

Original Research Article

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Effects of Different Doses of Fertilizer on Growth and Yield Attributes in Inter Cropping of Citronella (*Cymbopogon winterianus* L.)+Maize (*Zea mays* L.) and Bajra (*Pennisetum typhoides* L.)

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ABSTRACT

In India, farming ranges from small to very large farms. Different farmers thus have more or less land, money and access to information and technologies. Intercropping is an excellent technique to increase total yield, higher monetary return, greater resource utilization, risk management and to fulfill the diversified need of the farmers. The present study was carried out to check the effect of different doses [sole citronella, sole maize, sole Bajra, citronella + maize (100%RDF), citronella + maize (75%RDF), citronella + maize (50%RDF), citronella + Bajra (100%RDF), citronella + Bajra (75%RDF) and citronella + Bajra (50%RDF)] of fertilizer on growth attribute and yield attribute. Experiment results showed that citronella sole cropping was found to be better than citronella intercropping system with maize and Bajra in same proportions (100%, 75% and 50% RDF) in respect to the growth, yield attributes herbage and oil yields of citronella. Maize sole was found to be better in respect of growth parameters (plant population, plant height at 30, 60 DAS and harvesting stage, fresh weight of cobs and dry weight of cobs), yield parameters (number of cobs/plant, length of cobs, number of kernel row/cob, number of kernel/cob and girth of cob) and yields (grain and biological) over all other citronella + maize 100% RDF, 75%RDF and 50%RDF intercropping system in plant population proportions. Bajra sole stand was found to be better in respect of growth parameters (plant population, plant height and number of tiller/plant), yield parameters (day to 50% ear emergence, length, girth and weight of panicle) and yields (grain and biological) over all other citronella + Bajra (2:3) intercropping system in 100%, 75% and 50% RDF plant population proportions.

Keywords

Fertilizer, Growth and yield attributes, Citronella, Maize, Bajra

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Introduction

Agriculture is said to be a risk profession in India, since natural factor like temperature, precipitation and pest epidemics influences crop yield and the economic fate of the farmer. Intercropping has reducing risk and also proved beneficial under adverse climatic conditions. Oil of citronella grass is one of the essential oil obtain from different species of aromatic grasses. Citronella oil is a raw material for production of geraniol, citronellal, Hydroxyl citronella and other similarly high value perfumery bases. It is also widely used as a starting material for various aromatic chemicals used in scented soaps, sprays, deodorants, detergent, polishes, mosquito repellents etc. Maize, the Queen of cereals contains about 10% protein, 4% oil, 70% carbohydrates, 2.3% crude fibre, 10.4% albuminoids and 1-4% ash. Besides, maize grains also contains significant quantity of Vitamin A, nicotine acid, riboflavin and Vitamin E. Maize is fairly high in phosphorus and maize protein, *zein* is deficient in tryptophan and lysine, the two essential amino acids. It is capable of utilizing solar radiation due to its large sized leaves and has the highest photosynthetic rate. Bajra (*Penisetum typhoides*) is grown in around 40 countries around the world. Majorbajra producing countries are Senegal, Mali, Nigeria, Sudan, China and Uganda etc. Bajra is the fifth most important cereal crop in India. It is most important food crop mostly grown in semi-arid regions, particularly in the north-western part of the country. In India, it is grown on an area of 7.9 m ha, produces 9.18 mt with an average productivity of 11.64 q/ha Rajasthan, Uttar Pradesh, Gujarat and Haryana contribute about 87 per cent of the total area and about 73.5 per cent of the total production comes from these states In Uttar Pradesh bajra occupies an area of about 9.41 lakh ha of which about 95 per cent is under rainfed area and Mathura, Agra, Bulandshar, Aligarh and

Farrukhabad are the important Bajra growing district (Directorate of economics and statistics and crop insurance Govt. of Uttar Pradesh 2014-15).

Materials and Methods

Experimental site

The experiment was laid out in the well-established experiment in the field No. 03 at Student Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) India during *kharif* season 2015. The farm is located in the main campus of university. The field was well levelled having good irrigation and drainage facilities. The stubble of previous crop and weeds were removed from the field by manual practice.

Results and Discussion

Observations recorded during experiment

In order to determine the effect of different treatments, a number of observations on growth characters, yield contributing characters and yield of crops (Herbs, grain, cobs etc.) oil content through oil distillation, weed population were recorded at different stages of crop growth. Since it was not possible to study the all characters in individual plants, 5 sample plants from main and intercrops of each treatment were selected randomly and tagged for further study. All the observations taken are categorized into the following groups.

In Sole and Intercrop plots, Citronella root slips were transplanted at 60 × 60 cm. to maintain the 2:2 row ratio. After survival of plant, plant population was studies individual in each plot. The plant population of maize and Bajra was recorded after thinning at harvest stage. The height of plants was

measured in cm from ground level to the top portion of the plants. The number of tillers in all the 05 plants was counted and the average number of tillers/plant was worked out, mean values was expressed on plant basis. Leaf length of citronella, was recorded from the selected 05 plant in each treatment and average value was computed as final leaf length. The number of cobs/plant of maize were recorded by counting cobs in 5 sample plants and made average to obtain the cobs/plant. Cob length and girth was measured from three randomly selected cobs from sample plants. Cob length from sample plant was measured to get average length of one cob in cm. Girth of cob was also measured from centre of cobs and average girth of cob is mentioned in cm. Total cobs from the sample plants were weighed and mean values were recorded for weight/cob in gram. The grain rows of five randomly selected cobs were counted and the mean values were recorded for number of grains rows/cob. To count number of grains/cob five randomly selected cobs from the sample plants were collected and grains were separated through shelling by manual labour and counted. Length and Width of panicle (cm) was measured from five randomly selected panicle for sample plants. Panicle length of Bajra from sample plant was measured to get average length of cm. width of panicle was also measured from centre of panicle and average width of panicle is mentioned in cm. A random sample was taken from the produce of each plot after drying and cleaning. 1000 grains of Bajra were separated from each sample and weighed. The 1000-seed weight was recorded and expressed in grams (gm). The weight of fully dried plants including cobs weight of each treatment plots were recorded and expressed as biological yield and converted in to quintal/ha. After shelling and winnowing, Grain yield of maize and Bajra was on net plot basis was recorded and finally, yield was converted in to quintal per hectare. Herbage yield & distillation of citronella, the

leaves are ready for harvest about 5-6 months after planting, and are cut with the help of sickle at 20 cm above the ground level. The second and subsequent harvests can be taken thereafter at 2.5-3.0 months interval during the experiment period one harvesting was done. Distillation was done by the process of steam distillation. The distillation equipment consists of a boiler in which steam is produced, a distillation tub for distilling the grass, a condenser and separators.

Data presented in Table 1 showed that the significantly lowest number of tillers/ plant, leaf length and Herbage yield were recorded in the 50% RDF of Citronella + Maize and Citronella + Bajra intercropping system. Among the intercropping and citronella sole treatment the maximum leaf length(76.00cm) recorded in citronella + bajra 100% RDF intercropping system which were at par with citronella sole, C+M 100% RDF, C+B 75% RDF and C+M 75% RDF these was significant difference. The number of tillers per plant was highest in C+M and C+B 100% RDF ie.85.50/plant followed by Citronella sole and 75% RDF of both systems was not difference significantly. Significantly maximum herbage yield was found in citronella sole (88.50 q/ha) in comparison to all other treatment of intercropping. Among the intercropping system significantly highest herbage yield (69.50 q/ha) recorded in C+M gave the maximum number of tiller(85.50), Leaf length (76.00cm) and herbage yield of citronella sole (88.50q/ha) 1 00% RDF followed by C+B 100% RDF(65.75q/ha) and C+ B 75% RDF (65.50q/ha). The table 3 indicated that yield reduction of citronella is from 21 to 33% with 50% reduced plant population of citronella. Results indicate that different cropping systems were found to exhibit significantly variations in Citronella equivalent oil yield. Over all The significantly the highest Citronella equivalent oil yield was found in citronella sole system ie.87.5 0

liter/ha among the intercropping system significantly highest equivalent oil yield was found in C+M with 100% RDF followed by C+B 100% RDF. After 100% RDF, 75% RDF place second in position in both crops i.e. C+M and C+B respectively. Significantly lowest equivalent oil yield was noted in C+B50% RDF (59.25liter/ha) and C+M 0%RDF (53.75liter/ha).The cropping systems significantly affected the growth attributes (plant population/ plots, Leaf length (cm) and number of tillers/plants) at the cutting time. The higher growth performance in sole crop as compared to intercropping system has also been observed by Maheshwari *et al.*, (1998), Ram *et al.*, (2000), Patra *et al.*, (1990), Ansari *et al.*, (2014), Ansari *et al.*, (2015) and Srivastava *et al.*, (2016). It is also clear from the result that next to Citronella sole, C+M (100% RDF) row ratio treatment was also recorded significantly superior in the characters like Leaf length (cm) at the cutting time and number of tillers at the cutting time over all the treatments and at par with C+M (75% RDF) and C+B (75% RDF) row ratio treatment in cutting. The intercrop was affected due to the presence of inter and intra-specific competition between main crop and the intercrop (Maize, Bajra) for growth resources such as nutrients, moisture and solar radiation due to change in crop geometry as compared to sole crop. The results of the present investigation are in close conformity with the findings of Patra *et al.*, (1990) and Ansari *et al.*, (2014). Sole citronella significantly recorded higher values for herbage yields than their intercropping with Maize and Bajra. This may be due to optimum spacing available for the plants. The higher growth performance in sole crop as compared to intercropping system has also been observed by Patra *et al.*, (1990) and Ansari *et al.*, (2014). The intercrop was affected due to the presence of inter and intra-specific competition between main crop and the intercrop (Maize and Bajra) for growth

resources such as nutrients, moisture and solar radiation due to change in crop geometry as compared to sole crop. The results of the present investigation are in close conformity with the findings of Shersingh *et al.*, (2008).

The data recorded regarding plant height at 30, 60 DAS and harvesting stage were recorded, analyzed and presented in Table 2. Data presented in table 2 showed that the highest plant height recorded (66.75 cm) in Bajra sole system at 30 DAS, which is significantly highest in comparison to C+M and C+B 75% RDF, C+M and C+B 50% RDF but at par with Maize sole and 100% RDF of C+M and C+B respectively. Highest plant height 145.50cm and 176.25 cm recorded at 60 DAS harvesting stage is at par with 100% RDF of C+M and Bajra sole but it is significantly higher among the intercropping system of 75% and 50%RDF of C+M and C+B system of intercropping.

Data regarding that the plant population and Days to 50% ear emergence and test weight was recorded, analyzed and presented in Table 3. The highest Plant population (23.50) was recorded in sole bajra followed by citronella + bajra inter cropping with 100 % RDF and days to 50% ear emergence of bajra (56%) in C:B (100%RDF).The minimum plant population(23.00) and Days to 50% ear emergence(50.00) in C:B (50%RDF). The data recorded regarding Number of tiller per plant at 30DAS, 60 DAS and girth of plant at 60 DAS were recorded and analyzed presented in Table 4. There was non-significant difference among the treatment in relation to tillers and girth of plant. Numerically the highest Number of tillers/plant (3.00) and (3.75) recorded at 30 and 60 DAS in bajra sole treatment, respectively. The lowest Number of tiller 2.00 and 2.25 was recorded in C+B50%RDF treatment at 30 and 60 DAS, respectively. The highest Girth of plant was recorded at 60DAS (6.00) cm in bajra sole and followed by C:B 100% RDF

treatment and the lowest (4.25cm) in C:B, 50 % RDF treatment.

The data regarding the length of cob, girth of cob, number of kernel per cob and No. of cob pre pant were recorded, analyses and presented in Table 5. Data showed that the highest length of cob(17.75 cm), Girth of cob(17.25 cm), Number of kernel (14.50) per row and No. of cob per plant (1.75) were observed in Maize sole treatment which was significantly better overall other treatments but at par with citronella:Maize with 100%RDF.The lowest length of cob(14.75 cm) Girth of cob(14.00 cm), number of kernel/row (12.25) and no. of cob per plant (1.25) were observed in C:M2:2 row ratio with 50%RDF.

The data regarding fresh weight and, dry weight of cob and number of kernel per cob were recorded analyzed and presented in table 5. Data showed that the highest significantly fresh weight (147.50g), dry weight (133.50g) and number of kernel / cob(366.75)was recorded in maize sole treatment followed by citronella:Maize 100%RDF which was significantly superior over 75% and 50%RDF treatment. The lowest fresh weight (139.25g), dry weight (124.25g) and number of kernel (354.00) per row of cob recorded inC+M50%RDF in treatment. Data recorded regarding biological yield and grain yield were recorded analyzed, presented in Table 5. Data represented in table 5 showed that sole cropping of maize gave significantly highest biological yield (233.95q/ha) and grain yield (44.02q/ha), over all other treatments. Among the intercropping treatment citronella+Maize with 100% RDF gave the highest biological (124.47q/ha) and grain yield (23.85q/ha) is significantly highest intercropping to 75 and 50% RDF.

The lowest biological yield (118.02q/ha) and grain yield (17.40q/ha) were recorded in

citronella + Maize with 50%RDF treatments. Application of 100%, 75% and 50% RDF produced 54.18, 46.16 and 39.52% grain yield to that sole maize crop, respectively, while the plant population of maize of 50% to that of its sole cropping. The plant population recorded was non- significant but highest plant population recorded in Maize sole followed by 2:2 row ratio of Citronella + Maize with 100% RDF intercropping system. Growth parameters of maize were significantly influenced due to various combinations of cropping systems. The plant height recorded at 30, 60 DAS and harvesting stage significantly higher values with maize sole followed by C+M(2:2) with 100% RDF and C+M 75% RDF. Numerically the highest plant population (11.25/m²) has been recorded in sole Maize there was no significant difference among the treatment but at par with C+M 100%RDF followed the 75%RDF.

The highest length of cob (17.75 cm), Girth of cob (17.25 cm), Number of kernel (14.50) per row and No. of cob per plant (1.75) were observed in Maize sole treatment which was significantly better overall other treatments but at par with citronella+Maize with 100%RDF. The lowest length of cob (14.75 cm) Girth of cob (14.00 cm), number of kernel /row (12.25) and no. of cob per plant (1.25) were observed in C+M (2:2) with 50%RDF.Intercropping system. This could be attributed due to the dissimilar conditions of plant growth and development for maize in sole cropping as compared to intercropping system, Similar findings were also reported by (Adhikari *et al.*, 2005; Mayaka *et al.*, (2006), Marer *et al.*, 2007). While, the number of cob/plant, length of cob and number of kernel row/cob was not influenced significantly by various types of cropping combination of maize with citronella. Sole cropping of maize gave significantly highest biological yield (233.95q/ha) and grain yield (44.02q/ha), over all other treatments.

Table.1 Effect of the treatments on plant leaf length, number of tillers and herbage and equivalent oil yield of citronella

Treatments	Leaf length (cm)	Number of tillers/plant	Herbage yield (q/ha)	Equivalent Oil yield (Lha ⁻¹)
Citronella Sole	75.50	84.25	88.50	87.50
C:M(100%RDF)	75.50	85.50	69.50	68.25
C:M(75%RDF)	74.50	83.50	65.50	60.75
C:M(50%RDF)	72.50	79.50	59.50	59.75
C:B(100%RDF)	76.00	85.50	65.75	65.50
C:B (75%RDF)	75.50	83.25	61.00	60.00
C:B(50%RDF)	70.50	80.50	59.50	59.25
SEm±	0.573	0.733	1.512	0.612
CD(p=0.05)	1.705	2.180	4.494	1.819

Table.2 Effect of different treatments on plant height at 30, 60 and harvesting stage of maize and Bajra

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At Harvesting
Maize sole	65.75	145.50	176.25
Bajra sole	66.75	144.50	175.75
C:M (100%RDF)	65.50	145.00	176.00
C:M (75%RDF)	64.00	143.25	173.50
C:M (50%RDF)	62.50	140.50	170.75
C:B (100%RDF)	66.25	144.25	175.50
C:B (75%RDF)	64.25	141.75	172.50
C:B (50%RDF)	62.75	139.00	170.75
SEm±	0.611	0.467	0.569
CD (P = 0.05%)	1.798	1.375	1.675

Table.3 Effect of different treatments on plant population and days to 50% ear emergence of Bajra

Treatments	Plant population	No of tillers/plant	Girth of plant at 60 DAS	Days to 50%ear emergence of bajra
Bajra Sole	23.50	3.75	6.00	54.75
C:B(100%RDF)	23.25	3.50	5.75	56.00
C:B (75%RDF)	23.00	3.00	5.00	53.50
C:B (50%RDF)	23.00	2.25	4.25	50.00
SEm±	0.375	0.322	0.372	0.746
CD (P = 0.05%)	1.199	1.032	1.192	2.388

Table.4 Effect of different treatments on Length of cob in (cm), Girth of cob in (cm), total number of kernel/row of cob and No. of cob/plant in Maize

Treatments	Length of cob (cm)	Girth of cob (cm)	Number of row and cob/plant of maize	
			kernel/row of cob	cob/plant
Maize Sole	17.75	17.25	14.50	1.50
C:M (100%RDF)	17.25	17.00	14.25	1.75
C:M (75%RDF)	15.75	14.50	13.00	1.50
C:M (50%RDF)	14.75	14.00	12.25	1.25
SEm±	0.433	0.314	0.333	0.288
CD (P = 0.05%)	1.385	1.006	1.066	NS

Table.5 Effect of different treatments on fresh weight of cob (gm.), dry weight of cob (gm.), and number of kernel/cob of maize

Treatments	Fresh weight of cob(gm)	Dry weight of cob (gm)	Number of kernel/cob	Biological yield (q/ha)	Grain yield (q/ha)
Maize Sole	147.50	133.50	366.75	233.95	44.02
C:M (100%RDF)	143.50	128.50	362.00	124.47	23.85
C:M (75%RDF)	140.75	125.75	359.50	121.02	20.32
C:M (50%RDF)	139.25	124.25	354.00	118.02	17.40
SEm±	0.645	0.677	0.842	14.271	0.530
CD (P = 0.05%)	2.065	2.165	2.695	45.656	1.697

Table.6 Effect of different treatments on Length of panicle (cm), Width of panicle (cm), Harvest index and Test weight of Bajra

Treatments	Panicle Length (cm)	Width of panicle (cm)	Test weight (g)	Biological yield (q/ha)	Grain yield (q/ha)	Harvest index (%)
Bajra Sole	25.50	18.50	12.00	170.10	35.50	20.87
C:B (100%RDF)	24.50	17.50	12.00	72.70	19.30	26.54
C:B (75%RDF)	22.50	16.00	10.00	69.75	17.95	25.73
C:B (50%RDF)	20.75	15.25	9.00	68.27	17.50	25.63
SEm±	0.554	0.747	0.50	0.568	0.264	0.123
CD (P = 0.05%)	1.773	6.289	NS	1.818	0.846	0.394

Among the intercropping treatment citronella + Maize with 100% RDF gave the highest biological (124.47q/ha) and grain yield (23.85q/ha) is significantly highest intercropping to C+M 75% and C+M 50% RDF. The lowest biological yield

(118.02q/ha) and grain yield (17.40q/ha) were recorded in citronella + Maize with 50% RDF treatments. Similar results also reported by Bhagat (2002), Myaka *et al.*, (2006) and Ansari *et al.*, (2014).

Data regarding length of panicle, width of panicle, Test weight and harvesting index were recorded, analyzed and presented in table 6. Numerically the highest length of panicle (25.50cm) width of panicle (18.50cm) were recorded in bajra sole treatment and harvest index (26.54%) were recorded in bajra 100 %RDF treatment which followed by C:B75 % RDF but the lowest length of panicle (20.75cm) width of panicle (15.25cm) were recorded in C:B 50% RDF in treatment and minimum harvest index (20.87%) in Bajra sole. There was no significant difference in test weight among the treatments. Data regarding that biological yield (qha^{-1}) and grain yield (qha^{-1}) were recorded, analyzed and presented in Table 6. The highest biological yield(170.10 q/ha) and grain yield (35.50 q/ha) was recorded in Bajra sole treatment which were significantly superior over all treatment Among the intercropping combination significantly of C+B with 100% RDF were superior over 50% RDF. Application of 100, 75 and 50% RDF produced 54.37, 50.56 and 49.30% grain yield of bajra to 100% of sole crop respectively. The plant population recorded was non-significant but the highest plant population recorded in Bajra sole followed by of Citronella + Bajra (2:3) 100% RDF intercropping system. Growth parameters of bajra were significantly influenced due to various combinations of cropping systems. The growth parameters viz., plant height (cm). The highest significantly plant height C+B (2:3) was recorded in sole bajra (66.75cm) followed by C+B (2:3) 100% RDF (66.25) which was significantly higher over all other combinations of RDF treatment intercropping system and number of tiller per plant differ non-significantly this was might be due to competitive environment between main crop and the intercrop in respect of growth resources such as moisture, solar radiation and nutrient owing to differential growth habit of base (citronella) and intercrop

(Bajra) are in agreement with the present investigation. Cropping system significantly affected yield attributes of Bajra viz., length of panicle, girth of panicle and grain yield. Difference in yield of base crop and intercrop is due to different fertilizer doses proportions and row ratio. The test weight did not influence by cropping system. It is thus obvious that the conditions for growth and development of Bajra in intercropping and solid stand were identical being of different growth habit (canopy, height, growth duration etc.) could not put any competition for citronella. This was also reflected in the growth attributes of citronella. Thus the growth behaviour of the crop performed in a similar way for development activities of plants was reflected in yield attributes and yields of Bajra. Kurlekar *et al.*, (1980), Desale *et al.*, (2000), Chellamuthu (2000) and Velayudham *et al.*, (2011).

On the basis of experimental result conducted during *kharif* season (2015) following conclusion can be done. Citronella sole cropping was found to be better than citronella intercropping system with maize and Bajra in same proportions (100%, 75%, and 50% RDF) in respect to the growth, yield attributes herbage and oil yields of citronella. Maize sole was found to be better in respect of growth parameters (plant population, plant height at 30, 60 DAS and harvesting stage, fresh weight of cobs and dry weight of cobs), yield parameters (number of cobs/plant, length of cobs, number of kernel row/cob, number of kernel/cob and girth of cob) and yields (grain and biological) over all other sole Maize, citronella + maize 100% RDF, 75%RDF and 50%RDF intercropping system in plant population proportions. Bajra sole stand was found to be better in respect of growth parameters (plant population, plant height and number of tiller/plant), yield parameters (day to 50% ear emergence, length, girth and weight of panicle) and yields

(grain and biological) over all other citronella + Bajra (2:3) intercropping system in 100%, 75% and 50% RDF plant population proportions. In combination of citronella + Maize 100% RDF intercropping system is better than all other suitable combination citronella + Bajra intercropping system, respectively. Intercropping of *kharif* crop with citronella, the highest citronella equivalent oil yield was found in citronella+ maize 100% RDF followed by 75% and 50% RDF system, respectively.

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