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Effect of planting time, fertility level and phosphate-solubilizing bacteria on growth, yield and yield attributes of winter maize (*Zea mays*) under rice (*Oryza sativa*)–maize cropping system

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ABSTRACT

An experement was conducted during winters of 2000–01 and 2001–02 to find out effect of planting time, fertility level and phosphate-solubilizing bacteria on winter maize (*Zea mays* L.) after rice (*Oryza sativa* L.) at Varanasi, on sandy-loam soil conditions of eastern plain zone of Uttar Pradesh. Delay in planting from 15 December to 30 December decreased the maize yield by 19.25% with mean reduction of 82.7 kg maize yield/ha/day. Fertility level up to 180, 90 and 60 kg N, $P_2O_5$and K_2O/ha significantly improved growth, yield and yield attributes. On the basis of the 2 years average data (pooled), the increase in maize yield was 52.6 and 82.97% with 120, 60 and 40 kg N, P_2O_5 and K_2O/ha and 180, 90 and 60 kg N, P_2O_5 and K_2O/ha, respectively, over 60, 30 and 20 kg N, $P_2O_5$and K_2O/ha. Phosphate-solubilizing bacteria (PSB) inoculation alone or along with 5 tonnes FYM/ha and no-PSB inoculation also differed significantly with regarding to above parameters. The maximum maize yield was abtained with PSB inoculation along with 5 tonnes FYM/ha, whereas no-PSB inoculation gave the minimum maize yield.

Key words : Fertility level, Planting time, PSB, Winter maize

The entire Eastern Plains Zone of Uttar Pradesh where rice–wheat is a dominant cropping system, experiences observed decline in yield trend, particularly in wheat because of increasing threat of wild oat (*Avena ludoviciana*), *Phalaris minor* and the late harvest of rice or water stagnation after the flood recede in *diara* area make a late-sown wheat prone to very low temperature at early growth period and hot desiccating winds during flowering and ripening. The winter maize in this context seems a vital and alternate crop to bridge the noted productivity gap of rice–wheat cropping system. Pertaining to planting time of winter maize much of research work is available. But such information under specific situation where maize is to be grown preceded by rice is quite scanty. Evidently, the normally recommended rates on NPK fertilizers are sub-optimal in intensive cropping system and also in case of winter maize. This implies that higher nutrient depletion demands higher rate of nutrient replenishment to safeguard soil-fertility balance. This is no way that minimizes the importance of NPK but emphasises that the efficiency of NPK and returns from their application can be maximized. Phosphate-solubilizing bacteria (PSB) helps in increasing crop productivity by way of helping in solubilization of insoluble phosphate, stimulating plant growth by providing harmones, vitamins and other growth factors. Role of farmyard manure cannot be overlooked, as these are the only source of organic matter without which soil can never be productive. In addition to this, they supply all the essential nutrients for plants and increase the activity of bacteria. The present study was therefore undertaken to find out the effect of planting time, fertility level and PSB on growth, yield and yield attributes of winter maize under rice–maize cropping system.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the winter seasons of 2000–01 and 2001–02, in split-plot design with 3 replications. The soil was sandy loam, slightly saline in reaction, low in organic carbon (0.33%), available N (212 kg/ha), medium in available P (17.2 kg/ha) and K (181 kg/ha). The main plot consisted of 6 treatment combinations of 2 planting times (15 and 30 December) and 3 fertility levels (60: 30:

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20, 120: 60: 40 and 180: 90: 60 kg N: P_2O_5: K_2O/ha), while the sub-plot consisted to 3 PSB treatments (control, PSB inoculation along and along with 5 tonnes FYM/ha). Maize hybrid variety 'Deccan 103' was sown with a spacing of 60 cm × 25 cm. The nutrient sources used were urea, diammonium phosphate and muriate of potash. The entire quantity of P_2O_5 and K_2O along with one-third N (as per treatments) was applied as basal at the time of sowing. Remaining quantity of N was top-dressed in 2 equal splits, at knee-high and tasseling stages. A blanket application of zinc sulphate @ 25 kg /ha was made to all the experimental plots. *Bacillus polymyxa* H-5 strain of PSB was used for maize seed inoculation. Well-decomposed FYM 5 tonnes/ha was incorporated in to the soil 10 days before sowing as per treatment.

RESULTS AND DISCUSSION

Planting time

The crop sown on 15 December obtained significantly higher plant height, leaf-area index (LAI) and dry-matter accumulation/plant over the crop planted on 30 December (Table 1). The maize planted on 30 December experienced high temperature during later stages (at 120 DAS and at maturity). This effect resulted quick desiccation of the leaves, unbalanced ratio of photosynthesis and respiration, and eventually reduced the plant height, LAI and dry-matter production/plant. The maize planted on 15 December recorded significantly higher indices of cobs/plant, grains/cob, test weight, grain and stover yields and harvest index than that planted on 30 December (Table 1). The decrease in yield and yield attributes were due to significance decrease in leaf-area index and other ancillary characters (Table 1). The most detrimental factor in restricting growth was low minimum temperature during middle of January (6-8°C) compared with a minimum requirement of 10° C of the maize as reported by Berger (1962). The maturity period of the crop sown on 30 December was reduced because the crop experienced high temperature during later stages. The uptake of N, P and K by crop was also significantly higher with 15 December planting than 30 December planting (Table 2). This is because 15 December planting availed relatively longer duration and thus more time for the uptake of N, P and K and consequently registered higher biomass production, greater percentage of N, P and K content in grain and stover.

Fertility level

The plant height, leaf-area index and dry-matter accumulation/plant increased significantly with higher levels of N, P and K (Table 1). The increased levels of N, P and K accomplished the requirement of balanced crop nutrition and caused rapid division and elongation of cells that resulted an improvement in plant hight, leaf-area index and dry- matter accumulation/plant. Fertility levels could bring about significant differences in all the yield-attributing characters. In respect of these yield-contributing characters, 180, 90 and 60 kg N, P_2O_5 and K_2O/ha recorded the highest values, followed by 120, 60 and 40 kg N, P_2O_5 and K_2O/ha and 60, 30 and 20 kg N, P_2O_5 and K_2O/ha which in turn led to the significantly higher grain yield with 180, 90 and 60 kg N, P_2O_5 and K_2O/ha (7,572 and 7,080 kg/

Table 1. Effect of planting time, fertility level and phosphate-solubiliziing bacteria on growth, yield and yield attributes of winter maize (pooled data of 2000–01 and 2001–02)

Treatment	Plant height at harvest (cm)	Leaf-area index at 120 DAS	Dry matter (g/plant)	Cobs/ plant	Grains/ cobs	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index
Planting time									
15 December	234	3.5	288.8	0.92	439	243.5	6,434	10,195	38.6
30 December	225	3.1	262.1	0.86	396	234.9	5,193	9,185	36.0
CD (P=0.05)	3	0.1	10.0	0.02	13	5.2	229	437	0.8
Fertility (N: P_2O_5: K_2O kg/ha)									
60: 30: 20	212	2.8	213.1	0.81	328	218.3	4,004	6,973	36.4
120: 60: 40	234	3.3	280.1	0.91	442	244.6	6,110	9,916	38.0
180:90: 60	243	3.7	333.9	0.96	482	254.7	7,326	12,182	37.5
CD (P=0.05)	3	0.1	11.8	0.02	16	6.8	280	538	1.0
PSB treatment									
Control	224	3.1	259.0	0.88	396	234.8	5,351	8,964	37.1
PSB inoculation	229	3.2	272.2	0.89	413	237.8	5,703	9,515	37.3
PSB inoculation + FYM	236	3.5	290.1	0.91	444	254.7	6,385	10,592	37.5
CD (P=0.05)	3	0.1	9.6	0.01	11	4.9	182	401	NS

DAS, Days after sowing

ha) It was 82.97 and 19. 9% more than 60, 30 and 20 kg and 120, 60 and 40 kg N, P_2O_5 and K_2O/ha respectively. Improved plant growth (Table 1) consequently showed significant translocation and storage of photosynthates from source to sink, which resulted significant enhancement in all the yield attributes and greater grain and stover yields. Similar trend was also reported by Sahoo *et al.* (2001) Maximum harvest index was obtained with the application of 120, 60 and 40 kg N, P_2O_5 and K_2O/ha. This may be due to the better translocation of photosynthates from source to sink. Uptake of N, P and K by crop increased progressively with the increase in fertility levels (Table 2). The increased biomass production as well as concentration of N, P and K in grain and stover also might be the cause of higher uptake of N, P and K by the crop.

Table 2. Effect of planting time, fertility level and phosphate-solubilizing bacteria (PSB) on N, P and K uptake by winter maize (pooled data of 2000–01 and 2001–02)

Treatment	Total uptake (kg/ha)		
	N	P	K
Planting time			
15 December	159.6	47.9	202.2
30 December	125.6	36.1	173.9
CD (P=0.05)	6.7	2.1	8.7
Fertility (N: P_2O_5: K_2O kg/ha)			
60:30: 20	90.8	22.8	121.4
120:60: 40	148.1	44.0	195.1
180:90: 60	188.1	59.1	247.7
CD (P=0.05)	8.2	2.6	10.7
PSB			
Control	129.1	36.5	173.0
PSB inoculation	139.2	40.6	183.7
PSB + FYM	159.5	48.7	207.5
CD (P=0.05)	5.8	1.8	8.2

Phosphorus-solublizing bcacteria : Inoculation of PSB alone and along with FYM significantly improved the plant height, leaf-area index and dry-matter accumulation /plant over the control. Maximum values of these growth attributes were obtained with PSB inoculation along with FYM (Table 1). These bacteria secrete organic acids, which cause the solubilization of both inherent and added phosphorus and also produce amino acids, vitamins and growth-promoting substances, which are helpful to promote the plant growth. When the inoculation of PSB was added with FYM, the solubilization of phosphorus enhanced along with the quantity of plant nutrients contained by FYM. Patidar and Mali (2002) also reported similar effect of PSB +FYM on growth of sorghum. Number of cobs/ plant, grains/ cob, test weight, grain and stover yields improved significantly owing to PSB inoculation along with FYM over the control and PSB inoculation alone (Table 1). As that the crop growth influenced positively with the PSB inoculation, the enhanced availability of phosphorus due to PSB caused better root growth as well as nutrient added by FYM, improved the growth and development of maize plants. These results confirm the findings of Surendra and Sharanappa (2000). The PSB inoculation significantly increased N, P and K uptake by crop over the control (Table 2). However, PSB inoculation along with FYM significantly superior to the control and PSB inoculation alone. The increase in uptake of N, P and K might be owing to increased grain and stover yields and N, P and K content in them. Similar results on nutrient uptake was also reported by Mane *et al.* (2002).

REFERENCES

Berger, J. 1962. Maize production and manuring of maize. *Centre Detude De L'* azote 5 Geneva, Switzerland p. 40

Mane, S.S., Hadgaonakar, A.K., Suryamanshi, A.P. and Salunke, S.D. 2000. Response of pearl millet to inoculation phosphorus solubilising bacteria and *Azospirillum*. *Journal of Indian Society of Soil Science* **48**(3) : 617–619.

Patidar, M. and Mali, A.L. 2002. Integrated effect of FYM, seed inoculation of *Azospirillum* and phosphorus solubilizing bacteria on sorghum (*Sorghum bicolor*). (In) *Extended Summaries of the Second International Agronomy Congress,* held during 26–30 November, 2002 at New Delhi, India, vol 1, pp. 208–209.

Sahoo, S. C., Satapathey, P.C. and Kar, A.K. 2001. On farm assessment of hybrid variety and recommended does of fertilizer on the yield of maize (*Zea mays L.*). *Research on Crops* **2** (3): 443–444.

Surendra, S.T. and Sharanappa 2000. Integrated management of nitrogen and phosphorus in maize (*Zea maize*) and their residual effect on cowpea (*Vigna unguiculata*). *Indian Journal of Agricultural Sciences* **70** (2) : 119–121.