Combined application of phosphorus and biofertilizers yield of maize under intercroppingsystem in temperate region of Kashmir valley

M.Hussain Dar[*1], Ashiq Hussain Bhat[2] , S.shahid[3]

[1]*Department of Botany, Kurukshetra University, Kurukshetra, Haryana-136 119,*

[2] *Department of Statistics University of Kashmir Srinagar, (India)*

[3]*Department of Biochemistry, University of Kashmir Srinagar, (India)*

ABSTRACT

Maize being an exhaustive crop, it has very high nutrient requirement and its productivity is closely linked with nutrient management. Maize is currently the third most traded cereal, after wheat and rice, with a total production of 822 million tons in over 160 million hectares. Because of its low prices and world wide distribution, it has become the most important raw material for animal feed and for several industrial processes. No work has been done to evaluate the response of this crop to different biofertilizers under various levels of phosphorus. In order to study the effect of biofertilizers (Rhizobium, Azotobacter, Arbuscular mycorrhizae) under different levels of phosphorus (20 and 40 kg/ha) application on growth and yield components of maize crop in temperate regions of Kashmir. An experiment was conducted during kharif seasons of 2012 and 2013 at the Krishi Vigyan Kendra (KVK) of Shere-e-Kashmir University of Agricultural Sciences and Technology, Budgam, Jammu and Kashmir. The climate of the experimental site is temperate with mild summers and cold winters, showing wide variations in mean maximum and minimum temperatures. Temperature varies from 5˚C in winter to a maximum of 34˚C. The experiment was laid out in complete randomized block design (RBD). Different levels of DAP and various biofertilizers namely Rhizobium (Rhizobium leguminosarum), Azotobacter (Azotobacter vinelandi), VAM (Glomus mosseae) have been used during the research. Rhizobium with VAM @ 20 kg P/ha in the present research showed significant impact on all parameters of maize cop.

Key words: Maize, phosphorus, biofertilizers, and yield

I. INTRODUCTION

Maize or corn (*Zea mays,* L.)belongs to family Poaceae and is a very versatile crop, growing in all sorts of edaphic, altitudinal and fertility conditions, which explains its global adaptability and ability to incorporate into many purposeful products with well-defined varieties. It is mainly used for animal feed, food and industrial purposes. The trend for global cereal demand in the next decade is expected to increase, and in case of maize it is expected to surpass the demand of wheat and rice. Though India enjoys an exportable surplus of maize at present, there is an urgent need to gear up its production and productivity to meet the projected demand of 40-45 million tons by 2025. Maize is called the 'Queen of cereals' because of its higher productive potential compared to any other cereal crop. Being an exhaustive crop, it has very high nutrient requirement and its productivity is closely linked with nutrient management. Maize is currently the third most traded cereal, after wheat and rice, with a total production of 822 million tons in over 160 million hectares. Because of its low prices and world wide distribution, it has become the most important raw material for animal feed and for several industrial processes.

Increase in maize grain yield after intercropping with groundnut and green gram was observed by Reddy and Reddi (2007). The purpose of maize-legume association is to reach at full yield of the maize plus selected legume yield (Chui and Richards, 1984), however there is decline in maize yield as a result of varying spacing in intercrop with cowpea Mangasini *et al.* (2012) observed that the vegetative growth of component crop in a mixture is affected by intercropping. Ali and Mohammad (2012) observed that highest dry leaf/dry stem yield and total protein of plant was related to forage corn intercropping withpearl millet (*Pennisetum glaucum*). The objective of the present study was to find out the impact of different biofertilizers under various levels of phosphorus on various and yield components of maize crop under intercropping system.

II.MATERIALS AND METHODS

Treatments Details and Crop Culture: For proper seed bed preparation, field was ploughed thoroughly twice with a tractor. The plot was properly leveled for even and efficient fertilizer/water distribution. The gross plot size was 16.5 square meters (sqm) and the net plot size was 9.6 sqm. The experiment was laid out in a complete randomized design (CRD) with each treatment replicated three times. The detailed treatments are presented in Table 2. Common bean variety "Shalimar Rajmash-1" and maize variety "C-15" were used for the present study. The seeds were procured from KVK, Budgam, Jammu and Kashmir. The maize seeds were sown at row to row distance of 75 cm and plant to plant distance of 20 cm. The common bean seeds were sown in between the maize rows. Sowing was done in the last week of April, 2012 and 2013 and seeds were hand dibbled at a depth of about 2 cm in soil.

Biofertilizers and chemical fertilizers application: The seeds were surface sterilized by sodium hypochlorite (0.1%) for 2 minutes, thoroughly rinsed with distilled water and soaked in distilled water for 6 hours before sowing in plots. Peat based *Rhizobium leguminosarum* inoculum, vesicular arbuscular mycorrhizae (*Glomus mosseae*) and *Azotobacter vinelandi* was procured from the Division of Microbiology, IARI (New Delhi) India. For *Rhizobium* and *Azotobacter* inoculation, the seeds were moistened in sugar solution (48%) before the application of inoculums to get a thin uniform coating of inoculum on the seeds, immediately before sowing the seeds in field. The seed were then shade dried after inoculation.The mycorrhizal inoculum was applied after seed sowing at the rate of 25 Kg/ha by planting holes method.

The fertilizers for maize (120 N, 30 K_2O_5 Kg/ha) and for common bean (30 N, 30 K_2O_5Kg/ha) were applied according to plant population in the intercropping system. Phosphorus was applied as per the treatments. Half of the nitrogen and potassium were applied at sowing time as basal dose. The remaining nitrogen was top dressed when true leaves emerged (25 days).

III.TREATMENTS

(T_1) Maize + common bean (control).
(T2) Maize+ common bean treated with *Rhizobium* .
(T_3) Maize + common bean both treated with *Azotobacter*.
(T_4) Maize + common bean both treated with Arbuscular mycorrhizae.
(T_5) Maize + common bean both supplied with 20 kg Phosphorus/ha.
(T_6) Maize + common bean both supplied with40 kg Phosphorus/ha.
(T_7) Maize + common bean treated with *Rhizobium* + Arbuscular mycorrhizae.
(T_8) Maize + common bean treated with *Azotobacter* + Arbuscular mycorrhizae.
(T_9) Maize + common bean treated with *Rhizobium* + Arbuscular mycorrhizae + 20 kg Phosphorus/ha.
(T_{10}) Maize + common bean treated with *Azotobacter* + Arbuscular mycorrhizae + 20 kg Phosphorus/ha.
(T_{11}) Maize + common treated with *Rhizobium* + Arbuscular mycorrhizae + 40 kg Phosphorus/ha.
(T_{12}) Maize + common bean treated with *Azotobacter* + Arbuscular mycorrhizae + 40 kg Phosphorus/ha.
(T_{13}) Maize + common bean treated with *Rhizobium* + *Azotobacter* + Arbuscular mycorrhizae.

IV.COLLECTION OF EXPERIMENTAL DATA

Number of cobs and pods per plant

The total number of cobs and pods per plant were calculated from five randomly selected plants and were averaged at the time of harvest.

Cob and pod weight per plant (g)

The weight of cobs and pods/plant of randomly selected five cobs and pods from each experimental unit was recorded and expressed as gram per plant.

Number of seeds/plant

The numbers of seeds/plant of five individual plants were counted manually from each replication and the average of five plants was recorded as grain number per plant.

100 seed weight (g)

100 seed weight of three randomly drawn samples of sun dried seeds from each experimental plot was weighed in grams.

V.RESULTS

Significantly maximum cob length (17.10 cm) was recorded in T_9 followed byT_{10} and T_{13} (16.40 and 15.99cmrespectively).However, the treatments alone or in combination did not revealed significant differences within themselves for number of cobs per plant.The highest number of cobs (1.66) were recorded in T_9 and T_{13} [Table-1]followed byT_{10} (1.53). Lowest number of cobs per plant (1.20) were recorded in control plants (T_1). The data on weight of cobs/plant as influenced by phosphorus and biofertilizers on maize under intercropping system showed significant differences among the treatments. Among all treatments, *Rhizobium* + VAM + 20 Kg/ha recorded higher weight of cobs/plant (124.00 g) followed byT_{10} and T_{13} (120.00 g), where as minimum weight of cobs (96.33 g) was found in control plants (T_1). Persual of Table 1 revealed that highest number of seeds per plant (390.00) was recorded in T_9 (*Rhizobium*+ VAM + 20 Kg P/ha) followed by T_{10} and T_{13}(386.00 and 382.00, respectively). Among the single biofertilizer applications *Rhizobium* recorded highest number of seeds per plant (370.00) as compared to other treatments. Minimum number of seedsper plant (356.00) was recorded in control plants followed byT_3 (364.00).

Among all treatments,T_9 recorded highest 100 seed weight (39.23 g) followed byT_{10} and T_7 (38.03 g and 36.22 grespectively). Lowest hundred seed weight (32.00 g) was recorded in control plants (T_1) followed by T_6 (33.00 g).Moreover, the results further indicated that application of phosphorus and biofertilizers also had significant effect on economic yield of maize under intercropping. The results indicated that maximum economic yield [Table-1] was recorded in T_9 (153.01g/plant) followed byT_{10} and T_{13} (146.80 and 137.69g/plant) as compared to other treatments and control, while the minimum economic yield (113.93g/plant) for maize was recorded in control plants (T_1) followed byT_6 (120.80g/plant).

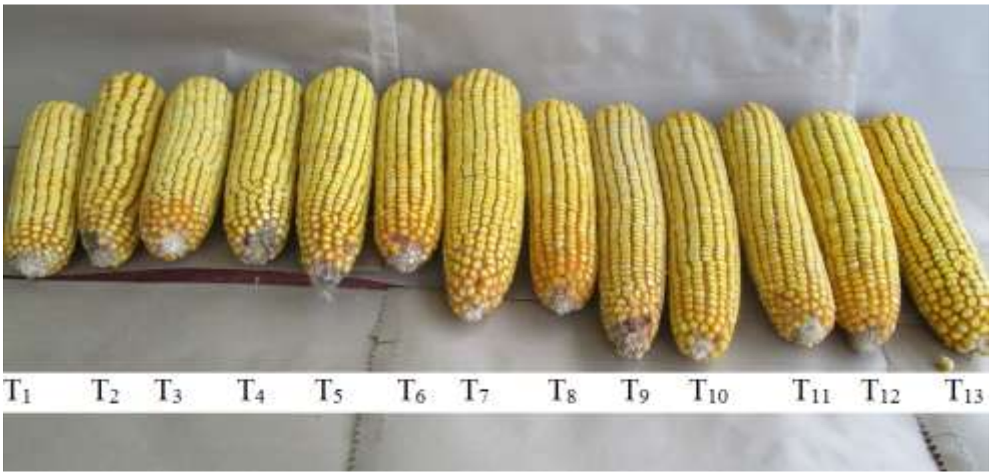

Fig. 1 Impact of phosphorus and biofertilizers on yield components of maize

T_1 (control), T_2 (*Rhizobium*), T_3 (*Azotobacter*), T_4 (VAM), T_5 (20 kg P), T_6 (40 kg P), T_7 (Rhz. +VAM), T_8 (Az. +VAM),T_9 (Rhz. + VAM + 20kg P),T_{10} (Az. + VAM + 20 kg P),T_{11} (Rhz.+ VAM + 40kg P),T_{12} (Az. + VAM + 40 kg P),T_{13} (Rhz. + Az. + VAM)

Table 1:- Impact of phosphorus and biofertilizers on number of seeds/ plant, 100 seed weight (g) and Economic yield/plant of maizeunder intercropping of common bean + maize.

Treatments	Number of seeds/plant	100 seed weight (g)	Economic yield (g/plant)
T_1 (Control)	356.00±1.14	32.00±0.01	113.93±0.37
T_2 (*Rhizobium*)	370.00±1.10	34.16±0.02	126.50±0.38
T_3 (*Azotobacter*)	364.00±1.13	33.25±0.03	121.04±0.51
T_4 (VAM)	368.00±1.15	34.04±0.02	125.29±0.47
T_5 (20 kg P)	371.33±1.15	33.24±0.01	123.31±0.42
T_6 (40 kg P)	366.00±1.12	33.00±0.00	120.80±0.40
T_7 (Rhz.+ VAM)	374.00±1.13	36.22±0.01	135.47±0.45
T_8 (Az.+VAM)	372.00±1.15	35.02±0.01	130.27±0.44
T_9 (Rhz.+ VAM+20kg P)	390.00±1.14	39.23±0.01	153.01±0.50
T_{10} (Az.+ VAM+20 kg P)	386.00±1.12	38.03±0.01	146.80±0.50
T_{11} (Rhz.+VAM+40 kg P)	374.00±1.11	36.02±0.01	134.71±0.45
T_{12} (Az.+VAM+40 kg P)	380.00±1.17	35.06±0.01	133.22±0.44
T_{13} (Rhz.+Az.+VAM)	382.00±1.16	36.04±0.02	137.69±0.44
C.D. @ 5%	0.271	0.048	0.138

Rhz. = *Rhizobium*, Az. = *Azotobacter*, VAM = *Vesicular arbuscular mycorrhizae*, P = Phosphorus, C.D. = Critical Difference

VI.DISCUSSION

Application of elemental phosphorus at different rates along with single, dual or multiple usesof biofertilizers had significant effect on maize yield parameters. In present study the maximum number of pods, largest pod length and highest pod weight were observed in combined inoculation of *Rhizobium*+ VAM along with 20 kg P/ha. Similarly, the number of seeds per plant and 100-seed weight showed increase in inoculated/Phosphorus applied treatments than control treatments. Zaffer *et al.* (2011) reported that combined application of phosphorusand plant growth promoting rhizobacteria (PGPR) increased seed yield by 27 to 115 percent over control. The positive yield response may be attributed to the increase in pods per plant and individual seed weight due to better availability of phosphorus. Addition of phosphorus inputs and plant growth promoting rhizobacteria (PGPR) resulted in significant increase in growth characteristics which would be eventually affect the yield and yield components of common bean. Chiezey and Odunze (2009) reported that pod yield and 100-seed weight in soyabeanincreased with phosphorus application which caused substantial increase in economic yield. Zaffer *et al*. (2011) have demonstrated that increase in yield and yield components in common bean due to integrated phosphorus supply is higher than that of sole application of either phosphorus sources. The present finding are in tune with Abbasi *et al.* (2008) and Chiezey and Odunze (2009) indicating that phosphorus supply is important in attaining high yields in maize under intercropping system.

VII.CONCLUSION

Integrated application of phosphorus in combination with *Rhizobium* and VAM significantly increased the various yield parameters of maize crop under intercropping system. Also application of different biofertilizers along with different levels of phosphorus plays a significant rule in becoming the inorganic phosphorus easily available to the plants. Therefore, integrated application of phosphorus with *Rhizobium* and VAM can be highly recommended in maize intercropping for enhancing various yield parameters of maize crop.

VIII.ACKNOWLEDGEMENTS

I would like to thank Director of KVK, Budgam, SKUAST-K, Shalimar, Srinagar for providing me research field and Director Central Institute of Temperate horticulture CITH (ICAR) Old Air Field Rangreth, Srinagar for providing me all laboratory facilities and help regarding the research work.

REFERENCES

[1] Abbasi, M.K., Majeed, A., Sadiq, A., Khan, S.R. 2008. Application of *Bradyrhizobium japonicum* and phosphorus fertilization improved growth, yield and nodulation of soybean in the sub-humid hilly region of Azad Jammu and Kashmir, Pakistan.*Plant Production Science*. 58:368-376.

[2] Ali, S. and Mohammad, H.S. 2012. Forage yield and quality in intercropping of forage corn with different cultivars of berseem clover in different levels of nitrogen fertilizer. *Journal of Food, Agriculture and Environment*. 10:602-604.

[3] Chui, J. A. N. and Richard, S. 1984. Influence of spatial arrangement of maize on performance of an associated soybeans intercrop. *Field Crops Research.* 8:187-198.

[4] Chiezey, U.F., Odunze, A.C. 2009.Soybean response to application of poultry manure and phosphorus fertilizer in the Sub-humid Savanna of Nigeria.*Journal of Ecology and Natural Environment*. 1: 25-31.

[5] Mangasini, A.K., Mwanahawa, L.M., Arbogast, G.M., and Neema, P.K. 2012. Agronomic factors limiting groundnut production: A case of smallholder farming in Tabora region. 17th annual research workshop dar es salaam, Tanzania.

[6] Reddy, T.Y. and Reddi, G.H.S. 2007.Principles of Agronomy.Kalyani Publishers, India. Pp.

[7] 468-489.

[8] Zafar, M., Abbasi, M.K., Khaliq, A. and Rehman, Z. 2011.Effect of combining organic materials with inorgan-ic phosphorus sources on growth, yield, energy content and phosphorus uptake in maize at Rawalakot Azad Jammu and Kashmir, Pakistan.*Archives of Applied Science and Research*. 3: 199– 212.