



Effect Of Cropping Pattern on Growth, Yield Attributes and System Productivity of Citronella (*Citronella Winterianus*) Intercropping with Mustard in Central U. P.

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ABSTRACT

A field experiment was conducted during Rabi season, 2011-12 at students Instructional Farm (SIF), Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during 2011-12 to study the Effect of cropping pattern on growth, yield attributes and system productivity of citronella (*Citronella winterianus* L.) intercropping with mustard in Central U.P. The experiment was laid out in randomized block design with different combination. Cultivation of citronella sole crop was superior over sole Mustard as well as their intercropping system adopting in different row pattern. There was significant superiority in growth, yield attributes and yield of sole cropping as compared to their intercropping. On an average significantly higher herbage yield of (87.08 q/ha) was recorded in citronella sole cropping followed by 1:2 row ratio of citronella + Mustard crop. However, the citronella sole cropping gave significantly highest citronella equivalent oil yield and net returns than other cropping systems. The higher B: C ratio was recorded under citronella sole (12.63) higher, intercropping system citronella: Mustard 2:2 row ratio (3.00) than other cropping systems. The higher LER values in citronella: Mustard intercropping 1.04, clearly indicate advantage over their sole stand. Citronella sole recorded the highest crop profitability.

KEYWORDS

Citronella, Cropping system, Land equivalent ratio, Mustard and System productivity

INTRODUCTION: Citronella (*Citronella winterianus* L.) oil is one of the major essential oils. It has a rose like odour and bitter taste. It is mainly used in the perfumery and cosmetic industry. Citronella oil is a raw material for production of geraniol, citronellal, hydroxy-citronellal and other similar high value perfumery bases. It is also widely used as a starting material for various aromatic chemicals used in scented soaps, sprays, deodorants, detergents, polishes, mosquito repellents etc. The essential oil bearing plants are playing a major role in commercial production of aromatic oils making India a major partner in the world scenario. It has become a profitable business in agricultural produce and post harvesting processing industry. Presently, India's position in world market is at top in the production of mints, grasses, spices, exotic flowers, roots and woody oil etc. At present 300 to 500 tons of oil is produced in India for the last 6 to 8 years in the state of Assam, Karnataka, Maharashtra, Tamil Nadu, West Bengal, and Uttar Pradesh. According to FFDC (Fragrance and flavour of development Centre, Govt. of India, kannauj 2009-2010) the demand of citronella oil is 620 tonnes per year but the production 480 tonnes per year in India. The country facing deficit of 140 tonnes oil per year. It would be justified to accept that inter cropping system will attract increasing attention to overcome ecological constraints.

The consumption of edible oils is rising continuously, outstripping the domestic production resulting in huge imports. During 2011-12, the country imported about 9.2 million tonnes of edible oils which was about half of its domestic requirement. Edible oil demand is projected to reach 16.64 million tonnes by the terminal year (2016-17) of the XII plan. This would require 59 million tonnes of oilseeds production provided the proportion of different oilseeds remains constant in

the coming years. Production of oilseeds during 2011-12 was 29.80 million tonnes which was slightly less than the 32.48 million tonnes recorded in 2010- 11. Oilseed cultivation is undertaken across the country in about 26 million ha on marginal lands, dependent on monsoon rains, nearly 72% of area under oilseeds is rainfed and with low levels of input usage. Mustard (*Brassica juncea* L.) is a very important *Rabi* oil seed crop of our country. In India it is grown in an area of about 5.9 million hectare, with total oil seed production is about 6.8 million tonnes and productivity 1152 kg ha⁻¹ during the year 2011-12. Madhya Pradesh is a largest oil seeds producing state, while Uttar Pradesh has largest *Rabi* oilseed producing state. (Anonymous, 2012). The annual per capita consumption of vegetable oils increased from 2.5 kg in 1955-56 to 9.81 kg in 1999-2000 while it will reach up to 16 kg in 2015 (The Hindu Survey of Indian Agriculture, 2012). In Uttar Pradesh, the area, production and productivity of Mustard are 0.88 million hectare, 0.99 million tonnes and 1123 kg ha⁻¹ respectively (Anonymous, 2012).

MATERIALS AND METHODS

The experiment was laid out in field No. 03 at Student Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) India during *Kharif* and *Rabi* season 2011 and 2011-12, respectively. The farm is located in the main campus of university. The experiment was laid out in randomized block design with different combination [sole citronella, sole Mustard, (2:1), citronella + Mustard (1:2), citronella + Mustard (2:2) and citronella + Mustard (2:4)] each replicated thrice.

The university is situated in indo-gangetic alluvial tract of Central Plain Zone of U.P. that is come in agro-climatic zone-V. In

order to determine the physico-chemical characteristics and fertility status of experimental field, the soil samples were collected randomly from the six places of the field to the depth of 0-15 cm with the help of soil sugar prior to fertilizer application. The soil samples of all the places were mixed together to form a composite sample for mechanical and chemical analysis. The soil analysis was done in the department of agronomy in this university.

Geographically, Kanpur is situated in subtropical region. It is situated at an elevation of 125.9 meter above mean sea level, 26020° 35°North latitude and 80018°35° East longitudes. It is situated in the alluvial belt of indo-gangetic plain in the Central Part of Uttar Pradesh, which comes into Agro-climatic zone-V. Normally the climate of the area is semi-arid with hot dry summer and moderate to severe cold during winter. The average annual precipitation of the area varies from 800 to 900 mm with a mean annual precipitation of about 818 mm, mainly through monsoon rains confined within June to last week of September with occasional frost and shower in winter season from North-East monsoon during December and January.

The number of harvests, which can be taken during a year, depends upon the growth of the plants. The leaves are ready for first harvest, about 5- 6 months after planting 20 cm above the ground level. The second and subsequent harvests can be taken thereafter at 3-4 months interval. Distillation was done by the process of steam distillation. The distillations equipment consists of a boiler in which steam is produced, a distillation tub for distilling the grass, a condenser and 2-3 separators.

Land equivalent ratio is the relative land area under sole crops i.e. required to produce the yield achieved in inter cropping. In the present experiment the LER was estimated by following formula /equations.

$$LER = \frac{\text{Yield of citronella in intercropping}}{\text{Yield of citronella in sole cropping}} + \frac{\text{Yield of Mustard in intercropping}}{\text{Yield of Mustard in sole cropping}}$$

Yield of citronella in sole cropping +

Yield of Mustard in intercropping

Yield of Mustard in sole cropping

RESULTS AND DISCUSSION

Effect of cropping system on citronella:-The cropping systems significantly affected the growth attributes (plant height and number of tillers/m row length) at 60 DAS and 120 DAS (Table1) in the experimentation. This may be due to optimum spacing available for the plants in sole cropping as compared to other combinations of cropping systems. Such higher growth performance in sole crop as compared to intercropping system has also been observed by Patra *et al.* (2005). It is also clear from the result that next to citronella sole, C:Mu (2:1) row ratio treatment was also recorded significantly superior in the characters like plant height at 60 and 120 DAS and number of tillers at 60 DAS over all the treatments and at par with C:Mu (1:1). The intercrop was affected due to the presence of inter and intra-specific competition between main crop and the intercrop (Mustard) 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.* (2005). The Highest herbage yield 98.50 q/ha was recorded in citronella sole which was significantly superior over rest of the treatments followed by 2:2 row ratio of citronella + Mustard 67.09 q/ha in (Table-2). 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.* (2005). The intercrop was affected due to the presence of inter and intra-specific competition between main crop and the intercrop (Mustard) 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 Sher *et al.* (2008).

Table 1 Effect of intercropping system on plant height, number of tillers and Herbage yield of citronella

Treatment	Plant height at harvest stage (cm)	Number of tillers at harvest stage	Herbage yield (qha ⁻¹)
Citronella sole	77.02	87.08	98.50
C:Mu (1:2)	74.05	87.02	51.45
C:Mu (2:2)	75.38	85.51	67.09
C:Mu (2:4)	75.04	85.82	50.85
SEm±	0.71	0.339	0.53
CD (P=0.05)	2.12	1.01	1.58

Effect of cropping system on Mustard :-The final plant population recorded at harvest stage significantly highest in sole stand of Mustard followed by 2:2 and 1:2 row ratio of citronella + Mustard intercropping system. Growth attributes (plant height and number of branches/plant) of Mustard were significantly influenced due to the cropping systems and highest under sole cropping at 60 DAS, and maturity stages of crop growth (Table 2) the plant height of Mustard was significantly higher in citronella + Mustard intercropping (2:2) at 60 DAS, and maturity stages of crop growth (Table 2). The highest values of growth and yield attributing characters (siliqua/plant and grains/siliqua as well as

Table 2 Effect of intercropping system on growth attributes of Mustard.

Treatment	Plant population m ⁻²		Plant height (cm)		Number of branch	
	Initial	Harvest	60 DAS	Maturity	Primary	Secondary
Mustard sole	8.50	7.85	97.84	138.70	6.50	12.50
C:Mu (1:2)	7.78	7.25	96.67	137.49	6.25	12.00
C:Mu (2:2)	8.20	7.75	96.90	140.16	6.75	13.50
C:Mu (2:4)	8.00	7.00	95.89	138.29	5.75	11.00
SEm±	0.44	0.44	0.37	0.40	0.29	0.60
CD (P=0.05)	NS	NS	1.22	1.30	NS	NS

the yields of Mustard were recorded under sole cropping as compared to intercropped in various combinations with citronella in (Table 3). However, in the yield attributes better under citronella + Mustard intercropping (2:2) (Table 3). This may be due to optimum spacing available for the plants such higher growth performance in sole crops as compared to intercropped ones has also been observed by Singh and Jadhav (2003). There was a general reduction in the plant population of Mustard and branching at later stages due to inter and intra-specific competitions under intercropping system. It might have occurred due to the presence of dominant competition between main crop and the intercrop (Mustard) because of vigorous growth of citronella and profuse branching and spreading nature of Mustard (Myaka *et al.* 2006). This could be attributed to the dissimilar conditions of plant growth and development of Mustard as was also evident in growth attributes (plant height, branches/plant and siliqua/plant). Such conditions increased the competition among plants for nutrients, soil moisture and sunlight resources (Ansari *et al.* 2012). The results of the present investigation are in close conformity with the findings of Marer *et al.* (2007) and Ghosh *et al.* (2009). Cropping systems had significant effect on grain,

stalk and biological yield of Mustard. The highest biological yield, grain yield and Stover yield was recorded in Mustard sole which was significantly superior to all other treatment in the experimentation. The harvest index has been recorded non-significant difference. Similar observations were also made by Ansari *et al.* (2014). Citronella + Mustard (2:2) intercropping system fetched higher net returns as well as B: C ratio over sole and other combinations due to more combined yield. This might be due to beneficial effect of intercropping system which resulted more in Mustard, equivalent yield as compared to either of the sole crops and combinations. Similar results were reported by Sharma *et al.* (2010).

Table 3 Effect of intercropping system on yield attributes and yields of mustard.

Treatment	Number of siliqua plant ⁻¹	Number of grain siliqua ⁻¹	Test weight (g)	Biological yield (qha ⁻¹)	Grain yield (qha ⁻¹)	Straw yield (qha ⁻¹)	Harvest index
Mustard sole	184.50	12.50	3.99	77.95	19.37	58.57	24.85
C:Mu (1:2)	183.50	12.00	4.00	40.45	10.08	30.36	24.98
C:Mu (2:2)	186.50	13.00	4.01	27.54	6.98	20.55	25.36
C:Mu (2:4)	183.50	12.00	3.96	41.25	10.53	31.53	24.85
SEm±	0.61	0.52	0.01	0.40	0.12	0.47	0.40
CD (P=0.05)	1.98	NS	NS	1.31	0.39	1.32	NS

Effect of cropping system on system productivity and economics: Citronella sole cropping system fetched higher net returns as well as B: C ratio over intercrops. Among intercropping system, citronella + mustard intercropping system gave higher economic profit. This might be due to beneficial effect of intercropping system which resulted more in Mustard equivalent yield as compared to either of the sole crops and combinations. Intercropping systems showed improvement in citronella equivalent oil yield (CEOY) (Table 4), net returns and B: C ratio (Table4). The citronella sole cropping system gave significantly the highest citronella equivalent oil yield, net returns and B: C ratio followed by citronella + Mustard (2:2) and citronella + Mustard (1:2) intercropping system than other cropping systems. Citronella sole system on an average fetched (212813.00) followed by citronella: Mustard (2:2) (5644.16) net returns (Table 4). The higher B: C ratio was recorded under citronella sole (12.63) followed by citronella: Mustard (2:2) (3.00) compare to other cropping systems. The results are in accordance with the findings of Saikia *et al.* (2006). Similar results were reported by Sharma *et al.* (2010). It was due to similar citronella oil yield under intercropping system as that of its sole stand, and additional yield of Mus-

tard as a bonus in intercropping system. The results are in accordance with the findings of Saikia *et al.* (2006).

Effect of cropping system on land equivalent ratio: The LER value in intercropping system indicated yield advantage over sole stand due to better land utilization. The higher LER values in intercropping, i.e.1.02 to 1.04 clearly indicate 2 to 4% advantage over their sole stand (Table 4). The results are in accordance with the Ghosh *et al.* (2009).

CONCLUSION: Thus results of the present investigation clearly demonstrate that citronella sole cropping followed by Mustard + citronella intercropping system (2:2) can be practiced to achieve better high yield as well as B: C ratio than other cropping system in sandy loam soils of central U.P.

Table-4 Effect of cropping system on Citronella oil equivalent yield, net returns, B: C ratio and land equivalent ratio

Treatment	CEOYqha ⁻¹	Net returns (Rs.ha ⁻¹)	B:C ratio	LER
Citronella sole	241.74	212813.00	12.63*	1.00
Mustard sole	61.16	38988.50	2.03	1.00
C:Mu (1:2)	79.93	52237.37	2.67	1.04
C:Mu (2:2)	79.05	5644.16	3.00	1.00
C:Mu (2:4)	74.56	51287.37	2.62	1.02
SEm±	0.47	-	-	-
CD (P=0.05)	1.37	-	-	-

*Highest B: C ratio of citronella because Kharif season planted in intercropping of kharif maize after harvesting sown in Rabi season intercropping with mustard.

REFERENCES

- Ansari M A, Rana K S, Ansari M H, Baishya L K, Babu Subhash, Das, Anup and Hari Om. (2014). Effect of transpiration suppressants and nutrients under rainfed conditions: An integral view on crop productivity and biological indices in millet/ pulses intercropping system. African Journal of Agricultural Research 9(3): 334-44. Ansari M A and Rana K S. (2012). Effect of transpiration suppressants and nutrients on productivity and moisture use efficiency of pearl millet (*Pennisetum glaucum* L.) - pigeonpea (*Cajanus cajan* L.) intercropping system under rainfed conditions. Indian Journal of Agricultural Sciences 82(8): 676-80. Ghosh P K, Tripathi A K M, Bandyopadhyay K K and Manna M C. (2009). Assessment of nutrient competition and nutrient requirement in soybean/sorghum intercropping system. European Journal of Agronomy 31(209): 43-50. Marer S B, Lingaraju B S and Shashidhara G B. (2007). Productivity and economics of maize and pigeonpea intercropping under rainfed conditions in northern transitional zone of Karnataka. Karnataka Journal of Agricultural Science 20(1): 1-3. Myaka F M, Sakala W D, Adu-Gyamfi J J, Kamalongo D, Ngwira A, Odgaard R, Nielsen N E and Jensen H H. (2006). Yields and accumulations of N and P in farmer-managed intercrops of maize-pigeonpea in semi-arid Africa. Plant and Soil 285: 207-20. Patra D D, Sukhmal Chand, Lal R K, Bahl J R and Khanuja, S P S. (2005). Agro-packages for cultivation of palmarosa (*Cymbopogon martinii* var. motia). Journal of Medicinal and Aromatic Plant Sciences 27 (4): 727-35. Saikia R C, Sarma Aniruddha, Sarma T C and Baruah P K. (2006). Comparative study of essential oils from leaf and inflorescence of java citronella (*Cymbopogon winterianus* Jowitt). Journal of Essential Oil-Bearing Plants 9(1) 85-7. Sharma Arjun, Rathod P S and Basavaraj K. (2010). Agronomic management of pigeonpea (*Cajanus cajan*)-based intercropping systems for improving productivity under rainfed conditions. Karnataka Journal of Agricultural Science 23(4): 570-4. Sharma A, Rathod P S and Basavaraj K. (2010). Agronomic management of pigeonpea (*Cajanus cajan*) based intercropping systems for improving productivity under rainfed conditions. Karnataka Journal of Agricultural Science 23(4): 570-4. Sheoran Parvender, Virender Sardana, Sukhvinder Singh and Bharat Bhushan. (2010). Bio-economic evaluation of rainfed maize (*Zea mays*)-based intercropping systems with blackgram (*Vigna mungo*) under different spatial arrangements. Indian Journal of Agricultural Sciences 80 (3): 244-7. Singh, Sher, Yadav, Om Narayan, Chauhan R K, Lohani N K H. (2008). Effect of different planting geometry on growth, yield and quality of citronella [*Cymbopogon winterianus* (Jowitt)]. Journal of Medicinal and Aromatic Plant Sciences 30(3): 267-9. Singh P K and Jadhav A S. (2003). Intercropping of sorghum with pigeonpea, groundnut and soybean under varying planting geometry. Indian Journal of Dryland Agricultural Research and Development 18(2): 126-9. The Hindu, Survey of Indian Agriculture (2011) a. Increase production rapidly. p 41.