):156-161.

Hossain, M.B., M. A. Sattar and M. Z. Islam. 2004. Characterization of P and characterization of phosphate solubilizing bacteria on wheat. J. Agric. Res.42 (3-4):295-303..

Kaiser, D.E., A.P. Mallarino and M. Bermudez. 2005. Corn grain yield, early growth, and early nutrient uptake as affected by broadcast and in furrow starter fertilization. Agron. J. 97:620-626.

Lehrsch, G.A., R.E. Sojka and D.T. Westermann. 2000. Nitrogen placement, row spacing and furrow irrigation water positioning effects on corn yield. Agron. J. 92(6):1266-1275.

Luis, S. 2001. Understanding plant density effects on maize growth and development: An important issue to maximize grain yield. Ciencia Rural, 3(1):1-17

Luque, S. F., A. G. Ciriloand and M.E. Otegui. 2006. Genetic gains in grain yield and related physiological attributes in Argentine maize hybrids. Field Crops Res., 95: 383-397.

Li, H., Y. Han and Z. Cai. 2003. Nitrogen mineralization in paddy soils of Taihu Region of China under anaerobic conditions, dynamics and model fitting.Geoderma, 115:161-175.

Maqbool, M.M., A. Tanveer, Z. Ata and R. Ahmad. 2006. Growth and yield of maize (Zea mays L.) as affected by row spacing and weed competition durations. Pak. J. Bot., 38(4):1227-1236.

Martin, E.C., T.L. Loudon, J. T. Ritchie and A. Werner. 1994. Useof drainage lysimetersto evaluate nitrogen and irrigation management strategies to minimize nitrate leaching in maize production. Trans. ASAE 37:79-83.

Mitchell, C.C. and S. Tu. 2005.Long-term evaluation of poultry manure as a source of N for cotton and corn. Agron. J. 97: 399-407.

Ministry of National Food Security and Research. 2015. Government of Pakistan. Agriculture Statistics of Pakistan.

Moriri, S.,L. G. Owoeye and I. K. Mariga. 2010. Influence of component crop densities and planting patterns on maize production in dry land maize/cowpea intercropping systems. Afr. J. Agric. Res., 5 (11): 1200-1207.

Modarres, A.M., M. Dijak, R.I. Hamilton, L.M. Dwyer, D.W. Stewart, D.E. Mather and D.L. Smith. 1998. Leafy reduced stature maize hybrid response to plant population density and planning patterns in a short growing season area. Maydica. 43(3): 227-234.

Sani, B. M. 2004. Irrigation and plant density effects on growth and yield of early maize at Samaru, Northern Nigeria.M.Sc Thesis, Dept. of Soil Science, Ahmadu Bello Univ. Zaria, Nigeria.

Shafi, M., M. Farooq, S. Munir, Z.U. Qamar, A. Siddiq and Z. Mahmood. 2011. Grain production as influenced by planting pattern in maize. Sarhad J. Agric 27(3):357-361.

Shah, S., S. Khan, Z. Muhammad, Y. Hayat and M. Arif. 2001. Effect of different row spacing and orientations on the performance of maize. Sarhad J. Agric. 17 (4):515-518.

Shapiro, C. A. and C.S. Wortmann. 2006. Corn response to nitrogen rate, row spacing, and plant density in eastern Nebraska. Agron. J. 98(3):529-535.

Stewart, G. 2001. Weed control in corn: Helping the crop compete. www.gocorn.net/Weed2.html

Tharp, B.E. and J.J. Kells.2001. Effect of glufosinate-resistant corn (Zea mays) population and row spacing on light interception, corn yield, and common lambsquarters (Chenopodium album) growth. WeedTechnol.15:413-418.

Sood, H, A. 1979. Effect of poultry manure level on the productivity of spring maize (Zea mays L.). J. Anim. Plant Sci. 19(3): 122-125.

Torbert, H., A. Potter and K. N. Morrison. 2001. Tillage system, fertilizer nitrogen rate and timing effect on corn yields in the Texas Blackland prairie. Agron. J. 93:1119-1124

Warren, J.G., S. B. Phillips, G. L. Mullins and C. J. Paren. 2006. Environmental and production consequences of using amended poultry manure as a nutrient source for corn. J. Environ. Qual. 35:172-182.

Witt, C. and J.M.C. A. Pasuquin. 2007. Maize in Asia and global demand II. E-Int. Fert.Corresp.14 (4):5-6.

Zeidan, M. S., A. Amany, M. F. Bahr El-Kramany. 2006. Effect of N-fertilizer and plant density on yield and quality of maize in sandy soil. J. Agric. Biol.Sci., 2(4):156-161.