

Effect of maize-based intercropping system on nutrient uptake and yield of crops in southern transitional zone of Karnataka

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ABSTRACT

A field experiment was conducted during Kharif season of 2013 at Zonal Agricultural Research Station, VC Farm, Mandya to study the effect of maize-based intercropping system on nutrient uptake and yield of crops in southern transitional zone of Karnataka. Treatments consisted of sole crops and different row proportions of maize + intercrops (pigeon pea, soybean and field bean). Intercropping increased total N, P and K uptake enhancing grain and stover/haulm yield of maize and intercrops. Among intercropping systems highest total nutrient uptake of maize was recorded in T₄ (Paired-row maize with pigeon pea at 45/75 cm spacing, 126.93, 30.28 and 120.93 kg/ha NPK respectively) as compared to T₁₀ (Sole maize, 102.77, 22.73 and 96.97 kg/ha NPK respectively) being on par with all other treatments except T₃ (Paired-row maize intercropped with field bean at 30/90 cm spacing) and T₉ (Maize + field bean, 1:1). Among intercropped pulses pigeon pea recorded higher nutrient uptake followed by field bean and soybean. The combined effect of paired-row maize with pigeon pea at 45/75 cm spacing recorded the highest kernel (8539 kg/ha) and stover (7831 kg/ha) yield.

Keywords: Maize; intercropping; nutrient uptake; yield; pigeon pea, soybean; field bean

INTRODUCTION

The main objective of intercropping is to improve the productivity per unit land area per unit time with equitable and judicious utilization of land resources and farming inputs including labour without reducing base crop yield (Marer et al 2007). Research on intercropping has revealed how niche differences in crop species can escort to resource capture and conversion of available resources leading to augmented biological efficiency and yield improvement (Hussain et al 2003). Available growth resources such as light, water and nutrients are more completely absorbed and converted to crop biomass by the intercrop because of differences in competitive ability for growth factors between intercrop components. Introduction of high yielding and thermo-insensitive hybrids of maize (*Zea mays* L) has made its cultivation well adapted to different seasons. Inter-row space in maize during the initial slow growth period provides ample scope to cultivate the compatible crops in between two rows of

maize and increase the productivity per unit area and time because of its wider row spacing and plasticity of the crop to row spacing.

Legumes in maize-based cropping systems are considered to be better alternatives for securing nitrogen economy and increasing yield of maize besides bonus yield, greater productivity per unit time and space and higher net returns of intercropping system over monoculture (Seran and Brintha 2010) due to their differential rooting habit, differential growth, demand for resources and complementary interactions as brought by nitrogen fixation of legumes since legumes add enormous organic biomass (leaf, nodules, roots etc). Kamanga et al (2010) reported that maize-legume intercropping was a more productive system and less risky technology. Among legume-cereal intercropping system the combination of maize + pigeon pea was highly suitable with a minimum competition for nutrients (Ghosh et al 2007). Farmers' fields were noticed to have the highest amount of vegetative biomass when

legume crops were intercropped with maize (Amos et al 2012) and efforts have been made to identify suitable intercropping in maize for various agro-climatic zones of Karnataka.

MATERIAL and METHODS

A field experiment was conducted at Zonal Agricultural Research Station, VC Farm, Mandya, Karnataka during Kharif 2013 which is situated between 11° 30' to 13° 05' North latitude and 76° 05' to 77° 45' East longitude with an altitude of 695 meters amsl. It falls under the Region III and southern dry zone of Karnataka (Zone VI). The soil of experimental site was sandy loam in texture, neutral in soil reaction (6.85) with low in organic carbon content (0.45%) and available nitrogen (245.56 kg/ha) but medium in available phosphorus (28.92 kg/ha) and potassium (173.27 kg/ha). The experiment was laid out in a randomized complete block design with thirteen treatments replicated thrice. Treatments comprised T₁ (Paired-row maize intercropped with pigeon pea at 30/90 cm spacing), T₂ (Paired-row maize intercropped with soybean at 30/90 cm spacing), T₃ (Paired-row maize intercropped with field bean at 30/90 cm spacing), T₄ (Paired-row maize intercropped with pigeon pea at 45/75 cm spacing), T₅ (Paired-row maize intercropped with soybean at 45/75 cm spacing), T₆ (Paired-row maize intercropped with field bean at 45/75 cm spacing), T₇ (Maize + pigeon pea, 2:1), T₈ (Maize + soybean, 1:1), T₉ (Maize + field bean, 1:1), T₁₀ (Sole maize), T₁₁ (Sole pigeon pea), T₁₂ (Sole soybean), T₁₃ (Sole field bean). Out of thirteen treatments statistical analysis was done only from T₁ to T₁₀ excluding T₁₁, T₁₂ and T₁₃ and hybrids/varieties used were HEMA (NAH 1137) of maize, BRG-2 of pigeon pea, JS-335 of soybean and HA-4 of field bean which were sown in August 2013 as per the treatments. Farm yard manure was applied at the rate of 10 tonnes/ha to each plot three weeks prior to sowing. The recommended doses of fertilizers for maize (150 kg N, 75 kg P₂O₅ and 40 kg K₂O/ha), pigeon pea (25 kg N, 50 kg P₂O₅ and 25 kg K₂O/ha), soybean (30 kg N, 80 kg P₂O₅ and 38 kg K₂O/ha) and field bean (25 kg N, 50 kg P₂O₅ and 25 kg K₂O/ha) were applied in the form of urea, single super phosphate and muriate of potash as basal dose. In case of maize 50 per cent of N was applied as basal and remaining (75 kg/ha) as top dressing at 40 days after sowing (DAS). In case of intercropping treatments, fertilizers were applied in proportionate to the sole optimum population for main and intercrops separately. The other management operations were

done as per recommended package of practices for both main and intercrops. Growth and yield parameters were recorded as per standard procedures. The oven-dried plant samples at harvest were chopped and ground in Wiley mill and were analysed for N, P₂O₅ and K₂O by following standard methods. The nutrient values were expressed as percentage on dry weight basis and were computed to kg/ha. The data obtained from yield and nutrient uptake were subjected to statistical analysis as described by Gomez and Gomez (1984).

RESULTS and DISCUSSION

Nutrients uptake by maize and intercrops was influenced by the combination and proportion of intercropping (Table 1). Paired-row maize with pigeon pea at 45/75 cm spacing (T₄) recorded highest total nutrient uptake (135.37, 37.47 and 129.37 kg/ha, NPK respectively) of maize as compared to sole maize (T₁₀) (102.77, 22.73 and 96.97 kg/ha NPK respectively). Except paired-row maize intercropped with field bean at 30/90 cm spacing (T₃) and maize + field bean (1:1) (T₇) treatments all other treatments viz T₁: Paired-row maize intercropped with pigeon pea at 30/90 cm spacing, T₂: Paired-row maize intercropped with soybean at 30/90 cm spacing, T₅: Paired-row maize intercropped with soybean at 45/75 cm spacing, T₆: Paired-row maize intercropped with field bean at 45/75 cm spacing, T₈: Maize + soybean (1:1) and T₉: Maize + field bean (1:1) were on par with each other. Among intercropped pulses all the treatments with pigeon pea expressed higher nutrient uptake as compared to treatments with field bean and soybean.

Such higher uptake might be due to the better availability and supply of N by the leguminous crops intercropped with maize. Like uptake of N uptake of P and K showed a similar trend. Intercropping with legumes might have caused the wide range of microbes of plant rhizosphere to mobilize the inherent P and K and nutrients increasing their availability and uptake by plants and by addition of organic matter in the form of leaf litter by legume components. The use of high quality plant residues would ensure timely nutrient release for enhanced crop uptake. Legumes produce the high quality residues and therefore offer a low cost opportunity for maintaining soil fertility by contributing nutrients during decomposition (Baijukya 2004) and improving soil organic matter and soil physical properties (Mureithi et al 2005). Dahmardeh et al (2009) reported that maize-cowpea intercropping

Table 1. Effect of spacing and intercrops in maize-based paired-row intercropping system on uptake of total nitrogen, phosphorous and potassium by the crops

Treatment	Nutrient uptake (kg/ha)					
	Maize			Intercrop		
	N	P	K	N	P	K
T ₁ : PR-PP (30/90 cm)	131.56	33.80	125.56	43.55	8.96	28.07
T ₂ : PR-SB (30/90 cm)	129.72	32.48	123.72	39.25	12.2	28.24
T ₃ : PR-FB (30/90 cm)	111.33	24.10	103.15	41.98	7.11	34.61
T ₄ : PR-PP (45/75 cm)	135.37	37.47	129.37	47.08	10.91	31.50
T ₅ : PR-SB (45/75 cm)	124.84	28.88	118.84	37.59	11.18	25.40
T ₆ : PR-FB (45/75 cm)	119.51	28.77	110.24	43.97	8.95	38.31
T ₇ : Maize + pigeon pea (2:1)	126.93	30.28	120.93	40.48	8.18	27.94
T ₈ : Maize + soybean (1:1)	122.56	28.97	115.90	35.48	9.36	23.13
T ₉ : Maize + field bean (1:1)	105.80	23.19	99.78	39.36	7.05	32.66
T ₁₀ : Sole maize	102.77	22.73	96.97	-	-	-
T ₁₁ : Sole pigeon pea	-	-	-	57.97	13.79	41.76
T ₁₂ : Sole soybean	-	-	-	45.69	17.55	33.06
T ₁₃ : Sole field bean	-	-	-	54.71	11.19	43.88
SEm±	6.96	2.99	5.46	NA	NA	NA
CD _{0.05}	20.69	8.88	16.13	-	-	-

PR-PP= Paired-row maize intercropped with pigeon pea, PR-SB= Paired-row maize intercropped with soybean, PR-FB= Paired-row maize intercropped with field bean, NA= Not analysed

increases the amount of nitrogen, phosphorous and potassium compared to monocrops of maize.

Improvement of nutrient uptake due to organic manures was reported by Cooperband et al (2002). An earlier study also revealed greater nutrient absorption in the maize-legume intercropping system than the sole maize (Chalka and Nepalia 2006). Intercropping maize with legumes had a synergetic effect and suppressed weed growth which increased the uptake of N, P and K (Katsaruware and Manyanhaire 2009, Eskandari and Ghanbari 2010).

Kernel and stover yields of maize were favourably influenced by maize-based intercropping system (Table 2). Paired-row maize with pigeon pea at 45/75 cm spacing recorded significantly higher kernel yield (8539 kg/ha) and was on par with paired-row maize with pigeon pea at 30/90 cm spacing (8008 kg/ha), paired-row maize with soybean at 30/90 cm spacing (7977 kg/ha) and maize + pigeon pea at 2:1 row ratio (7720 kg/ha). Lower kernel yield was recorded in paired-row maize with pigeon pea at 30/90 cm spacing (6156 kg/ha). Higher stover yield was

recorded in paired-row maize with pigeon pea at 45/75 cm spacing (7831 kg/ha) as compared to sole maize (6419 kg/ha). Among intercropped pulses respective sole stand treatments viz T₁₁ (Sole pigeon pea), T₁₂ (Sole soybean) and T₁₃ (Sole field bean) recorded higher grain yield (861, 1159 and 1192 kg/ha respectively) and haulm yield (2415, 1706 and 2588 kg/ha respectively). This may be due to added higher growth, yield attributes and nutrient uptake along with better utilization of the available resources (Mandal et al 2014). The presence of pigeon pea in the paired-row system probably had more synergistic effect and thereby maize crop in association with pigeon pea in paired row system reported comparable yield due to their differential maturation time adding to better utilization of area and time. Row arrangement in contrast to arrangement of component crops within rows may also influence the productivity of an intercropping system (Oseni and Aliyu 2010). The most probable reason for production of greater yield in an intercropping system is the addition of N in the soil from biological nitrogen fixation (BNF) (Khogali et al 2011), better utilization of available growth resources (water, nutrients, light and air) (Li et al 2003), better

Table 2. Yield of maize and component crops as influenced by spacing and intercrops in maize-based paired-row intercropping system

Treatment	Maize kernel yield (kg/ha)	Maize stover yield (kg/ha)	Intercrop yield (kg/ha)	Intercrop haulm yield (kg/ha)
T ₁ : PR-PP (30/90 cm)	8008	7293	385	1243
T ₂ : PR-SB (30/90 cm)	7977	7127	768	954
T ₃ : PR-FB (30/90 cm)	6156	5506	229	561
T ₄ : PR-PP (45/75 cm)	8539	7831	489	1495
T ₅ : PR-SB (45/75 cm)	7025	7610	630	812
T ₆ : PR-FB (45/75 cm)	6578	7673	276	649
T ₇ : Maize + pigeon pea (2:1)	7720	7085	311	1000
T ₈ : Maize + soybean (1:1)	6842	6631	600	772
T ₉ : Maize + field bean (1:1)	6727	6503	190	493
T ₁₀ : Sole maize	6656	6419	—	493
T ₁₁ : Sole pigeon pea	—	—	861	2415
T ₁₂ : Sole soybean	—	—	1159	1706
T ₁₃ : Sole field bean	—	—	1192	2588
SEm±	423.81	440.14	NA	NA
CD _{0.05}	1259.20	1307.73	-	-

PR-PP= Paired-row maize intercropped with pigeon pea, PR-SB= Paired-row maize intercropped with soybean, PR-FB= Paired-row maize intercropped with field bean, NA= Not analysed

use of available piece of land (Singh and Kalidindi 2003) and inter-specific interactions and facilitation of the component crops (Zhang and Li 2003, Fan et al 2006).

CONCLUSION

The present investigation revealed that based on the performance of maize under maize-based intercropping system pigeon pea would be the best combination with more productive and remunerative option when planted in 45/75 cm spaced paired-rows of maize in southern dry zone of Karnataka. Maize + soybean combination was the next best system followed by maize + field bean. Same trend was obtained in the nutrient uptake.

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