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Effect of Sowing Date and NPK on the Forage Yield and Quality in the Crop Combination of Maize and Cowpea in Newer Alluvial Zone of West Bengal, India

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Abstract: Growing of more than one crop simultaneously by intercropping on the same land with definite row arrangement is considered effective in achieving maximum production from unit area per unit time. A field experiment was conducted on maize-cowpea intercropping at Grass Land Research Station, State Fodder Production Cum Seed Multiplication Farm, Haringhata, Nadia, West Bengal (23°N Latitude, 89°E Longitudes with elevation of 9.75 m above MSL) during rainy (kharif) season of 2008-2009 and 2009-2010. Maize (AT) and cowpea (E C 4216) were sown during 2008 and 2009 to estimate the effect of application of different NPK doses on forage yield with five treatment combinations including maize as a sole crop. The observation on the effect on quality of green forage yield and dry matter accumulation of different treatments indicated significant variability. Highest forage productions were observed in sole maize (62.1 ton) and (73.9 ton) during 2008 and 2009. Sole maize exhibited highest dry matter (551.08 and 558.65 g⁻²) production in 2008 and 2009, while, 2:1 with cowpea mixture produced (320.95 g⁻²) in 2008 and (322.88 g⁻²) in 2009. Moreover the digestible crude protein content in maize+cowpea (2:1) and cowpea+maize (2:1) exhibited 10.4 and 38.9% increase over control during 2008 while 10.3 and 38.4% in 2009 with N, P₂O₅, K₂O (100:50:50) and (20:60:40), respectively. Therefore, it appears that forage quality and yield of maize with cowpea influenced the quality of forage production in maize based grass-legume intercropping system.

Key words: Forage, legume, fertilizer, intercropping

INTRODUCTION

In India, there is a great competition for land between food and fodder production. So far, as the fixed geographical area of India is concerned, there is very little scope for horizontal expansion but there is great scope for vertical expansion through intensified cropping (Kanwar, 1972). However, there has been an improvement in meat, milk and egg production along with food production, keeping pace with the increasing growth of human population. There has been enough awareness among the farmers, planners and scientists about forage production. The forage crops are utilized to feed the domestic herbivores who provide meat and dairy products and play an important role in total food production. The maize crop (*Zea mays*), which is the third most important cereal crop of world, is an important dual purpose crop used in human diet and animal feed. Maize has the potential to supply large amounts of energy-rich forage for animal diets and its fodder can safely be fed at all

stages of growth without any danger of oxalic acid, prussic acid as in case of *sorghum* (Dahmardeh *et al.*, 2009). Thus, forage maize has become a major constituent of ruminant rations in recent years, where its inclusion in dairy cow diets improves forage intake, increases animal performance and reduces production costs (Anil *et al.*, 2000; Cusicanqui and Lauer, 1999).

Cereal-legume intercropping plays an important role in subsistence food production in both developed and developing countries, especially in situations of limited water resources (Tsubo *et al.*, 2005). Yields of intercropping are often higher than in sole cropping systems. The reasons are mainly that resources such as water, light and nutrients can be utilized more effectively than in the respective sole cropping systems (Li *et al.*, 2001). A study by the Winrock Foundation estimated that forages provide more than 90% of the feed energy consumed by the herbivorous livestock of the world. Even in the developed countries of the temperate zone forages supply about 75% of the feed consumed by the

beef cattle and 60% of the feed consumed by dairy animals (Bula *et al.*, 1977). Forages are important in the world's food resources as plant materials containing high amounts of structured carbohydrates and their usefulness lies in utilization by ruminant animals. Ruminant is unique in having the potential for cycling forage materials, poor quality protein and non protein nitrogen sources into the human food supply as meat, egg and milk. Thus, management of forage crop production must be more regarded. Livestock nutritional resources are pastures, green fodder and forage crops. Although, concentrates have been used in the dairy cattle rations, forage crops perform an important role in energy and protein supply for livestock. Therefore, the objective of this study is to determine the effect of inorganic fertilizer (N,P,K) on forage yield and quality in the combination crop of maize and cowpea under the agro climates of West Bengal, India.

MATERIALS AND METHODS

Materials: The field experiment was conducted during kharif seasons of 2008 and 2009 where kharif crop was raised under rainfed condition to assess the forage yields of maize and cowpea under various intercropping systems. The experiment was conducted at Grass Land Research Station under State Fodder Production Cum Seed Multiplication Farm, Haringhata, Nadia, West Bengal. The Farm is situated at 23°N Latitude and 89°E Longitude with an altitude of 9.75 m above mean sea level (MSL) and comes under new alluvial zone West Bengal.

The soil of the experimental field was typical Gangetic alluvium (Entisol), sandy-loam in texture with good drainage facility. The physicochemical properties of the experimental soil have been summarized as coarse sand (6.67%), fine sand (37.50%), silt (34.20%), clay (21.63%). Soil pH is 6.5, total N, organic carbon, available P and available K was found to be 120.62, 0.59, 15.72, 152.87 kg ha⁻¹, respectively. The experiment was conducted in a sub-tropical humid climate with mild short winter and long hot humid summer. The summer temperature is not too high as well as the winter is not so intense. The seasons are broadly classified as: (1) Summer season, (2) Rainy season and (3) Winter season. Total rainfall during 2008 and 2009 was 1577.5 and 1200.4 mm. During the experimental period maximum and minimum temperatures ranged between 25.9-36.9 and 11.6-26.5°C during summer and winter in 2008 and 23.2-38.9°C and 10.0°-26.2°C during summer and winter in 2009, respectively. Maximum and minimum relative humidity ranged between 76.8-93.9 and 38.9-76.6% during 2008 and 2009.

Methods: The experiment was laid out in a randomized block design with six treatments and four replications. Each experiment was repeated twice with maize (cv. AT), cowpea (cv. EC 4216), during kharif (sowing date: 19.06 2008 and 28.06 2009) to study the forage quality and yield of maize intercropped with cowpea.

The experiments were conducted under natural field condition during kharif seasons to study the effect of N, P₂O₅, K₂O and intercropping system on growth and yield of green maize and cowpea on various competition function as well as economic analyses.

The treatments were T₁ Maize sole with 100:50:50 (N: P₂O₅: K₂O in kg ha⁻¹), T₂ Cowpea sole 20:60:40 (N: P₂O₅: K₂O in kg ha⁻¹), T₃ Maize+Cowpea (2:1) 100:50:50 (N: P₂O₅: K₂O in kg ha⁻¹), T₄ Maize+Cowpea (1:2) 20:60:40 (N: P₂O₅: K₂O in kg ha⁻¹) T₅ Maize+Cowpea (mixed) 100:50:50 (N: P₂O₅: K₂O in kg ha⁻¹), T₆ Cowpea+Maize (mixed) 20:60:40 (N: P₂O₅: K₂O in kg ha⁻¹). Maize and cowpea were sown as sole and different intercropping systems in kharif season. Maize was sown at 5 cm depth of soil and cowpea was sown at 3 cm depth and Maize+Cowpea (mixed) in broadcasting method. In intercropping of Maize and cowpea the row to row distance was 30 cm and the inter-row distance was 10 cm.

RESULTS AND DISCUSSION

Green forage production: The green forage yield of sole maize produced significantly higher yield of 62.1 ton ha⁻¹ in 2008 and 73.9 tonnes ha⁻¹ in 2009, with higher level of NPK (100:50:50) in both the years of 2008 and 2009 (Table 1). Increment on forage yield in maize by 60, 47 and 30% was observed compared with intercropping (1:2), mixed cropping and intercropping (2:1), respectively. Besides the highest green forage production was recorded in maize as a sole crop and in intercropping on 50 DAS. Cowpea, while grown as a sole crop, produced significantly higher yield of 26.00 ton ha⁻¹ in 2008 and 30.00 ton ha⁻¹ in 2009. The increased forage production in cowpea by 22, 20, 34% in 2008 and 40, 53,

Table 1: Effect of cropping systems on green forage production of maize and cowpea across the year 2008 and 2009

Cropping system	Green forage yield (ton ha ⁻¹)			
	Maize		Cowpea	
	2008	2009	2008	2009
Sole crop	62.1	73.9	26.0	30.0
Inter crop (2:1)	40.8	54.0	20.3	18.1
Inter crop (1:2)	37.5	43.2	21.9	20.4
Mixed crop*	52.3	47.8	18.6	25.8
Mixed crop**	56.0	56.2	22.1	28.2
SEM (±)	4.1	4.7	1.1	2.0
LSD (p = 0.05)	4.1	8.2	6.7	6.9

*NPK (100:50:50), **NPK (20:60:40)

21% in 2009, respectively was observed over intercropping (2:1), intercropping (1:2) and mixed cropping. Intercropping defined as the growing of two or more crop species simultaneously in the same field during a growing season is important for the development of sustainable food production systems particularly in cropping systems with limited external inputs. This may be due to some of the potential benefits for intercropping systems viz., high productivity and profitability. Improvement of soil fertility through the addition of nitrogen by fixation and excretion from the component legume, efficient use of resources, reducing damage caused by pests, diseases and weeds and improvement of forage quality through the complementary effects of two or more crops grown simultaneously on the same area of land (Bingol *et al.*, 2007; Lithourgidis *et al.*, 2006; Ross *et al.*, 2004). Intercropping of maize and cowpeas (*Vigna unguiculata*) is especially beneficial on nitrogen poor soils (Vesterager *et al.*, 2008). As cowpeas obtain the majority of their nitrogen from the atmosphere, they do not compete with maize for nitrogen in the soil.

The green as well as dry forage yields of maize+cowpea were significantly influenced with the increasing levels of nitrogen supply upto harvest during kharif seasons. This result was in agreement with the findings of several workers, all the intercropped maize+cowpea plots produced higher green forage as well as dry forage yields compared with their expected values. Trenbath (1979) postulated that when soil factors were non-limiting, the mixture of plant species of different heights having dissimilar canopy characteristics led to a advantage in terms of daily net photosynthesis. Mixed cropping is the practice of growing more than one crop in a field at a given time. Intercropping is the practice of growing more than one crop simultaneously in alternating rows of the same field (Beets, 1990). Intercropping is therefore a type of mixed cropping. Intercropping with maize in sub arid regions is a way to grow a staple crop while obtaining several benefits from the additional crop. The yield advantage of intercropped maize+cowpea noted in this investigation confirmed that postulation. The yield advantage of maize+cowpea in the intercropping system probably accrued from the differences in the timing of utilization of resources by the different crop species or from differences in exploitation of resources from different soil layers, especially during peak vegetative and reproductive stages of growth thus resulting from both temporal and spatial complementarity. Similar observation was made by several workers (Trenbath, 1974; Snaydon and Harris, 1979; Willey, 1979; Chatterjee and Mandal, 1992).

Dry matter accumulation of maize: The height and growth of the plant increased with the age of the plant in both the experimental years irrespective of any of the treatment. The results indicated significant variation on dry matter accumulation in maize for both sole as well as intercropped with cowpea at varying fertilizer doses during 2008 and 2009 (Table 2). The highest dry matter accumulation was recorded in maize as a sole crop (551.08, 558.65 g⁻²) followed by intercropping with cowpea (2:1) (340.9, 348.50 g⁻²) and mixed cropping and 1:2 ratio with NPK:20:60:40 (338.57, 381.42 g⁻²) during 2008 and 2009.

The DM accumulation at a particular stage of harvest depended on the supply of nutrients, water as well as inter-species and intra-species competitions. The forage yield of a species depends on the DM accumulation at any particular stage of harvest. The competition between the component crops was most complex when grasses used to be grown in mixtures with legumes. The relationship between the yield of DM unit⁻¹ area from a mixture of two forage species and that of the constituent species was studied by several workers. The importance of herbaceous forage legumes in increasing herbage production of grasses and quality of feed produced has been recognized in Kenya.

Dry matter accumulation of cowpea: Inclusion of a legume in fodder grass production would not only provide a nitrogen source to promote grass growth but enhance the quality of feed. Legumes benefit grasses by contributing nitrogen to the soil through atmospheric fixation, decay of dead root nodules and mineralization of shredded leaves. The height and growth of cowpea in intercropping (2:1) with (N, P₂O₅, K₂O 20:60:40) maize exhibited significant variations among the treatments on dry matter accumulation in both the years 2008 and 2009 (Table 3).

The highest dry matter accumulation was recorded in cowpea (320.95 and 322.88 g⁻²) as a intercrop

Table 2: Effect of nitrogen, phosphorus, potash and different system of cropping on dry matter accumulation of maize during kharif seasons of 2008 and 2009

Cropping system	Fertilizer dose (kg ha ⁻¹)			DMA (g ⁻²)	
	N	P ₂ O ₅	K ₂ O	2008	2009
Sole maize	100	50	50	551.08	558.65
M+C (2:1)	100	50	50	340.91	348.50
M+C (1:2)	20	60	40	308.55	381.42
M+C (Mixed)	100	50	50	316.74	276.39
M+C (Mixed)	20	60	40	338.57	244.12
SEm (±)				39.73	37.27
LSD (p = 0.05)				12.89	12.09

DMA: Dry matter accumulation, M: Maize, C: Cowpea

Table 3: Effect of nitrogen, phosphorus, potash and different cropping systems on dry matter accumulation of cowpea during kharif seasons of 2008 and 2009

Treatment	Fertilizer dose (kg ha ⁻¹)			DMA (g ⁻²)	
	N	P ₂ O ₅	K ₂ O	2008	2009
Sole cowpea	20	60	00.40	223.32	234.09
C+M (2:1)	20	60	00.40	320.95	322.32
C+M (1:2)	100	50	00.50	213.75	215.73
C+M (Mixed)	100	50	00.50	182.37	131.01
C+M (Mixed)	20	60	00.40	191.95	123.32
SEm (±)			17.45	17.66	
LSD (p = 0.05)			12.89	12.09	

DMA: Dry Matter Accumulation, M: Maize, C: Cowpea

Table 4: Effect on crude protein content of maize-based cropping system

Cropping system	Fertilizer dose (kg ha ⁻¹)			Crude protein (%)	
	N	P ₂ O ₅	K ₂ O	2008	2009
Sole maize	100	50	50	9.30	8.61
M+C (2:1)	100	50	50	8.12	7.44
M+C (1:2)	20	60	40	10.39	10.48
M+C (Mixed)	100	50	50	8.93	8.24
M+C (Mixed)	20	60	40	9.20	9.41
SEm (±)				0.33	0.29
LSD (p = 0.05)				2.86	2.84

M: Maize, C: Cowpea

(2:1) followed by sole cowpea (223.32 and 234.09 g⁻²) and in intercrop (1:2) with 100:50:50 (213.75 and 215.73 g⁻²) during 2008 and 2009, respectively. Cereals are widely used in livestock nutrition due to their high dry matter production and low cost and a number of cereals grown for forage e.g., maize, wheat and oats, have become of increased importance in the rations of ruminants animals (Leaver and Hill, 1992).

These types of cereal-based forages have the potential to supply large amount of energy for animals. Legumes are good source of protein and can be used to compensate cereal protein shortage (Gebrehiwet *et al.*, 1996). This may be due to some of the potential benefits for intercropping systems such as high productivity and profitability (Yildirim and Guvenc, 2005), improvement of soil fertility through the addition of nitrogen by fixation and excretion from the component legume (Haggard-Nelson *et al.*, 2001) and improvement of forage quality through the complementary effects of two or more crops grown simultaneously on the same area of land (Bingol *et al.*, 2007; Lithourgidis *et al.*, 2006; Ross *et al.*, 2004).

Proximate composition of crude protein: Fodder is productive during wet season and nutritive value is generally low and does not meet the animal production requirements throughout the year. It contains low to moderate Crude Protein (CP) content (6-12%) during the wet season, but declines to less than 5% during the dry

Table 5: Effect on crude protein content of cowpea-based cropping system

Cropping system	Fertilizer dose (kg ha ⁻¹)			Crude protein (%)	
	N	P ₂ O ₅	K ₂ O	2008	2009
Sole cowpea	20	0.60	0.40	9.50	8.53
C+M (2:1)	20	0.60	0.40	11.05	9.97
C+M (1:2)	100	0.50	0.50	8.60	8.05
C+M (Mixed)	100	0.50	0.50	9.22	8.54
C+M (Mixed)	20	0.60	0.40	9.57	8.11
SEm (±)		0.36	0.31		
LSD (p = 0.05)		2.94	2.45		

M: Maize, C: Cowpea

period. Below a critical level of 6-8% CP in cattle diet, digestibility and voluntary intake of forage are likely to be reduced (Humphreys, 1991). The major challenge is to overcome the inadequate quantity and quality of these cultivated fodders. Use of fertilizers to improve yield and commercial concentrates as livestock supplements to enhance nutritive value is limited due to inability of farmers to purchase them.

Forage dry matter can be divided into two fractions on the basis of nutritional availability. The first fraction corresponds to the cellular contents and is composed of lipids, soluble carbohydrates, most protein and other water-soluble matter. This fraction is essentially available but its digestibility appears incomplete because of the excretion of fecal non-cell-wall matter which is principally of endogenous and bacterial origin.

The crude protein content of different treatments of maize based intercropping indicated significant variability among the treatments (Table 4, 5). It has been reported that the digestibility of protein increases exponentially as the concentration of crude protein in forages increases (Santra *et al.*, 2008). The maximum crude protein content of maize+cowpea (1:2) are 10.39 and 10.48% during 2008 (Table 4), while cowpea+maize (2:1) indicated 11.05 and 9.97% during 2009 (Table 5) suggests intercropping of these treatments may have potential to increase forage digestibility.

CONCLUSION

It can be concluded that forage quality and yield of maize with cowpea which is intercropped proved to be much effective by maximizing the production. Higher green forage and dry forage yields are observed at all the intercropped plots. Effect of N,P,K and different cropping system was pronounced by increased dry matter accumulation of both maize and cowpea. Dry matter accumulations of maize and cowpea as intercrop are found to trigger the advancement of crop growth and are significantly influenced by increasing levels of nitrogen supply with systems of cropping during kharif seasons. Sole as well as all intercropped maize significantly

responded up to 100:50:50 kg N: P₂O₅: K₂O ha⁻¹. Considering the effect of crude protein on intercropping it is found that increase of crude protein in forage increases the digestibility of protein in animals. Therefore it can be inferred that maize-cowpea proves to be beneficial to overcome the inadequacy of both fodder quantity and quality through intercropping during rainy (kharif) season.

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REFERENCES

- Anil, L., J. Park and R.H. Phipps, 2000. The potential of forage-maize intercrops in ruminant nutrition. *Anim. Feed Sci. Technol.*, 86: 157-164.
- Beets, W.C., 1990. Raising and Sustaining Productivity of Smallholder Systems in the Tropics: A Handbook of Sustainable Agricultural Development. Agbe Publishing, Alkmaar, Netherlands.
- Bingol, N.T., M.A. Karsli, I.H. Yilmaz and D. Bolat, 2007. The effects of planting time and combination on the nutrient composition and digestible dry matter yield of four mixtures of vetch varieties intercropped with barley. *J. Vet. Anim. Sci.*, 31: 297-302.
- Bula, R.J., V.L. Letchtenberg and D.A. Halt, 1977. Potential of the world's forages for ruminant animal production. Winrock Report, Winrock International Livestock Research and Training Center, pp: 7-28.
- Chatterjee, B.N. and R.K. Mandal, 1992. Present trends in research on intercropping. *Indian J. Agric. Sci.*, 62: 507-518.
- Cusicanqui, J.A. and J.G. Lauer, 1999. Plant density and hybrid influence on corn forage yield and quality. *Agron. J.*, 91: 911-915.
- Dahmardeh, M., A. Ghanbari, B. Syasar and M. Ramroudi, 2009. Effect of intercropping maize (*Zeamays* L.) with cow pea (*Vigna unguiculata* L.) on green forage yield and quality evaluation. *Asian J. Plant Sci.*, 8: 235-239.
- Gebrehiwot, L., R.L. McGraw and G. Assefa, 1996. Forage yield and quality profile of three annual legumes in the tropical highlands of Ethiopia. *Trop. Agric.*, 73: 83-89.
- Haggard-Nelson, H., P. Ambus and E.S. Jensen, 2001. Inter-specific competition, nitrogen use and interference with weeds in pea-barley intercropping. *Field Crops Res.*, 7: 101-109.
- Humphreys, L.R., 1991. Tropical Pasture and Utilization. Cambridge University Press, London, UK.
- Kanwar, J.S., 1972. Cropping patterns, scope and concept. Proceedings of the Symposium on Cropping Patterns in India, January 27-31, 1968, New Delhi, India, pp: 11-38.
- Leaver, J.D. and J. Hill, 1992. Feeding Cattle on Whole-Crop Cereal. In: Whole-Crop Cereals, Stark, B.A. and J.M. Wilkinson (Eds.). 2nd Edn., Chalcombe Publication, Canterbury, UK., pp: 59-72.
- Li, L., J.H. Sun, F.S. Zhang, X.L. Li, S.C. Yang and Z. Rengel, 2001. Wheat/maize or wheat/soybean strip intercropping: I. Yield advantage and interspecific interactions on nutrients. *Field Crop Res.*, 71: 123-137.
- Lithourgidis, A.S., I.B. Vasilakoglou, K.V. Dhima, C.A. Dordas and M.D. Yiakoulaki, 2006. Forage yield and quality of common vetch mixtures with oat and triticale in two seeding ratios. *Field Crops Res.*, 99: 106-113.
- Ross, S.M., J.R. King, J.T. O'Donovan and D. Spaner, 2004. Intercropping berseem clover with barley and oat cultivars for forage. *Agron. J.*, 96: 1719-1729.
- Santra, A.K., S. Pan, A.K. Samanta, S. Das and S. Halder, 2008. Nutritional status of forage plants and their use by wild elephants in South West Bengal, India. *Trop. Ecol.*, 49: 251-257.
- Snaydon, R.W. and P.M. Harris, 1979. Interactions below-ground: The use of nutrients and water. Proceedings of the International Workshop on Intercropping, January 10-13, 1979, Hyderabad, India.
- Trenbath, B.R., 1974. Neighbour effects in the genus *Avena*. III. A diallel approach. *J. Applied Ecol.*, 12: 189-200.
- Trenbath, B.R., 1979. Leaf canopies and utilization of light use efficiency of crops and the potential for improvement through intercropping. Proceedings of the International Workshop on Intercropping, January 10-13, 1979, Hyderabad, India, pp: 141-154.
- Tsubo, M., S. Walker and H.O. Ogindo, 2005. A simulation model of cereal-legume intercropping systems for semi-arid regions: I. Model development. *Field Crops Res.*, 93: 10-22.
- Vesterager, J.M., N.E. Nielsen and H. Hogh-Jensen, 2008. Effects of cropping history and phosphorus source on yield and nitrogen fixation in sole and intercropped cowpea-maize systems. *Nutrient Cycling Agroecosystems*, 80: 61-73.
- Wiley, R.W., 1979. Intercropping its importance and research needs. Part I. Competition and yield advantage. *Field Crops Abst.*, 32: 1-10.
- Yildirim, E. and I. Guvenc, 2005. Intercropping based on cauliflower: more productive, profitable and highly sustainable. *Eur. J. Agron.*, 22: 11-18.